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A Prospective Study of the Impact of Current Poverty, History of Poverty, and Exiting Poverty on Accumulation of Disease Damage in SLE

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Abstract

Objective—To estimate the effect of current poverty, number of years in poverty, and exiting poverty on disease damage accumulation in SLE.

Methods—783 persons with SLE were followed from 2003–2015 through annual structured interviews. Respondents were categorized in each year by whether they were in households 125% of the Federal Poverty Level. Linear and logistic regression were used to assess the impact of poverty in 2009, number of years in poverty between 2003 and 2009, and permanent exits from poverty as of 2009 on extent of disease damage or accumulation of a clinically meaningful increase in disease damage by 2015.

Results—After adjustment for sociodemographics, health care characteristics and health behaviors, poverty in 2009 was associated with an increased level of accumulated damage in 2015 (0.62 points, 95% CI 0.25–0.98) and increased odds of a clinically important increase in damage (OR 1.67, 95% CI 0.98–2.85). Being poor in every year between 2003 and 2009 was associated with greater damage (2.45, 95% CI 1.88, 3.01) than being poor half of years or more (1.45, 95% CI 0.97, 1.93), fewer than half of years (1.49, 95% CI 1.10, 1.88), or no years (1.34, 95% CI 1.20, 1.50). Those exiting poverty permanently had similar increases in damage (1.30, 95% CI 0.90, 1.69) as those who were never in poverty (1.36, 95% CI 1.23, 1.50) but much less damage than those who remained in poverty (1.98, 95% CI 1.59, 2.38).

Conclusion—The effect of current poverty, dose of poverty, and exiting poverty suggest a critical role of poverty in accumulated SLE damage.

Despite many years of research showing the effect of poverty on disease outcomes and mortality in general^{1,2} and in systemic lupus erythematosus (SLE) or other autoimmune conditions specifically^{3–6}, our understanding of the reasons behind these effects is limited. It is not yet established whether it is poverty per se or factors associated with poverty that account for its effects. Such factors include inadequate access to health care and lower quality of care^{7–9}, harmful health behaviors, residual effects of long-term poverty on human

capital (the combination of formal training, skills, and experience) to deal with disease^{10,11}, or immediate effects of such phenomena as exposure to adverse neighborhoods, stress, and economic deprivation^{12,13}.

The present paper reports on the results of a longitudinal study of persons with SLE that evaluated the extent to which the relationship between poverty and outcomes meets criteria for causal plausibility in observational studies and then tested several hypotheses about why the poor experience dramatically poorer outcomes including stress, economic deprivation, adverse neighborhood circumstances, depression, and cognitive impairment.

In this study, we evaluate the impact of poverty at one point, the impact of the number of years in poverty, and the effect of permanently exiting poverty on the extent of subsequent damage accumulation in SLE.

Methods

Data Source

The data source for the research is the Lupus Outcomes Study (LOS)¹⁴. 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, their medical records were reviewed by rheumatologists or nurses working under a rheumatologist's supervision. The sampling outside of tertiary care centers permitted us to evaluate a wide range of kinds and quality of care for SLE, including a range of specialties assuming primary responsibility for the care of SLE and the extent of health insurance coverage.

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 activity¹⁵ and accumulated damage (Brief Index of Lupus Damage or BILD)¹⁶, assessments of cognitive status and mood^{17,18}; 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; quality of SLE care²¹; assessment of the nature of interactions between patients and providers and health systems^{22,23}; health behaviors including height and weight and smoking history using items from the Behavioral Risk Factor Surveillance System²⁴, a record of health insurance coverage based on items from the Medical Expenditures Panel Survey²⁵; the Perceived Stress Scale²⁶, extent of economic deprivation such as food, housing, and medical care insecurity²⁷ and standard demographic measures.

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 was chosen because it is the cutoff for eligibility

for several Federal programs and because many of the LOS respondents live in expensive areas of the country.

Contextual information about the area surrounding the participants' residential addresses was matched via geocoding to survey data from the American Community Survey at various levels of geographic aggregation. Most of the contextual information was added at the level of the Census block group, encompassing between 600 and 3,000 individuals in the immediate neighborhood. The data included the proportion of neighbors in poverty, median income, median earnings, home ownership rates, and racial composition²⁸. Information on income inequality from the Census data was at the level of the county of the LOS participants²⁹. Because of its relationship to personal poverty, the principal contextual measure was whether the neighborhood was an area of concentrated poverty which could exacerbate the effect of personal poverty. For the analyses reported below, areas of concentrated poverty were those in which at least 30 percent of individuals met the Federal poverty standard defined above.

Analyses

The goal of treatment in lupus is to reduce the frequency and magnitude of flares in disease activity and to reduce the subsequent accrual of damage to organ systems³⁰. Prior studies of lupus outcomes required periodic access to specialists to assess activity and damage which both precluded annual measurement and limited studies to participants with some ongoing contact with research centers. In contrast, the present study developed and validated measures of accumulated disease damage and quality of care based on patient report and validated a previously developed measure of disease activity^{16,21,31}. These were all available as of the 2009 interview. Accordingly, here we assess the impact of sets of variables previously hypothesized to affect long-term outcomes of SLE and measured in 2009 or earlier on change in the BILD damage score by the 2015 interviews. The principal independent variables included poverty status in 2009 and poverty status since the inception of the LOS through 2009; the latter permits the estimation of the impact of episodic versus permanent poverty as well as the effect of permanently leaving poverty.

We began by developing a base model of outcomes incorporating poverty status and sociodemographics (age, gender, education, race/ethnicity, and marital status), health behaviors (smoking status and body mass index), health care characteristics (number of physician visits, managed care vs. fee-for-service sector, provider specialty mix treating lupus, and whether or not lupus care met a standard of high quality, defined as a pass rate of 85% or greater on the validated quality indicator set for lupus)³².

We then tested various mitigating circumstances that might reduce or exacerbate the impact of poverty on outcomes, including the persistence of poverty and residence in an area of concentrated poverty as well as other characteristics of the community, as outlined above. We also assessed whether the impact of income on outcomes continued throughout the income distribution or, instead, was limited to those in the lowest tiers of income. In additional analyses, we focused on whether higher education levels, a proxy for human capital, can offset the impact of poverty-level incomes; whether intergenerational socioeconomic status as measured by parental education worsened the effect of current

poverty; the extent to which current stress as measured by the Perceived Stress Scale²⁶ accounted for the effect of poverty; and whether exiting poverty had a beneficial impact on outcomes. Poverty may be associated with receipt of substandard care, which could result in greater accumulation of SLE damage. Accordingly in sensitivity analyses we also evaluated the impact of three different regimens involving the use of prednisone: prednisone monotherapy defined as 7.5mg/day for three months or more in the prior year in the absence of other immunosuppressive medications; prednisone use of at least 10mg/day for three months or more in this period; and prednisone use of 20mg/day for three months or more in the period.

We then assessed the conjoint impact of the level of perceived stress, social support, cognitive function, and depressed mood on outcomes beyond the economic, demographic, and health characteristics outlined above. In addition, we assessed whether tangible measures of economic deprivation such as food, housing, and medical care insecurity expected in the ensuing two-month period after the annual interview had effects beyond that of the generalized measure of stress. On a community level, we also evaluated the incremental effect of the number of friends and family available to provide tangible social support³³ to mitigate the effects of living in areas of concentrated poverty.

We used ordinary least squares regression to estimate the impact of poverty and other characteristics on change in the extent of accumulated damage between 2009 and 2015. We also analyzed the impact of poverty on whether a minimally clinically important difference (MCID) in damage had occurred. In the BILD damage measure, the MCID was defined as two points or greater based on the ability to predict an elevated risk of subsequent mortality³⁴. Logistic regression was used to estimate the impact of poverty and covariates on the probability of a change of at least a MCID in newly accumulated damage.

In 2009, there were 849 respondents to the LOS survey who had been interviewed continuously since 2003. Of these, 67 had died by 2015 (7.9%) and were excluded from the present analysis. Of the remaining 782, 643 (82.2%) were interviewed continuously between 2009 and 2015, 36 (4.7%) were lost to follow-up between 2009 and 2015, and 103 (13.2%) declined to continue in the study during this time frame. Among the 643, 97 (15.1%) had a missing value on one of the principal variables in the analysis.

To account for the impact of the attrition due to loss to follow up, lack of participation, or item non-response, we used multiple imputation with chained equations to model missing values, based on 15 replications³⁵⁻³⁷. We report the results based on the use of multiple imputation, but in no instance were the results substantially different in direction or magnitude from analyses among those interviewed continuously through 2015. As a sensitivity analysis, we included those who were deceased by 2015 in analyses completed with multiple imputation. As expected, including the deceased strengthened the relationship between poverty and accumulated damage because those who subsequently died were both more likely to have been poor and, prior to death, to have experienced a higher level of accumulated damage. The results reported below, however, are based on the primary analyses excluding those who died as of 2015.

In addition to the foregoing estimations, we evaluated whether there were statistically significant interactions between poverty and select other characteristics, including living in an area of concentrated poverty, cognitive impairment, extent of depressive symptomatology, and level of perceived stress. Despite those in poverty having more adverse levels on each of these variables, the only one for which the interaction with poverty status was statistically significant, and thus the only one reported in the main text, was living in an area of concentrated poverty.

Several of the mechanisms proposed, for example, having depressive symptoms, cognitive impairment, high levels of perceived stress, or low technical quality of care could be said to mediate the impact of poverty on the outcomes. Accordingly, we formally tested whether the impact of poverty on the outcomes was direct or operated through the proposed mechanisms^{38–40}. In no instance did the proposed mediating variables account for more than a quarter of the variance in outcomes associated with poverty, even though the mediating variables were significantly related to the outcomes, indicating that lack of statistical power did not account for the small effect of the variables on the outcomes. Finally, we assessed the impact of community characteristics other than concentrated poverty, but none of these other characteristics had a substantial effect on outcomes.

Results

The LOS participants were 49.8 years old on average and had had lupus for an average of 16.9 years (Table 1), 94% were females and 37% were members of racial/ethnic minority groups. About 15 percent of the LOS participants met the study definition of poverty. About 8 percent lived in areas of concentrated poverty and 8 percent reported extreme difficulty living on their incomes.

Those in poverty reported higher disease activity levels, accumulated damage, poorer overall quality of life as measured by SF-36 physical and mental component scores, higher (worse) CESD scores, and higher levels of cognitive impairment as measured by the Hopkins Delayed Recall Test z-score. LOS participants in poverty were much more likely to report high levels of perceived stress and slightly smaller social networks.

Table 2 reports the results for accumulated damage between 2009 and 2015 by poverty status, with and without adjustment. Change in disease damage, at 1.43 was substantial, representing about a 75 percent increment over the 2009 value of 1.9. Persons in poverty experienced substantially greater accrual of disease damage between 2009 and 2015 than those not in poverty: 0.68 (95% CI 0.34, 1.02) before adjustment and 0.62 (95% CI 0.25, 0.98) after adjustment.

The table also compares the groups in the proportion who experienced at least a minimally clinically important difference (MCID) in the BILD, defined as a 2-point increment. On both an unadjusted and adjusted basis, those in poverty had a higher likelihood of an MCID in BILD (unadjusted OR 1.71, 95% CI 1.11, 2.67; adjusted OR 1.67, 95% CI 0.98, 2.85).

Living in an area of concentrated poverty accentuated the effect of personal poverty on the extent of accrued damage (Table 3). Personal-level poverty was associated with damage

accrual regardless of residential area, but the poor living in areas of concentrated poverty accrued far more damage than the poor not living in such areas (after adjustment, 2.71 points, 95% CI 1.93, 3.49). In contrast, there was no effect of the racial composition of the local community, the median level of household income and earnings, and inequality of local income on damage accrual (data not shown).

Table 3 also shows that the level of damage accrual was proportional to the “dose” of poverty prior to 2009, with the persistence of poverty having a significant effect on level of damage accrual. Thus, with and without adjustment, those who were never poor prior to 2009 experienced less damage accrual than those who were episodically poor who, in turn, experienced less damage accrual than those who were always poor. LOS participants reporting household incomes up to \$40,000 per year had significantly higher levels of damage accrual than those with higher incomes. Beyond \$40,000 a year, however, damage accrual did not differ by level of income, suggesting a ceiling effect.

In Table 4, we investigate several mechanisms that could account for the impact of poverty on damage accrual starting with the education of LOS participants and that of their parents. We found no difference in damage accrual between those in poverty who had at least some college and those with a high school education or less, both of whom experienced higher levels of damage accrual than the non-poor. We also observed no difference in accrued damage between the poor whose parents had at least some college versus those whose parents had a high school education or less, with both groups having higher levels of damage accrual than those not in poverty.

In both unadjusted and adjusted analyses, persons who were never in poverty, with average levels of newly accumulated damage of 1.36 (95% CI 1.23, 1.50), were similar in damage accrual to all those who left poverty (1.30, 95% CI 0.90, 1.69), in contrast to those who remained in poverty, with average levels of accumulated damage of 1.98 (95% CI 1.59, 2.38). Persons who left poverty as little as a year before the 2009 baseline interview experienced a level of damage accrual very similar to those who were never in poverty.

To evaluate the extent to which those who were destined to leave poverty differed from those who remained poor, we compared their baseline damage scores. The two groups did not differ significantly or substantially in baseline damage scores, suggesting that any selection bias in those who subsequently were to leave poverty was minimal (data not shown).

In sensitivity analyses, we evaluated the differential impact of prednisone usage between the poor and non-poor. The poor were significantly more likely than the non-poor to receive prednisone of at least 7mg/day for three months or more in the absence of any other immune suppressive agents in the prior year (3.8 vs. 1.5%, $p < .01$), to receive 10mg/day for three months or more in this period (20.3 vs. 6.9%, $p < .01$), and to receive 20mg/day for three months or more in the period (7.6 vs. 2.4%, $p < .01$). Each of the prednisone regimens was associated with a significantly greater amount of accumulated damage. However, the regimens did not have a significant or substantial impact on the effect of poverty on accumulated damage (data on the effect of the regimens not in tables).

Potential mechanisms for the effect of poverty on accumulated damage include the level of perceived stress, extent of cognitive impairment, and presence of symptoms of depression. Each of these phenomena was significantly associated with accrued damage in unadjusted and adjusted models that included poverty status (data not in table). However, the combined effect of all these potential mechanisms, reduced the impact of poverty on damage by about 43 percent, from 0.68 to 0.39 (Figure 1), but still left a residual effect of poverty. Adding the measure of personal economic deprivation, the report of having extreme difficulty living on one's income, had little effect beyond the more encompassing measure of stress (data not in table). While the higher prevalence of stress, impaired cognition, and depressed mood contributed to damage accrual among the poor, there was no interaction of any of these variables with poverty; that is, the effect of each of these did not differ by poverty status.

Discussion

The present study of persons with SLE advances the literature on poverty and outcomes in this disease in several ways. We observed that not only is poverty at any one time related to the extent of subsequent accumulation of damage, but the “dose” of poverty in terms of the proportion of years with a poverty-level income also affects the amount of damage accrual. Furthermore, exiting poverty permanently is associated with a disease course that closely resembles that experienced by persons who were not poor at any time as opposed to the course of those who were episodically poor, an effect observed within a year or two of having first left poverty.

The Lupus Outcomes Study permitted us to test several hypotheses from the literature about the mechanisms underlying the relationship between poverty and outcomes. We first developed a basic model incorporating demographic characteristics, health status, health behaviors, number of physician visits, and the characteristics of the health care system. This model accounted for a small part of the effect of poverty on accumulated damage. Stress, cognitive impairment, and depressive symptoms accounted for more of the effect. Nevertheless, even after taking all of these factors into account, there remained a residual effect of poverty. Together with the finding that exiting poverty results in a lower level of accumulated damage, that the poor living in areas of concentrated poverty have worse outcomes than the poor living elsewhere, this suggests that poverty itself plays a large role in why the poor experience worse outcomes of SLE.

In observational studies, the plausibility of an association, even one in which the exposure precedes the outcome, is increased when the outcome is proportional to the “dose” of the exposure and when the withdrawal of the exposure leads to improved outcomes. In the present study, we were able to observe that the number of years in poverty affects the magnitude of accumulated damage. While we could not experimentally remove the exposure of poverty, we were able to observe that those who left poverty experienced less accumulated damage than those who remained in poverty, in fact levels that were similar to those who were never in poverty, consistent with the view that exiting poverty may improve outcomes in SLE. Finally, the impact of income on extent of accumulated damage occurred only among those with household incomes below \$40,000 per year, suggesting that it is low income rather than gradations in income beyond low income levels that affect damage

accrual, a finding at odds with population-wide studies of the health impacts of income gradations⁴¹.

However, even in an observational study with twelve years of follow-up, it is not possible to completely disentangle the effect of poverty from the other characteristics of the poor beyond their poverty. The fact that we did not observe that those who exited poverty had substantially or significantly lower levels of accumulated damage prior to exiting poverty than those who did not suggests that selection bias probably did not account for all of the impact of exiting poverty. Another risk of observational studies is that severe disease may cause some individuals to fall into poverty rather than poverty causing poor outcomes. In this study, however, we measured poverty status for six years prior to measuring the extent of accumulated damage, increasing the probability that the poverty was antecedent to the outcome. Finally, the use of self-report proxy for physician-observed damage measures may bias the results, although we had previously established that the BILD is a reliable indicator when compared to physician-observed measures¹⁶, and validated its use for longitudinal studies³⁴. Use of the proxy did permit us to include individuals with SLE with minimal contact with the health system, in turn permitting the analysis of a wider variation in the kind and quality of health care than in studies conducted among patients in tertiary care settings. The study design also permitted us to observe damage accumulation from 2009 forward, in effect modeling the increment of damage from the point of presentation to health care providers. However, because we did not follow respondents from the point of onset forward, it is possible that the effects of health care may have been substantial prior to enrollment in the LOS.

The results indicating that variations in health care and health behaviors play a limited role in explaining differences between the poor and non-poor in extent of accumulated damage in SLE should be seen in the context of dramatic improvements in SLE care over the last several decades^{4,42,43}, improvements that probably have been sufficiently diffused to encompass the care of both groups. Further improvements in care may, therefore, play an important role in attenuating disparities between the poor and non-poor with SLE in extent of accumulated damage. We had previously shown that technical quality of care and ratings of interactions with providers and health plans, especially coordination of care, by persons with SLE predicted subsequent outcomes of disease^{32,44}. The sensitivity analyses in which we evaluated the impact of three prednisone regimens as a possible additional factor contributing to outcome differences between the poor and non-poor indicate that, although the poor are more likely to receive each of the tested regimens, little of the difference in accumulated damage was due to their more frequent receipt of each of the regimens. This is consistent with the primary results that showed limited effects of variations in health care in explaining differences in damage accrual between the poor and non-poor.

Overall, the present study shows that the effects of poverty extend far beyond variations in technical quality of care and in how persons with SLE interact with providers and health systems to incorporate the life circumstances of the individual.

The observation that stress, cognitive impairment, and depressive symptoms account for a significant amount of variation in extent of accumulated damage associated with poverty and

that exiting poverty sets persons with SLE on a more benign course of disease raises important questions about what should be done to deal with the poverty of such persons and by whom. Coordination of care is traditionally seen in terms of the medical care services needed, in the case of SLE including helping persons with the condition gain access to Medicaid and organizing referrals to the range of providers to deal with the diversity of manifestations common in this disease. However, such coordination might also encompass ensuring access to the benefits that reduce the impacts of poverty and are not traditionally seen as within the purview of health care providers. These would encompass income support programs, Supplemental Nutrition Assistance Program (formerly food stamps)⁴⁵, and housing assistance, for example, rent subsidies and vouchers to move to better neighborhoods⁴⁶. Of course, such coordination of services, traditionally provided by social workers, are difficult to fund in the present U.S. health care system, and are likely to become more so if such mechanisms as Accountable Care Organizations which were part of the Affordable Care Act are not maintained in health policy in the years to come.

The observation that high levels of perceived stress account for a significant amount of the effect of poverty suggests that attention within the health care system to stress management may be a worthwhile supplement to traditional medical care for SLE. However, there is likely to be a limit to the amount that the profound stress associated with persistent poverty and living in areas of concentrated poverty can be mitigated by stress management programs, primarily because dealing with the daily issues of food, housing, and medical care insecurity reduces the capacity to handle other issues that arise¹³, for example a severe illness like SLE.

The potential value of the opportunity to move out of neighborhoods with high concentrations of poverty⁴⁷ became clear by this study's finding that, among the poor, accumulated damage was greater for those living in such areas. The burgeoning literature on the salutary effects of moving out of areas of concentrated poverty incorporates a range of effects such as high school graduation, attendance at and completion of college, and subsequent earnings, with the positive effects greater for those who left areas of concentrated poverty at younger ages⁴⁷. However, the evidence for health effects is, at present, limited to the observation that risk factor profiles⁴⁸ and self-reported subjective health⁴⁹ may improve. Nevertheless, advocacy for persons with SLE to obtain housing vouchers so that they have the option of leaving adverse neighborhoods may be warranted; at the very least research to evaluate the impact of such a strategy should be initiated.

In the present study, we could explain only part of the role that poverty plays in subsequent disease damage through specific mechanisms tested, including extent of human capital of the individual and their parents, variations in kind and quality of medical care, health behaviors, level of stress (or experience of economic deprivation), and cognitive and mental health status. It is possible that one could account for a greater amount of the effect of poverty on outcomes through a more extensive list of potential mechanisms or through better measurement of each mechanism. However, it is likely that there is much more about poverty that results in adverse disease outcomes than these mechanisms capture and that, although we can ask health providers to be cognizant of the impact of poverty in their clinical encounters⁵⁰, indeed to assume some responsibility for what goes on outside of the

health care setting⁵¹, much of the impact of poverty lies beyond health care and must encompass anti-poverty policy more generally. In addition, there may be hidden but profound differences in persons with SLE who do and do not exit poverty that limits the potential effect of anti-poverty efforts for the long-term poor.

The results reported here speak to the importance of poverty in accumulation of disease damage in SLE, but the extent to which redress of the impacts of poverty can occur within clinical settings remains an open question. The present study adds to the evidence that there is something etiologically important about poverty with respect to SLE damage, but much more needs to be done to know to what extent the effects of poverty can be mitigated within the health care system, even construed to include advocacy for benefits not traditionally thought to be within the purview of health providers such as housing vouchers.

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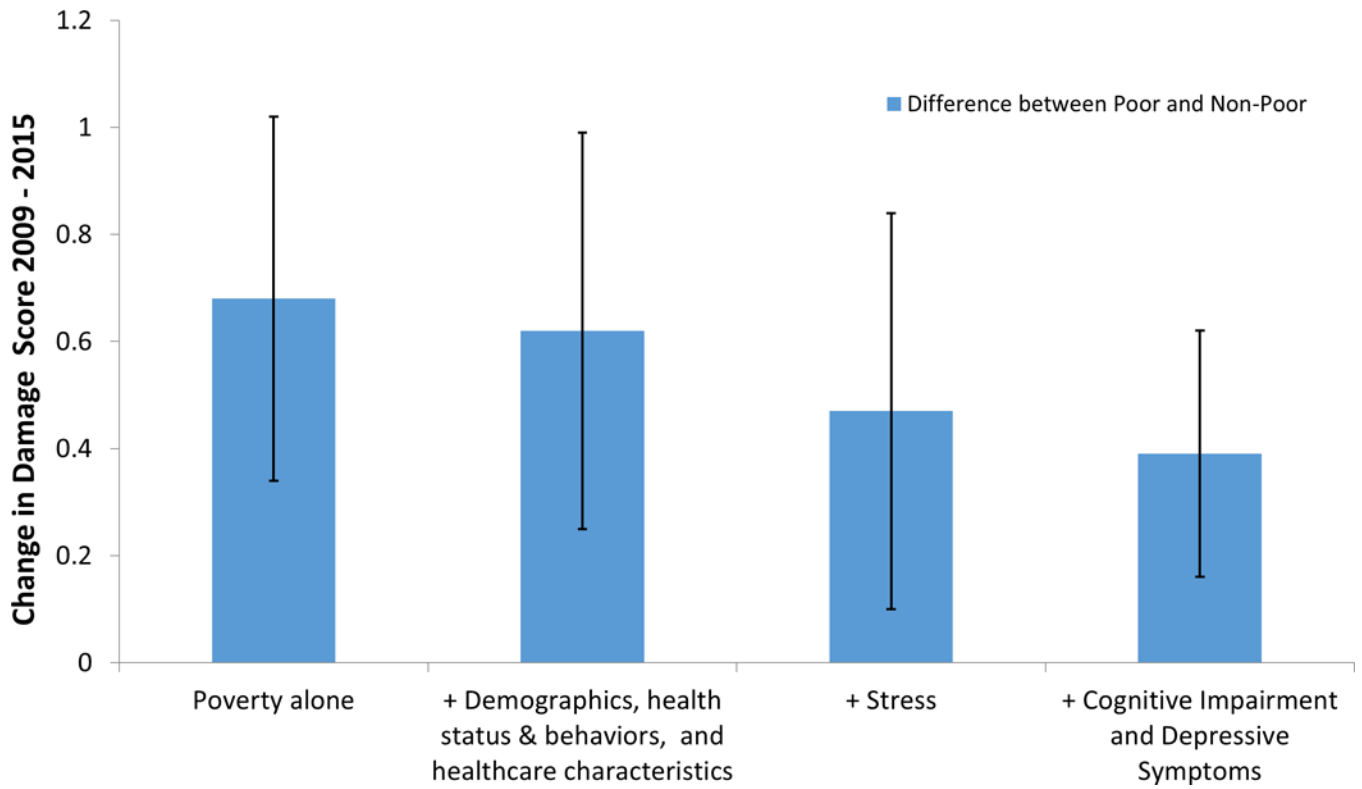


Figure 1. Legend. Incremental Effect of Poverty, Characteristics of Individuals and their Health Care, Stress, and Cognitive Impairment and Depression on Accumulated Damage between 2009 and 2015. Error bars are 95% confidence intervals. Damage Score = Brief Index of Lupus Damage (BILD).

Table 1
 Characteristics of Lupus Outcome Study Participants in 2009, by Poverty Status

Demographics	Poverty Status						
	Total (n=783)	125% Fedl pov limit (n=117, 15%)		> 125% Fedl pov limit (n=666, 85%)			
	%	Mean±sd	(range)	%	Mean±sd	%	Mean±sd
Age		49.8 ±12.3	(20–83)	46.7 ±13.9	50.1 ±12.8		*
% Female	94%			96%		93%	
Race/ethnicity							*
White, nonHispanic	63%			44%		67%	
African American	10%			14%		9%	
Hispanic	10%			22%		7%	
Asian American	11%			7%		11%	
Other/Mixed/Unknown	6%			13%		6%	
Own Education							*
% HS or Less	13%			38%		13%	
% Some College or More	87%			62%		87%	
Parents' Education							
% HS or Less	46%			54%		44%	
% Some College or More	55%			46%		56%	
Marital Status							*
% Never Married	16%			36%		16%	
% With Partner	21%			36%		17%	
% Widowed, Sep, Divorced	63%			28%		67%	
Lupus Status							
Duration in Years		16.9 ±8.3	(1–51)	15.5 ±8.8	16.9 ±8.6		
Disease Activity ¹		11.1 ±7.4	(0–38)	15.6 ±9.4	10.7 ±7.3		*
Disease Damage ²		1.9 ±2.0	(0–12)	2.4 ±2.4	1.9 ±2.0		*
Health Behaviors							
Body Mass Index		27.2 ±7.1	(15–65)	29.4 ±8.5	26.7 ±7.0		*
Smoking status							*

	Poverty Status			
	Total (n=783)	125% Fedl pov limit (n=117, 15%)	> 125% Fedl pov limit (n=666, 85%)	
Demographics	%	Mean±sd	%	Mean±sd
% Current Smokers	8%		18%	7%
% Past Smokers	30%		31%	30%
% Never Smokers	62%		51%	63%
Pack-Years among ever smoked	13.1 ±22.9 (0–68)	13.5 ±19.1		13.0 ±23.7
Health Care Characteristics				
Number of Physician Visits	14.3 ±10.2 (2–54)	16.6 ±15.3		14.7 ±12.8
Insurance Status				
% with No Insurance	2%		6%	2%
% in Managed Care	30%		16%	29%
Specialists				*
Rheumatologist, No Generalist	15%		24%	14%
Rheumatologist, Generalist	63%		54%	65%
No Rheumatologist, Generalist	18%		18%	18%
Other specialties only	4%		5%	3%
% with Quality Indicator Pass Rate	85% ³		12%	19%
Psychological and Cognitive Status				
CESD ⁵	12.3 ±10.9 (0–48)	19.9 ±12.8		11.9 ±11.1
Hopkins Delayed Recall Test -Zscore ⁶	-0.1 ±1.2 (-6.8–1.4)	-0.8 ±1.4		-0.03 ±1.2
Economic Deprivation				
% Living in Area of Concentrated Poverty ⁷	8%		22%	8%
% with Extreme Difficulty Living on Income	8%		25%	6%
Perceived Stress Scale Score⁸	4.9 ±3.4 (0–16)	6.7 ±3.5		4.9 ±3.4
Social Network: # Close Friends/Relatives⁹	5.3 ±2.3 (0–8)	4.7 ±2.6		5.4 ±2.1

* p<0.05 for difference between poor and not poor

¹ Systemic Lupus Activity Questionnaire, potential range 0–47 (high activity)

² Brief Index of Lupus Damage, potential range 0 – 18 (high level of damage)

³ SLE Quality Indicators, proportion of eligible services received

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- ⁴ SF36 component scores, range 0 – 100 (best)
- ⁵ Center for Epidemiological Studies-Depression Score, potential range 0–60 (most depressed)
- ⁶ Hopkins Verbal Learning Test-Revised
- ⁷ Census block groups with >30% of households <125% of Federal Poverty Limit
- ⁸ Perceived Stress Score, potential range 0 – 16 (most stress)
- ⁹ Berkman Social Network Score

Table 2

Change in Accumulated Damage and Odds of Experiencing a Clinically Meaningful Difference in Damage Score¹ from 2009–2015, by Poverty Status, with and without adjustment for Demographic Characteristics, Health Care Measures, and Health Behaviors

Accumulated Disease Damage	Mean ± standard deviation	
Score in 2009	1.9 ± 2.0	
Change in score 2009–2015	1.43 ± 1.76	
Models of continuous measure (change in score)	Difference (95% CI) between Poor and Non-Poor	
Unadjusted	0.68 (0.34, 1.02)	*
Adjusted ²	0.62 (0.25, 0.98)	*
Meaningful Clinically Important Difference (MCID) in accumulated damage		
MCID cut-point	2	
Percentage with MCID	36%	
Models of MCID	Odds Ratios (95% CI) for Poor vs. Non-Poor	
Unadjusted	1.71 (1.11, 2.67)	*
Adjusted ²	1.67 (0.98, 2.85)	**

*
p<0.05

**
p<0.10

¹Brief Index of Lupus Damage (BILD)

²Adjusted for demographic characteristics, disease duration, health care characteristics, and health behaviors.

Table 3

Effect of Personal and Neighborhood Poverty, Persistence of Poverty, and Household Income Level on Change in Damage¹ between 2009 and 2015, with and without Adjustment for Demographic Characteristics, Health Status, Health Care Characteristics, and Health Behaviors

Economic Status Variables	Unadjusted	Adjusted ³
Combination of Personal and Neighborhood Poverty ²	cells are mean change in damage (95% CI)	
Not poor, not living in area of concentrated poverty	1.35 (1.21, 1.49)	1.36 (1.22, 1.50)
Not poor, living in area of concentrated poverty	1.35 (0.87, 1.84)	1.29 (0.82, 1.77)
Poor, not living in area of concentrated poverty	1.82 (1.46, 2.20)	1.75 (1.38, 2.13)
Poor, living in area of concentrated poverty	2.59 (1.82, 3.35)	2.71 (1.93, 3.49)
p-value for interaction	0.121	0.029
Persistence of Poverty prior to baseline		
Never Poor	1.32 (1.18, 1.46)	1.34 (1.20, 1.49)
Poor Fewer than Half of Years	1.54 (1.16, 1.92)	1.49 (1.10, 1.88)
Poor Half of Years or More	1.59 (1.11, 2.07)	1.45 (0.97, 1.93)
Poor All Years	2.52 (1.99, 3.05)	2.45 (1.88, 3.01)
p-value for overall association	<0.001	0.0037
Level of Household Income		
\$20,000/year	1.89 (1.62, 2.17)	1.73 (1.42, 2.04)
\$20,001–40,000/year	1.76 (1.48, 2.03)	1.76 (1.49, 2.03)
\$40,001–60,000/year	1.33 (1.03, 1.64)	1.37 (1.07, 1.67)
\$60,001–80,000/year	1.17 (0.84, 1.50)	1.13 (0.80, 1.47)
> \$80,000/year	1.15 (0.94, 1.36)	1.24 (1.02, 1.47)
p-value for overall association	<0.001	0.0164

¹Brief Index of Lupus Damage (BILD)

²Neighborhood poverty defined as Census block group with 30% or more of residents in poverty

³Adjusted models include poverty status plus demographic characteristics, disease duration, health care characteristics, and health behaviors.

Table 4

Effect of Economic Status in Mitigating or Exacerbating the Effect of Poverty on Accumulated Damage¹ Between 2009 and 2015, with and without Adjustment for Demographic Characteristics, Health Status, Health Care Characteristics, and Health Behaviors

Economic Status Variables	Models with Economic Status Variables Only	Fully Adjusted Models ²
Poverty Income alone	cells are mean change in damage (95% CI)	
Below 125% of FPL (poverty income)	2.02 (1.70, 2.35)	1.97 (1.63, 2.31)
Above 125% of FPL (not in poverty)	1.33 (1.20, 1.46)	1.34 (1.21, 1.47)
p-value for overall association	<0.001	0.001
Conjoint Poverty and Education		
Poverty Income		
Individual with at least some college	2.05 (1.65, 2.46)	1.88 (1.47, 2.30)
Individual with high school education or less	1.97 (1.45, 2.49)	2.16 (1.56, 2.76)
Not in poverty	1.33 (1.20, 1.46)	1.34 (1.21, 1.47)
p-value for overall association	<0.001	0.003
Intergenerational SES		
Poverty Income		
Parents with at least some college	2.10 (1.58, 2.61)	2.06 (1.56, 2.56)
Parents with high school education or Less	1.96 (1.51, 2.41)	1.89 (1.43, 2.36)
Not in Poverty	1.33 (1.20, 1.46)	1.34 (1.21, 1.47)
p-value for overall association	0.001	0.01
Exiting Poverty		
Remained in Poverty	2.08 (1.72, 2.45)	1.98 (1.59, 2.38)
Left Poverty Permanently	1.40 (0.99, 1.80)	1.30 (0.90, 1.69)
Left Poverty 1 Year Before Baseline	1.47 (0.80, 2.15)	1.24 (0.60, 1.88)
Left Poverty 2–3 Years Before Baseline	1.43 (0.84, 2.03)	1.44 (0.85, 2.02)
Left Poverty 5–11 Years Before Baseline	1.17 (0.27, 2.07)	1.08 (0.22, 1.94)
Never in Poverty	1.33 (1.19, 1.47)	1.36 (1.23, 1.50)
p-value for overall association	<0.001	0.009

¹Brief Index of Lupus Damage (BILD)

²Adjusted models include poverty status plus demographic characteristics, disease duration, health care characteristics, and health behaviors.