INEQUALITY IN LIFE EXPECTANCY, FUNCTIONAL STATUS, AND ACTIVE LIFE EXPECTANCY ACROSS SELECTED BLACK AND WHITE POPULATIONS IN THE UNITED STATES*

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We calculated population-level estimates of mortality, functional health, and active life expectancy for black and white adults living in a diverse set of 23 local areas in 1990, and nationwide. At age 16, life expectancy and active life expectancy vary across the local populations by as much as 28 and 25 years respectively. The relationship between population infirmity and longevity also varies. Rural residents outlive urban residents, but their additional years are primarily inactive. Among urban residents, those in more affluent areas outlive those in high-poverty areas. For both whites and blacks, these gains represent increases in active years. For whites alone they also reflect reductions in years spent in poor health.

The broad influence of race/ethnicity and socioeconomic position on functional status, active life expectancy, and mortality is well documented (Backlund, Sorlie, and Johnson 1996; Bound, Schoenbaum, and Waidmann 1995; Clark and Maddox 1992; Elo and Preston 1996; Feldman et al. 1989; Hayward and Heron 1999; House et al. 1990, 1994; Institute of Medicine 1991; Kitigawa and Hauser 1973; LaPlante and Carlson 1996; Manton, Patrick, and Johnson 1987; Martin and Soldo 1997; Pincus, Callahan, and Burkhauser 1987; Ycas 1991). Less is known, however, about variability in these and other health outcomes *within* the African American or poverty population. The magnitude of the effect of socioeconomic position on at least some health outcomes appears to vary by race/ethnicity and, within race/ethnicity, by nativity status (Diez-Roux et al. 1995; James 1993; Sorlie, Backlund, and Keller 1995; Williams et al. 1997; Williams and Collins 1995). The relationships between socioeconomic position or race/ethnicity and health may be modified by geographic influences and community conditions that contextualize and structure these relationships; this possibility is a matter of growing conceptual and empirical interest (Davey Smith et al. 1998; Geronimus 2000; Hayward, Pienta, and McLaughlin 1997; LeClere, Rogers, and Peters 1997).

Recent descriptive findings comparing mortality profiles across diverse local populations are consistent with this possibility. They suggest that analyses of national or state data sets that average across different types of black or poor communities may conceal striking variation in excess mortality among these communities. For example, African American youths in high-poverty urban areas face extremely disadvantageous mortality schedules through middle age in comparison with national averages, with black residents of more affluent communities, with white residents of poor urban or rural areas, and even with black residents of rural communities that are equally poor (Geronimus, Bound, and Waidmann 1999; Geronimus, Bound, Waidmann et al. 1996; McCord and Freeman 1990; Wilson and Daly 1997).

Such findings suggest that poverty, race, and place exert an important interactive influence on mortality in young through middle adulthood. Would these findings be replicated in a study of health-related dimensions of life quality, such as the likelihood of experiencing health-induced functional limitations or the length of active life expectancy? The relationship between population morbidity and mortality is ambiguous (Crimmins 1996; Hayward and Heron 1999; Manton 1982; Verbrugge 1984); theory and research suggest competing hypotheses.

On one hand, the case for expecting similar heterogeneity across local areas is simple, if not uncontested. Cause-of-death analyses reveal that high rates of excess mortality among young through middle-aged adults in poor urban African American populations are substantially and increasingly due to chronic disorders, notably circulatory disease, cancer, and (in specific locations) HIV/AIDS (Geronimus et al. 1999). These chronic disorders often impair functioning for a period before death; thus we have reason to expect a higher rate of functional limitation among African Americans in high-poverty urban areas than among residents of other types of local areas.

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On the other hand, other area-specific factors complicate the relation between morbidity and mortality. Homicide, for example, although a lesser cause of excess mortality than chronic disease in any area, is a greater influence in poor urban areas than in better-off or rural areas (Geronimus, Bound, Waidmann et al. 1996; Geronimus et al. 1999). Because homicides are acute and occur disproportionately among youths, they are unlikely to reflect a prolonged morbidity process. Also, it is theoretically possible that life expectancy is increased at the cost of greater time spent in ill health (Gruenberg 1977; Kramer 1980). Although this proposition has not been supported in the context of the great national gains in overall life expectancy (e.g., Freedman and Martin 1998; Manton, Corder, and Stallard 1997), it is still an empirical question whether a trade-off exists between longer life and worse population health in poor rural populations. Overall, residents of nonmetropolitan areas appear to be in worse health than those living in metropolitan areas (Braden and Beauregard 1994; LaPlante and Carlson 1996; McNeil 1993; NCHS 1984, 1994), even though rural residents also appear to have a mortality advantage (Elo and Preston 1996; Geronimus et al. 1999; Hayward et al. 1997; Kitigawa and Hauser 1973; Miller, Stokes, and Clifford 1987; Schneider and Greenberg 1992). Findings on morbidity to date do not focus on comparisons between *high-poverty* urban and rural areas. Nevertheless, working-class jobs in rural areas are more likely than those in urban areas to be hazardous to health (Dill and Williams 1992; Griffith and Kissam 1995; Hewitt 1993; Levitan, Gallo, and Shapiro 1993; Tickamyer 1992), suggesting the possibility that the rural poor may be less healthy than the urban poor, even though they live longer (Geronimus et al. 1999).

Another related question marked by competing hypotheses is whether the disparity in morbidity between black residents of high-poverty urban areas and black residents of more affluent areas is as substantial as the difference in mortality. A socioeconomic gradient in morbidity and mortality for the general population, well established in micro-level analyses, suggests that health improves markedly as one moves from the lowest levels of income to average or median levels (House et al. 1990; Mirowsky and Hu 1996; Sorlie et al. 1995). This might lead us to expect similar patterns for both mortality and functional health status among African Americans.

Yet recent scholarship suggests caution in assuming that socioeconomic position influences African Americans' health as steeply as that of other populations. For example, middle-class African Americans suffer a greater prevalence of cardiovascular disease than do middle-class whites (James 1994), and African American women of reproductive age experience more health deterioration, or "weathering," than their white counterparts (Geronimus 1994, 1996). Some social epidemiological studies point to race-related stress and prolonged use of high-effort coping mechanisms as explanations for high rates of chronic disease among middle-class African Americans (James et al. 1992; Light et al. 1995; Williams 1999; Williams et al. 1997). On a material level, African Americans at a given income level may be disadvantaged relative to whites at the same level in their ability to translate economic resources into good health. For example, African Americans possess far less wealth than their white counterparts, and they do not enjoy the same range of residential options (Conley 1999; Massey and Denton 1993; Oliver and Shapiro 1995). In light of structural racism, African Americans at all socioeconomic levels may pay a higher price in stress-related disease for their membership in American society than do other populations (Geronimus 2000).

It may be reasonable to suppose, then, that any morbidity advantage enjoyed by black residents of economically better-off areas over their high-poverty counterparts would be less than their mortality advantage. Link et al. (1998) posit that the greater access to information, technology, and other resources enjoyed by economically advantaged groups can help them to avert premature death, even in the presence of disease. For example, although the incidence of breast cancer is higher among white women than black women, white women's declines in breast cancer mortality have been greater than black women's; probably this is due to white women's greater access to early diagnosis through mammography and to advances in treatment, especially the use of tamoxifen/hormonal therapy after surgery (Link et al. 1998; Peto et al. 2000).

In this paper we use empirical analyses to explore several questions implied by the competing hypotheses that characterize this area of research. As noted, earlier work indicates that youths' probability of surviving through middle age varies significantly by community. We employ a residential perspective in extending these mortality analyses through old age; we also provide the first estimates, to our knowledge, of possible heterogeneity in functional status and active life expectancy among local African American and poverty populations. By comparing findings on mortality with those on functional health, we hope to increase understanding of the relationship between population infirmity and longevity. Given the enormous variation in mortality profiles already described in a diverse set of local populations (Geronimus et al. 1996, 1999), we believe that this residential approach offers a unique vantage point for evaluating this relationship. By comparing findings between urban and rural areas and between high-poverty and more affluent areas for blacks and for whites, we also hope to contribute to ongoing discussion regarding the importance of a residential perspective in understanding how socioeconomic resources influence health, and whether residential segregation or other forms of racism impair African Americans' ability to translate economic resources into good health.

RESEARCH DESIGN AND METHODS

Study Populations

We calculated population-level estimates of mortality, functional health status, and active life expectancy for adults (age 16 and older) living in a diverse set of 23 local areas in 1990, and for blacks and whites nationwide. Each local area encompasses the entire black or non-Hispanic white population in aggregates of census tracts or ZIP codes in urban areas and counties or parishes in rural areas (for mortality calculations) matched to Public Use Microdata Areas (for disability calculations). The local areas include socioeconomically disadvantaged geographic areas (seven predominantly black and six predominantly white) and, where data permitted, socioeconomically better-off local areas that are geographically proximate to specific poor study populations and are matched on race. We were able to match better-off local areas to all urban poor populations, but only to white rural populations. In rural areas, we were unable to locate distinct, economically better-off black populations large enough for this analysis.

Table 1 provides summary information about the populations' size, economic characteristics, and location. (A fuller listing of the localities encompassed by each study area is provided in Appendix Table A1.) We report median household incomes and poverty rates for the areas, unadjusted and adjusted for differences in cost of living (Citro

TABLE 1. ECONOMIC CHARACTERISTICS OF STUDY POPULATION 1990, UNADJUSTED AND ADJUSTED FOR COST OF LIVING

		Unadjusted			Adjusted	
	Acronym	Median Household Income	Poverty Rate (%)	Adjustment Factor	Median Household Income	Poverty Rate (%)
Black						
Total U.S.		$19,300	32	1.00	$19,300	32
Poor						
Harlem	hlm	$12,000	43	1.19	$10,084	48
Central City Detroit	ccd	$10,700	50	1.06	$10,094	51
South Side Chicago	ssc	$10,800	54	1.06	$10,189	55
Watts	wts	$12,600	45	1.22	$10,328	53
East North Carolina	enc	$12,600	36	0.83	$15,181	33
Black Belt Alabama	bba	$9,000	52	0.83	$10,843	33
Delta Louisiana	dla	$8,500	47	0.86	$9,884	44
Nonpoverty						
Queens	qny	$50,000	7	1.19	$42,017	8
Northwest Detroit	nwd	$30,000	21	1.06	$28,302	21
Southwest Chicago	swc	$28,000	25	1.06	$26,415	26
Crenshaw/Baldwin Hills	cbh	$21,500	22	0.86	$25,000	19
White						
Total U.S.		$31,200	7	1.00	$31,200	11
Poor						
Cleveland	cld	$19,100	23	1.06	$18,019	24
Detroit	det	$17,500	30	1.06	$16,509	32
Appalachian Kentucky	aky	$14,500	38	0.83	$17,470	33
West North Carolina	wnc	$20,100	17	0.90	$22,333	16
Northeast Alabama	nal	$21,000	15	0.83	$25,301	11
South Central Louisiana	cla	$18,700	22	0.86	$21,744	19
Nonpoverty						
Western Cleveland	wcl	$36,100	5	1.06	$34,057	5
Sterling Heights	shd	$45,400	3	1.06	$42,830	4
Western Kentucky	wky	$21,500	17	0.83	$25,904	14
West Central North Carolina	cnc	$29,500	7	0.90	$32,778	5
Southwest Alabama	sal	$24,000	12	0.83	$28,916	10
Southeast Louisiana	sla	$32,500	11	0.86	$37,791	9

Source: 1990 U.S. Census 5% PUMS.

Notes: Income and poverty rates are for black or white non-Hispanic residents of study areas. Incomes are household incomes. Poverty rates refer to nonelderly (ages 0–64) black or white residents of study areas.

and Michael 1995). Reflecting the national distribution of income and the concentration of poverty in some urban black areas, the African American areas—both poor and higher-income—are less well off than the white. Thus, although the designations "poor" and "better-off" apply within races, "poor" or "better-off" black populations cannot be regarded as socioeconomically comparable to "poor" or "better-off" white populations.

The populations we studied were chosen to reflect racial and geographic diversity, subject to data constraints such as population size and availability of data. Because the death certificate data were provided by state vital statistics offices, we were limited to states that included geographic identifiers in their files and (for areas with large Hispanic populations) that separated non-Hispanic from Hispanic whites.

Data

Because of our focus on entire local populations, we were required to analyze census and death certificate data. The death certificate files contain geocode information that enabled us to match them to census data by census tract, ZIP code, or county. Census Summary Tape Files (STF) from the 1990 Census provide counts of the population by age, race, and sex, which we used to estimate the population base for mortality rate calculations. The numerator for the mortality calculations is derived from tape files containing death certificate information, which is available from the vital statistics departments of each state and from New York City. To moderate the random fluctuation in the number of deaths in any one year, we analyzed deaths for 1989 through 1991 (centered on the 1990 census year).

Although functional limitation variables also are included in the STF files by census tract, county, and ZIP code, the age detail is much too broad for our purposes (16 to 64, 65+). Thus we used data from the 5% Public Use Microdata Sample (PUMS) of the 1990 Census to calculate disability rates by race, age, and sex. To protect confidentiality, the Census PUMS data are available by Public Use Microdata Areas (PUMA). We took care to match geographic identification among data sets as closely as possible. In the great majority of local areas, we were able to match PUMA and mortality areas perfectly. In the few areas where the match is not identical, the 1990 PUMA designations correspond closely to the geographic sample definitions used in the mortality analyses, and are comparable in their socioeconomic characteristics. (For comparison of local mortality areas and PUMAs, see Appendix Table A2.)

We used the responses to the following census questions about limitations in work, mobility, and personal care activities resulting from health conditions of at least six months' duration:

(1) Does this person have a physical, mental, or other health condition that has lasted for 6 or more months and which limits the kind or amount of work this person can do at a job?

(2) Because of a health condition that has lasted for 6 or more months, does this person have any difficulty going outside the home alone, for example, to shop or visit a doctor's office?

(3) Because of a health condition that has lasted for 6 or more months, does this person have any difficulty taking care of his or her personal needs, such as bathing, dressing, or getting around inside the home?

We conducted all analyses first by combining answers to all of these questions (which we refer to as "any" disability) and then by counting as disabled only respondents who indicated a limitation in either mobility or personal care. In the second case we excluded the work disability responses because of a concern that they would differ systematically with local labor market variations. On the other hand, by counting as disabled only those who are limited in their mobility or personal care activities, we obtain an extremely conservative measure of functional limitation.

In general, we are confident that the quality of data is high. Coverage of mortal events in death certificate data is known to be virtually universal, and uniformity among states in the data obtained on certificates is achieved through federal-state coordination (Rosenberg 1989). Self-reported measures of health, although subjective, are correlated highly with clinical measures of morbidity, and predict subsequent death, utilization of health care, and labor market behavior (Idler and Benyamini 1997; Manning, Newhouse, and Ware 1982).

The census is the *only* data set that allows the study of entire populations living in specific places to detect any important variation in functional status. Even so, legitimate concerns have been raised about the validity of the census disability items; these are based on a mailback questionnaire rather than an interview, are sometimes filled out by proxy respondents, and contain only general questions on functional limitation rather than the more specific and more highly detailed information on Activities of Daily Living (ADLs) or Instrumental Activities of Daily Living (IADLs) and on functional limitations obtained in other surveys such as the National Health Interview Survey.

Little empirical attention has been given to the validity of the census disability items. Andresen et al. (2000) found that responses to the more global census questions do not correspond precisely to responses to narrow questions about specific, individual ADLs or IADLs. This finding, however, is neither surprising nor particularly pertinent to our analysis. For us, the important question is whether differences across areas in responses to census questions accurately reflect differences across areas in the respective populations' age-specific functional capacities. Research validating the use of census data for this purpose is needed (Verbrugge 1997). To mitigate our own concern about the validity of these data, we performed an array of analyses and were reassured by the results.

On a simple level, general patterns of functional limitations by age and race are consistent with what is known about age and racial patterns of disability from other sources; this finding suggests that these data have "face validity." For example, Table 2 shows the percentages of African American and white men identified in the census as experiencing functional limitations for selected age groups. Disability rates rise with age. Older Americans are more likely than younger ones to suffer multiple limitations (as evidenced by the extent to which the number with any limitation is smaller than the sum of individuals with work, mobility, or personal care limitations). African Americans' disability rates are higher than those of whites: racial disparities are most pronounced in young through middle adulthood, and then approach convergence in old age. Limitations in young through middle adulthood are largely work limitations; those in mobility and personal care increase in old age. Each of these patterns is consistent with expectations based on what is known, from other sources, about age and racial patterns of disability.

In addition, we note and augment relevant comparisons between tabulations based on census data and those based on data from the National Health Interview Survey (NHIS). We find that the two surveys yield similar patterns where comparisons can be made. For example, the NHIS traditionally has asked a question on activity limitations that is comparable to the census question on work limitation for the working-age population. Using their respective questions, the Census and the NHIS provide similar estimates of the proportion of men and women who suffer work limitations, both in levels and in trends over time (Waidmann, Bound, and Schoenbaum 1995). Further, in our own tabulations we found that nationally, the percentage of individuals identified in the census as suffering either mobility or personal care limitations is approximately equal to the fraction identified in the 1994 NHIS disability supplement (NCHS 1996) as having at least one limitation in an ADL or IADL.

Multivariate logistic regressions of disability status by age, race, and education, based first on 1994 NHIS data and then on census data, show patterns that are quite similar across the two surveys. For example, regressions on work limitations result in correlations of .95 for men and .96 for women between the two sets of coefficients, whereas correlations between the coefficients on reporting an ADL or IADL (in the NHIS data) and on reporting a limitation in mobility or personal care (in the census) are .78 for men and .84 for women. Our findings that the NHIS and the census produce similar estimates of cross-group differences in disability rates are consistent with findings from the United Kingdom, where census and disability surveys have produced similar estimates of cross-region differences in disability and active life expectancy (Bebbington 1993; Bone et al. 1995). Moreover, time trends reported by investigators using global questions on functional limitation in the NHIS (Crimmons, Saito, and Reynolds 1997; Waidmann et al. 1995) are consistent with trends in functional limitations reported for similar periods based on ADL and IADL questions from the National Long Term Care Survey (Manton et al. 1997). As a group, these various findings suggest that the use of a mailback questionnaire rather than an interview does not affect responses qualitatively and that responses to global questions, such as those in the census, may be satisfactory for gauging area differences in the respective populations' age-specific functional capacities.

We were also concerned about imputed data. Nationwide, roughly 7% of whites and 10% of blacks fail to respond to one or more of the census questions regarding disability status. The fractions failing to report are somewhat higher in poor populations. For nonresponding individuals, the census imputes values for these variables using other characteristics of the individual. The use of imputed values, however, is likely to result in underestimates of actual differences between groups (Lillard, Smith, and Welch 1986). We performed our analyses with and without individuals for whom disability status had been imputed; our results were insensitive to their inclusion or exclusion. The results we report here include the individuals for whom disability status was imputed.

Another concern with data is that every decennial census enumeration has suffered from coverage error, which results in a net undercount (West and Fein 1990). Moreover, analyses by the Census Bureau reveal that certain groups in the population are more likely than others to be undercounted: men are more likely to be missed than women, blacks more often than nonblacks, and those who are young, poor, and urban, or who are not members of nuclear-family households, more often than their counterparts (Wolter 1991). This would suggest that calculations based on popu-

TABLE 2. PERCENTAGES OF AFRICAN AMERICAN AND WHITE MEN IDENTIFIED IN THE 1990 CENSUS AS EXPERIENCING WORK, MOBILITY, OR PERSONAL CARE LIMITATIONS: SELECTED AGES

	African American				Non-Hispanic White			
Age	Work	Mobility	Personal Care	Any Limitation	Work	Mobility	Personal Care	Any Limitation
25–34	8.8	2.9	7.4	14.2	5.6	1.3	2.1	7.0
45–54	18.3	5.5	9.8	24.2	11.3	2.4	3.1	12.9
65–74	39.2	14.7	17.2	45.4	30.0	7.8	8.1	33.0
85+	62.6	47.5	39.1	68.9	55.9	42.0	32.3	62.2

Source: 1990 U.S. Census 5% PUMS.

Notes: Because some individuals suffer multiple limitations, the values in the columns for work, mobility, and personal care do not sum to those in the "any limitation" columns.

lation counts, such as death rates, are subject to bias. In particular, because mortality data are accurate, estimates of death rates using (undercounted) population counts in the denominator will result in overestimation of those rates.

The census has deployed considerable resources to determine the exact size of the undercount (Hogan 1993; Robinson et al. 1993a). Although accurate quantification is undeniably difficult (Clogg and Himes 1993; Hogan 1993; Mulry and Spencer 1993; Passel 1993; Robinson et al. 1993a, 1993b), the extensive analyses made by the Census Bureau through a combination of administrative and vital statistics data, special post-enumeration surveys, and ethnographies (Hainer et al. 1988) have led to some consensus on its nature and size. The Census Bureau produces age-, race-, and sex-specific estimates of the national undercount using demographic methods (Robinson et al. 1993a); these estimates generally are regarded as reasonably accurate. The Census Bureau also produces local-area estimates of the undercount using post-enumeration surveys (Hogan 1993; U.S. Bureau of the Census 2000). Although both the reliability and the validity of these local-area estimates have been questioned, they are consistent with expectations that the proportional undercount is highest in urban areas with large minority populations. Local-area estimates may not be accurate enough to serve as a basis for apportionment decisions; yet they contain useful information about the size of the undercount in each of our study populations.

To mitigate biases introduced by the census undercount in computing the mortality rates, we adjusted the population counts within our study areas to compensate for coverage error. First, we used the age-, race-, and sex-specific national estimates produced by the Census Bureau (Robinson et al. 1993a). Second, we used the local-area estimates to adjust the national estimates (U.S. Bureau of the Census 2000). For example, our analyses of the website data for the census tracts making up central Harlem indicate that the rate of undercount for African Americans is 7.1%; this figure, as expected, is somewhat higher than the estimate of 5.1% for Harlem that we would reach using national estimates. Thus for our second adjustment in the Harlem example we multiplied the age-, race-, and sex-specific national estimates by 1.4 (7.1/5.1).

When we compared estimated survival probabilities adjusted by using national undercount estimates with those based on local-area estimates, we found virtually no differences for whites or for black women, and only small differences for black men. In fact, the correlations between estimates based on the national and the local-area estimates were greater than .99 in all cases. This finding suggests that our results are insensitive to the specific undercount correction we use. Any plausible correction to the undercount will leave intact the qualitative nature of the cross-area comparisons.

Statistical Analysis

For each local population and for blacks and whites nationwide, we estimated survival curves, life expectancy, age-specific disability rates, and active life expectancy separately for men and women age 16 or older. (PUMS disability data are collected only for persons 16 or older.) We performed all calculations both including and excluding those age 65 or older, because the quality of age reporting on African American elders' death certificates is in question (Preston et al. 1996). Because our findings for persons 16 to 65 were not sensitive to whether the elderly were included or excluded, we report estimates based on analyses of all adults age 16 and older. As noted, to mitigate biases due to census undercounting, we adjusted population counts using national and local undercount adjustments. The results we report here are based on adjustments made with local-area estimates.

To calculate age- and sex-specific death rates, we combined population-specific death certificate information for 1989–1991 with age-stratified counts of men and women in each population taken from the 1990 Census. We employed Greville's method (Greville 1943; Nambordiri and Suchindran 1987) to derive probabilities of survival to various ages for 16-year-olds living in the study populations.

Because we were constrained to data from a 5% sample, the size of the sample available for the disability analyses was reduced significantly. To minimize resulting variability in the local estimates of disability rates by single years of age, we estimated predicted prevalence of disability at various ages under the assumption that the local-area age-specific disability trajectories follow the same pattern as the age-specific disability trajectories for African American women and men in the nation as a whole, but that the level may vary. In particular, we estimated logit models of the following form for men and for women separately:

$$\ln[d_{ij} / (1 - d_{ij})] = \alpha_i + \beta_j , \qquad (1)$$

where d_{ij} represents the fraction of the population in the ith single year of age and jth location that is disabled, and α_i and β_j respectively are the single year of age- and location-specific parameters. Because we use the entire 5% sample of white or African American women or men to estimate Eq. (1), the α_is represent age-specific national averages, while the β_js represent local-area deviations around these averages. Eq. (1) allows levels to vary but constrains the age profile of disability to be similar across geographic areas. We experimented with specifications that allowed for across-area differences in the effect of age on disability status. Although we found some evidence that across-area differences in the odds of being disabled tended first to rise and then to fall with age, these interactions did not approach statistical significance.

The predicted age- and location-specific disability rates estimated with Eq. (1) are combined with the age- and location-specific survival probabilities to calculate the probability that an individual will survive able-bodied to specific ages. We summarize this information in terms of life expectancy and disability-free (active) life expectancy. We calculated active life expectancy using a prevalence-based life table model. The years of active life lived in the age interval $(x, x + n)$ by each population are given by

$${}_nLa_x = {}_nL_x \, {}_na_x ,$$

where ${}_na_x$ is 1 minus the weighted average of the single-year-of-age disability rates in the population (d_{ij}) over the age range (x,$x + n$). Active life expectancy is calculated analogously to life expectancy as

$$ea_{16} = \frac{\sum_{t=16}^{\omega} {}_nLa_t}{l_{16}}.$$

This formulation follows the construction of the "working life table" in Shryock and Siegel (1975). Our approach is conceptually similar to that used by Crimmins, Saito, and Ingegneri (1989, 1997) and by Hayward and Heron (1999).

Longitudinal data would have permitted us to follow individuals and cohorts over time and would have allowed us to apply multistate life table methods to calculate active life expectancies. There are no longitudinal data, however, that would allow us to consider our central research questions. Mathers and Robine (1993), comparing our approach with the multistate method, concluded that the method we use is quite acceptable and provides an accurate estimate of the true period value of active life expectancy, except in rare cases of sudden changes in mortality rates.

In addition, we were forced to rely on cross-sectional data on morbidity and mortality to draw inferences about the morbidity and mortality experiences that members of the study populations can expect as they age. Yet increases across cohorts in life expectancy, and especially active life expectancy, imply that if fully longitudinal microdata were available with sample sizes sufficient to provide local-area estimates of the type we seek here, such data probably would show greater life and active life expectancies than do our estimates for many of the population groups studied (Manton and Land 2000). However, unless such data and models greatly and differentially affected the population groups' active life table estimates, it is likely that the main findings of the present study about variations among local population groups would still hold.

In addition, existing evidence suggests that socioeconomic differences in mortality have been rising nationally (Feldman et al. 1989; Pappas et al. 1983), and there is evidence that they increased between 1980 and 1990 at many of the specific sites we study (Geronimus et al. 1999). Thus, if longitudinal data were available, we would expect the differences between areas to be (if anything) somewhat greater than we report.

We used standard methods (Chiang 1961) to estimate the sampling variability associated with each measure of mortality. The estimated 95% confidence intervals never exceeded plus or minus .04 for the survival probabilities or plus or minus one year for the life expectancy estimates. Accuracy is such that estimates that appear qualitatively different always show a statistically significant difference at the 5% level. Our estimates of the morbidity differences across local areas are not quite so accurate: the standard errors on our estimated β_js (from Eq. (1)) range from 0.08 to 0.10. Consequently the estimated confidence intervals around the age-specific disability prevalence estimates are typically about plus or minus 20%. Although estimated differences between poor or between nonpoor areas do not always display a statistically significant difference from each other, the estimates for the poor areas typically differ significantly from the estimates for the nonpoor areas.

Finally, to summarize the results across populations, we estimated simple descriptive regressions, separately by gender and race, of each health outcome (e.g., life expectancy, disability, or active life expectancy) on the local area's poverty rate and on a dummy variable for rural residence. In addition to reporting coefficient estimates from these regressions, we report p values for two-tailed tests of the hypothesis that the coefficients on the poverty rate and the rural dummy variables are different for black and for white populations. We also report the p value for the test that blacks and whites show no statistically significant difference in mortality rates or life expectancy, with controls for differences in area poverty rates and urban/rural residence. These last tests are derived from regressions pooling blacks and whites, in which the coefficients on the poverty rate and the rural dummy variable were constrained to be equal.

RESULTS

Mortality

Table 3 shows the probability that 16-year-old male or female residents of each local study area, and 16-year-old blacks and whites on a national level, will survive to ages 45, 65, and 85, and displays their remaining life expectancy in years. Areas vary substantially in the probability of survival through middle age and to old age. Generally, residents of urban poor areas fare worse than their race- and sex-specific national average and worse than residents of rural poor areas matched on race and gender. Among African Americans, residents of poor rural areas have mortality profiles comparable to the black national average; those in relatively advantaged urban areas fare as well as blacks nationwide, or better; and those in the advantaged population of New York City fare as well as whites nationwide.

African American residents of impoverished urban areas, especially men, fare substantially worse than residents of other areas. Fewer than half of the 16-year-old males in these areas can expect to survive through middle age, and fewer than 10% can expect to survive to age 85. This latter probability is about one-third lower than the probability that a black male youth in an impoverished rural study area or in the nation overall will survive to age 85; one-third to two-thirds lower than the chance that a black male youth in a relatively advantaged study population will reach age 85; and about one-half to three-quarters lower than the chance that a white male youth in the nation overall will survive to that age. Similar variability is seen in remaining life expectancy, which ranges from 42 additional years for black male residents of Chicago's South Side to 58 additional years for black male residents of Queens; expectancies for black residents of rural poor areas and of the nation overall fall between these figures.

Clustering for whites is generally similar, but the differences are smaller and less consistent than for blacks. As

TABLE 3. PROBABILITY OF SURVIVAL TO AGES 45, 65, AND 85, CONDITIONAL ON SURVIVAL TO AGE 16; AND LIFE EXPECTANCY AT AGE 16: MEN AND WOMEN IN SELECTED POPULATIONS

	Probability of Survival to Age					Probability of Survival to Age			
Area	45	65	85	Life Expectancy	Area	45	65	85	Life Expectancy
U.S. Women					U.S. Men				
Whites	0.98	0.87	0.42	64	Whites	0.95	0.77	0.23	58
Blacks	0.95	0.77	0.31	60	Blacks	0.88	0.62	0.14	52
Black Women					Black Men				
Urban poor					Urban poor				
Harlem	0.87	0.65	0.25	54	Harlem	0.71	0.37	0.08	42
Central City Detroit	0.91	0.69	0.29	56	Central City Detroit	0.81	0.46	0.09	46
South Side Chicago	0.91	0.66	0.23	55	South Side Chicago	0.76	0.40	0.07	43
Watts	0.90	0.67	0.24	55	Watts	0.77	0.46	0.08	44
Rural poor					Rural poor				
East North Carolina	0.95	0.77	0.31	59	East North Carolina	0.88	0.55	0.10	50
Black Belt Alabama	0.95	0.77	0.32	60	Black Belt Alabama	0.90	0.60	0.13	51
Delta Louisiana	0.94	0.75	0.29	59	Delta Louisiana	0.90	0.57	0.13	51
Urban nonpoverty					Urban nonpoverty				
Queens	0.97	0.86	0.45	65	Queens	0.91	0.76	0.29	58
Northwest Detroit	0.95	0.81	0.30	61	Northwest Detroit	0.86	0.61	0.17	51
Southwest Chicago	0.95	0.77	0.26	59	Southwest Chicago	0.84	0.59	0.11	50
Crenshaw/ Baldwin Hills	0.96	0.81	0.35	61	Crenshaw/ Baldwin Hills	0.86	0.62	0.17	51
White Women					White Men				
Urban poor					Urban poor				
Cleveland	0.96	0.77	0.29	59	Cleveland	0.91	0.61	0.11	51
Detroit	0.95	0.76	0.32	59	Detroit	0.85	0.57	0.12	49
Rural poor					Rural poor				
Appalachian Kentucky	0.97	0.81	0.36	62	Appalachian Kentucky	0.93	0.69	0.16	54
West North Carolina	0.98	0.89	0.46	65	West North Carolina	0.95	0.78	0.22	58
Northeast Alabama	0.97	0.85	0.40	63	Northeast Alabama	0.94	0.72	0.16	55
South Central Louisiana	0.96	0.86	0.40	63	South Central Louisiana	0.93	0.73	0.19	55
Urban nonpoverty					Urban nonpoverty				
Western Cleveland	0.98	0.88	0.41	64	Western Cleveland	0.96	0.82	0.21	58
Sterling Heights	0.99	0.89	0.42	65	Sterling Heights	0.97	0.83	0.15	59
Rural nonpoverty					Rural nonpoverty				
Western Kentucky	0.98	0.90	0.58	70	Western Kentucky	0.96	0.82	0.32	61
West Central North Carolina	0.97	0.88	0.43	64	West Central North Carolina	0.94	0.75	0.19	57
Southwest Alabama	0.98	0.89	0.44	65	Southwest Alabama	0.93	0.75	0.22	56
Southeast Louisiana	0.98	0.89	0.43	65	Southeast Louisiana	0.95	0.77	0.24	57

Sources: 1990 U.S. Census Summary Tape Files (with population counts adjusted by local area undercount estimates) and State and City Vital Statistics Data 1989–1991.

among blacks, white residents of impoverished urban areas fare the worst of all whites. Their probability of surviving to age 85 is about half that of whites nationwide for men and about two-thirds for women. It is also somewhat lower than the probability for residents of rural white populations. White residents of urban poor areas have mortality profiles comparable to those of black residents of poor rural areas and blacks nationwide, and somewhat worse than residents of relatively advantaged black urban areas. Although residents of white rural poor areas fare better than those in urban areas, residents of white rural advantaged areas fare about the same as those in advantaged urban areas—a little better for women, a little worse for men.

In regard to years of remaining life expectancy, the variation among whites is smaller than among blacks: the difference between the best and the worst areas is 11 years for women and 12 years for men. Life expectancies in the worst black areas are substantially lower than in the worst white areas, but the advantaged black areas are more comparable to the advantaged white areas; these two groups overlap somewhat in number of remaining years.

Results of the summary regressions are reported in Table 4. The first two subcolumns show results where the dependent variables respectively are the log-odds of survival to age 65 and life expectancy (at age 16). Comparison of results from areas with low poverty rates (e.g., 5%) and high poverty rates (e.g., 50%) shows that the probability of surviving to age 65 is reduced by more than half; this is true for blacks and whites and for men and women. The same comparison is associated with an average of about 10 years of additional life (a little less for women, a little more for men). These differences are substantial. For blacks, residence in a rural area is associated with a quantitatively and statistically significant rise in both the odds of living to age 65 and the average years lived after age 16. The magnitude of the rural effect for white women is similar to the effect for blacks, but it is smaller for white men, and the differences usually are not statistically significant.

Figures 1a (for women) and 1b (for men) represent the regression results graphically. The lines represent predicted life expectancy for an urban resident. The graphs clearly show the strong relationship between an area's poverty rate and life expectancy. These figures also reveal an interaction with urban/rural residence. Scatter points for rural populations are often well above the regression line, indicating greater life expectancies than would be predicted on the basis of their poverty rate alone. It is also striking that, for women, whites' and blacks' regression lines coincide and that, for men, the difference between black and white is small. In fact, the p values in Table 4 indicate no statistically significant differences between blacks and whites, once we have accounted for area poverty rates.

Functional Limitations

Of those residents of the study areas who survive, what proportion suffers functional limitations? In Tables 5 and 6 we present the estimated percentage of survivors in each population who, at ages 35, 55, and 75, report any limitation (in work capacity, personal care, or mobility) and the subset of these who report only the more extreme cases of limitations in personal care or mobility.

Nationwide, black men and women are substantially more likely than whites to suffer activity limitations. At age 35, blacks are about twice as likely as whites to suffer any limitation, and three times as likely to suffer from limitations in mobility or personal care. At age 55, almost one-third of blacks suffer any limitation, while the percentage suffering the more severe limitations is roughly on a par with the percentage of whites suffering any limitation. By age 75, the racial gap narrows somewhat, but more than half of all blacks suffer limitations, compared with about 40% of all whites. One-third or more of surviving blacks suffer the more extreme limitations, compared with about one-quarter of white women and one-fifth of white men.

In contrast to mortality, where women consistently have higher life expectancies than men, women and men in a given population suffer generally similar levels of functional limitations. We find modest indications of gender differences over the life span: women are less likely than men to be limited at younger ages, and more likely to be limited at older ages.

At ages 35 and 55, the prevalence of any limitations among black residents of the relatively advantaged urban areas is intermediate between the prevalences for whites and for blacks nationwide. The prevalence of the more extreme limitations at all ages and the prevalence of any limitations at age 75 are comparable for residents of relatively advantaged black urban areas and for blacks nationwide, and greater than those for whites.

Functional limitations are substantially more prevalent among black residents of impoverished urban areas than among black residents of more advantaged urban areas or blacks nationwide. Differences in functional limitation generally favor black residents of poor rural areas over those in poor urban areas, but these differences are much smaller than for mortality. By age 55, black residents of impoverished urban or rural areas suffer rates of functional limitation more than double the rate for whites nationwide: 16 to 23% of blacks suffer the more extreme limitations, compared with 6 to 7% for whites nationwide. The differences are slightly greater at age 35 and slightly less at age 75.

Among whites, residents of poor urban and rural populations are more likely to suffer functional limitations than whites nationwide. Although prevalence of limitations generally is similar for poor white urban and poor white rural locales, white residents of Appalachian Kentucky are substantially more likely to suffer limitations than residents of any other white area. Indeed, surviving residents of the Appalachian population suffer functional limitations at rates comparable to those for surviving residents of poor black urban or rural populations.

White residents of relatively advantaged areas are generally similar in their disability prevalence to whites nationwide, although rates in rural areas tend to be slightly higher than in urban areas. As a group, these whites fare noticeably better than white residents of impoverished areas.

Summary regressions of the log-odds of being disabled at age 55 on poverty rates and rural/urban status are shown in the second two subcolumns (any disability and mobility or personal care) of Table 4. Disability rates increase as poverty rates rise, about comparably for men and for women,

TABLE 4. ESTIMATED ASSOCIATIONS BETWEEN AREAL POVERTY RATES AND MORTALITY, FUNCTIONAL LIMITATIONS, AND ACTIVE LIFE EXPECTANCY

	Mortality				Functional Limitations			
	Log-Odds of Survival to Age 65		Life Expectancy at Age 16		Log-Odds of Any Disability		Log-Odds of Mobility or Personal Care Disability	
	Female	Male	Female	Male	Female	Male	Female	Male
White								
Pov/100	–2.65	–3.14	–16.25	–23.23	2.80	3.59	2.41	3.14
	(0.35)	(0.79)	(3.19)	(5.50)	(0.50)	(0.37)	(0.40)	(0.34)
Rural	0.27	0.11	2.51	1.90	0.25	0.20	0.17	0.18
	(0.09)	(0.16)	(1.08)	(1.20)	(0.11)	(0.09)	(0.09)	(0.08)
R^2	0.78	0.64	0.51	0.61	0.82	0.91	0.82	0.90
Black								
Pov/100	–2.30	–2.75	–19.20	–26.21	1.29	1.44	0.87	1.01
	(0.24)	(0.53)	(3.11)	(5.42)	(0.22)	(0.24)	(0.21)	(0.26)
Rural	0.26	0.39	2.79	4.41	0.03	0.14	–0.13	0.05
	(0.10)	(0.21)	(1.12)	(2.19)	(0.07)	(0.07)	(0.06)	(0.09)
R^2	0.91	0.78	0.85	0.77	0.83	0.85	0.67	0.67
Tests for Equality of Coefficients (*p* Values, Two-Tailed Test)								
Poverty	0.41	0.68	0.52	0.70	0.01	0.00	0.00	0.00
Rural	0.95	0.31	0.86	0.33	0.11	0.58	0.01	0.29
Test of That Coefficient on Black in Pooled Model = 0								
p value	0.53	0.48	0.77	0.92	0.00	0.18	0.00	0.00

	Active Life Expectancy				% of Life Span Active			
	No Limitation		No Mobility or Personal Care Limitation		No Limitation		No Mobility or Personal Care Limitation	
	Female	Male	Female	Male	Female	Male	Female	Male
White								
Pov/100	–33.08	–43.71	–24.51	–32.51	–0.32	–0.46	–0.17	–0.21
	(3.95)	(4.10)	(1.99)	(4.77)	(0.08)	(0.04)	(0.04)	(0.03)
Rural	–1.01	–0.52	0.40	0.71	–0.05	–0.03	–0.03	–0.02
	(0.96)	(0.99)	(0.73)	(1.04)	(0.02)	(0.01)	(0.01)	(0.01)
R^2	0.84	0.88	0.77	0.78	0.78	0.93	0.75	0.88
Black								
Pov/100	–22.20	–27.49	–18.98	–25.48	–0.14	–0.16	–0.06	–0.07
	(2.97)	(4.17)	(2.18)	(4.25)	(0.03)	(0.04)	(0.03)	(0.04)
Rural	0.99	1.42	2.74	3.13	–0.02	–0.03	0.01	–0.01
	(0.91)	(1.58)	(0.91)	(1.99)	(0.01)	(0.01)	(0.01)	(0.01)
R^2	0.91	0.86	0.90	0.79	0.71	0.73	0.31	0.46
Tests for Equality of Coefficients (*p* Values, Two-Tailed Test)								
Poverty	0.04	0.01	0.07	0.28	0.04	0.00	0.07	0.01
Rural	0.14	0.31	0.06	0.29	0.11	0.97	0.01	0.55
Test of That Coefficient on Black in Pooled Model = 0								
p value	0.03	0.41	0.00	0.02	0.02	0.34	0.00	0.00

Notes: Based on simple OLS cross-populations regressions of adjusted poverty rate (see Table 1) and a rural indicator on the health outcome. Regressions were estimated separately by gender and race. The 11 black populations and 12 white populations listed in Table 1 represent the samples. The first two rows of test statistics represent *p* values for the test that the coefficients on the poverty rate and the rural indicator for the black and white populations are not statistically different from each other. The third row of test statistics represents *p* values for the test that there is no difference between blacks and whites in a regression that pools the white and black populations and constrains the slope coefficients to be the same across the races.

FIGURE 1. LIFE EXPECTANCY AND AREA POVERTY

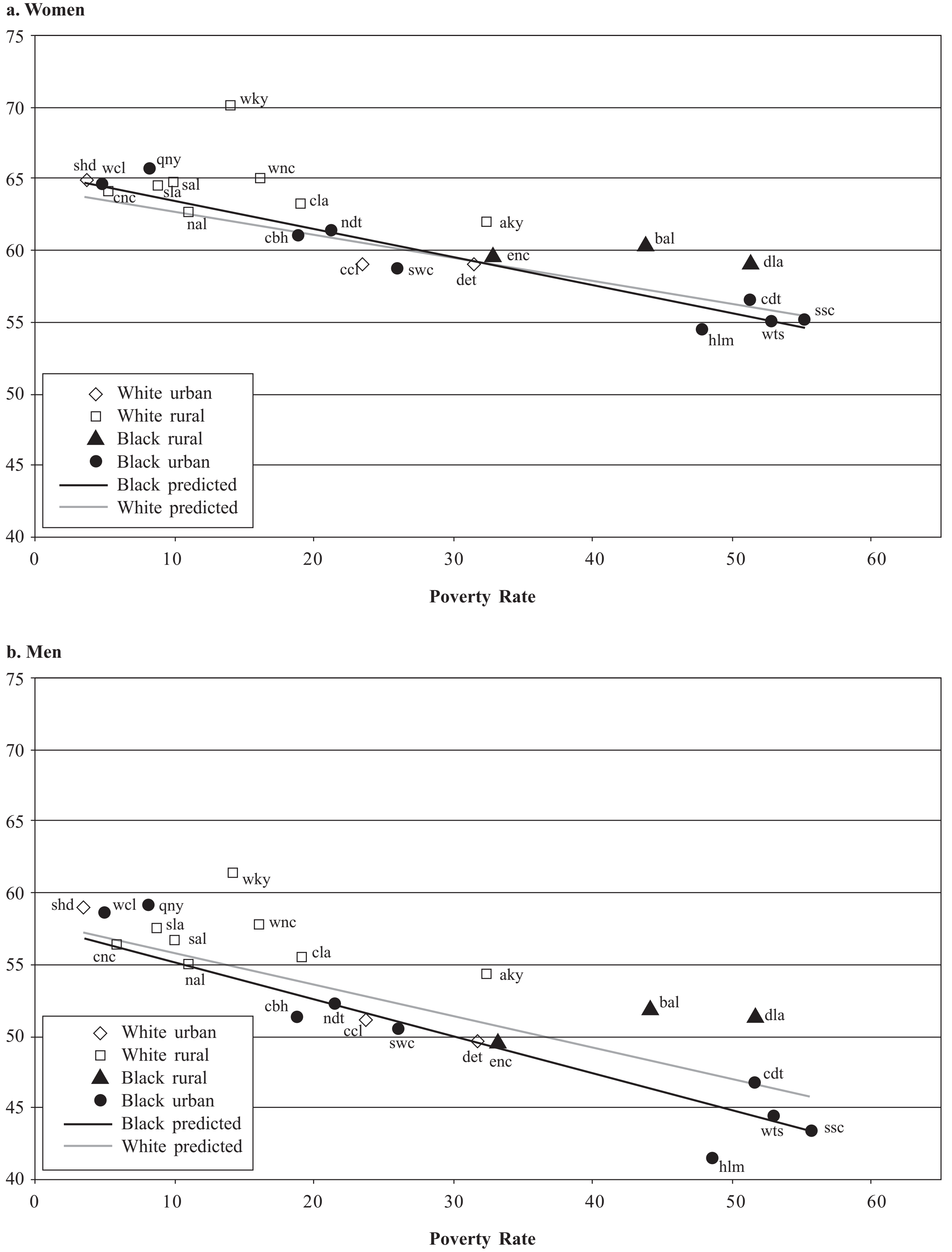


TABLE 5. PREDICTED PREVALENCE OF FUNCTIONAL LIMITATION AMONG BLACKS: PERCENTAGE WITH ANY LIMITATION (PERCENTAGE WITH ONLY PERSONAL CARE/MOBILITY LIMITATIONS IN PARENTHESES)

	All U.S.		Poor Urban				Poor Rural		
	Whites	Blacks	Harlem	Central City Detroit	South Side Chicago	Watts	East North Carolina	Black Belt Alabama	Delta Louisiana
Women, Age									
35	7 (3)	15 (9)	16 (11)	17 (10)	17 (12)	20 (13)	15 (9)	17 (10)	16 (9)
55	17 (7)	33 (18)	34 (20)	36 (17)	35 (21)	40 (23)	33 (16)	36 (17)	35 (17)
75	42 (26)	56 (38)	58 (41)	60 (38)	59 (43)	65 (46)	56 (35)	60 (38)	59 (37)
Men, Age									
35	9 (3)	18 (10)	21 (14)	22 (11)	23 (14)	27 (16)	22 (13)	23 (13)	25 (12)
55	20 (6)	32 (16)	34 (20)	35 (16)	37 (20)	42 (22)	36 (18)	37 (19)	39 (17)
75	41 (20)	54 (33)	57 (38)	59 (33)	60 (39)	66 (42)	59 (36)	60 (37)	62 (35)
			Nonpoverty Urban						
			Queens	Northwest Detroit	Southwest Chicago	Crenshaw/ Baldwin Hills			
Women, Age									
35	7 (3)	15 (9)	10 (8)	14 (9)	12 (8)	14 (9)			
55	17 (7)	33 (18)	23 (15)	32 (16)	27 (14)	30 (16)			
75	42 (26)	56 (38)	44 (34)	55 (35)	49 (32)	53 (36)			
Men, Age									
35	9 (3)	18 (10)	13 (10)	17 (9)	15 (10)	17 (10)			
55	20 (6)	32 (16)	23 (14)	32 (13)	26 (14)	28 (15)			
75	41 (20)	54 (33)	43 (29)	53 (37)	47 (29)	51 (31)			

Source: 1990 U.S. Census 5% PUMS.

but far more steeply for whites than for blacks. Figures 2a (for women) and 2b (for men) summarize these relationships graphically for health-induced limitations in mobility and personal care. (General patterns are similar for any functional limitation.) A striking finding is that in areas with high poverty rates, blacks' and whites' prevalences of functional limitation almost converge, whereas in areas with low poverty rates, whites are substantially less likely than blacks to suffer severe limitations. Although economic characteristics of residential areas are strongly related to the prevalence of severe limitations among whites, this relationship is somewhat less strong for blacks. Even blacks who live in relatively high-income areas suffer greater functional limitation than whites. Unlike the case of life expectancy, the regression results for functional limitations show relatively little evidence of any interaction between poverty rate and urban/rural residence among blacks. Whites living in rural areas, however, are more likely to be disabled than those in urban areas.

Active Life Expectancy

To summarize the variation among the study populations in mortality and disability experience, we estimate the average years of active life expectancy for 16-year-old males and females in each population. In Tables 7 and 8 we report these figures along with the percentage of years of expected life after age 16 that are estimated to be inactive. Again, these findings highlight variation within and between whites and blacks and between men and women. They also indicate differences in aging and quality of life for individuals across groups.

Nationwide, blacks have both shorter life expectancies and shorter active life expectancies than whites, and also spend a larger fraction of their lives inactive. Similar to findings based on national averages (Hayward and Heron 1999), our findings show that women have longer life expectancies and active life expectancies than men; in almost every population, however, women spend a larger proportion of their lives inactive than do men. When we combine the disadvantages associated with being black and being female, we find that black 16-year-old women can expect to spend more than one-quarter of their remaining years suffering from a chronic health-induced activity limitation, and almost one-fifth of their remaining years suffering from one of the more severe disabilities that limit their mobility or capacity for personal care. The former proportion is about 50% higher than the proportion of life spent with any limitation by white women nationwide (and 65% higher than among white men nationwide); the latter is about twice as great as the proportion of

TABLE 6. PREDICTED PREVALENCE OF FUNCTIONAL LIMITATION AMONG WHITES: PERCENTAGE WITH ANY LIMITATION (PERCENTAGE WITH ONLY PERSONAL CARE/MOBILITY LIMITATIONS IN PARENTHESES)

	All U.S.		Poor Urban		Poor Rural			
	Whites	Blacks	Cleveland	Detroit	Appalachian Kentucky	West North Carolina	Northeast Alabama	Central Louisiana
Women, Age								
35	7 (3)	15 (9)	10 (4)	11 (5)	16 (6)	10 (4)	10 (4)	10 (4)
55	17 (7)	33 (18)	22 (10)	24 (11)	33 (15)	22 (10)	23 (10)	21 (10)
75	42 (26)	56 (38)	48 (30)	51 (34)	62 (41)	48 (31)	50 (30)	48 (32)
Men, Age								
35	9 (3)	18 (10)	14 (5)	16 (7)	19 (7)	11 (4)	11 (4)	14 (4)
55	20 (6)	32 (16)	27 (9)	31 (13)	36 (14)	23 (8)	23 (8)	27 (8)
75	41 (20)	54 (33)	53 (25)	57 (34)	63 (36)	48 (25)	47 (24)	53 (23)
			Nonpoverty Urban		Nonpoverty Rural			
			West Cleveland	Sterling Hghts. N. Sub., Detroit	Western Kentucky	West Central North Carolina	Southwest Alabama	Southeast Louisiana
Women, Age								
35	7 (3)	15 (9)	5 (2)	7 (3)	9 (3)	7 (3)	9 (4)	8 (4)
55	17 (7)	33 (18)	11 (5)	17 (8)	19 (8)	15 (7)	19 (9)	19 (9)
75	42 (26)	56 (38)	30 (19)	40 (25)	45 (25)	37 (23)	44 (28)	44 (29)
Men, Age								
35	9 (3)	18 (10)	6 (2)	8 (3)	11 (4)	9 (3)	10 (4)	8 (4)
55	20 (6)	32 (16)	12 (4)	16 (6)	22 (7)	19 (7)	21 (8)	17 (7)
75	41 (20)	54 (33)	30 (14)	37 (17)	46 (22)	41 (20)	45 (23)	38 (22)

Source: 1990 U.S. Census 5% PUMS.

life spent with severe limitations by white women nationwide (and more than twice that of white men nationwide).

Active life expectancy after age 16 varies widely across the local study populations, from a low of 30 years for black men in some poor urban locales to a high of 55 years for white women in the advantaged Cleveland population. The percentage of remaining years spent inactive ranges from 12% (for any limitation) and 5% (for the more severe limitations) among white men in the advantaged Cleveland population to 33% (any limitation) and 22% (more severe limitations) for black women in Watts. That is, the group with the worst profile spends almost three times as great a proportion of life with some health-induced limitation as the group with the best profile, and almost five times as great a proportion with a severe limitation.

Among African Americans, residents of poor urban areas have the fewest years of active life expectancy; those in the poor rural areas have slightly higher active life expectancies, which approximate the black national average; and those in relatively advantaged populations tend to exceed the black national average somewhat. The more compressed distribution of prevalence of limitations, compared with mortality, also results in a narrower distribution of active life expectancy. For example, men in Black Belt Alabama have nine more years of life expectancy at age 16 than their counterparts in Harlem; yet the difference in active life expectancy is only four years. Despite their longer life expectancy, residents of Black Belt Alabama spend a larger proportion of their lives inactive than do Harlem residents.

Among white populations, we find a pattern of length of active life expectancy similar to that among blacks: urban poor populations and Appalachia are at the low end, followed by the other white rural poor populations, and white rural advantaged populations are intermediate between these groups and white urban advantaged populations. The difference between white urban poor and white urban advantaged populations is quite large: 7 to 10 fewer years of active life expectancy among women, and over 10 fewer years among men. Active life expectancies among poor urban white populations and poor white Appalachians are comparable to the black national average and to active life expectancies in the poor rural black populations.

In general, life expectancies are longest and the duration of life spent inactive is shortest for whites nationwide and for those who live in affluent areas. Urban poor blacks face the shortest life expectancies, and spend a large proportion of their short lives suffering functional limitations. The rural poor have longer life expectancies than the urban poor, but

FIGURE 2. LOG-ODDS OF PERSONAL CARE DISABILITY, AGE 55 AND AREA POVERTY

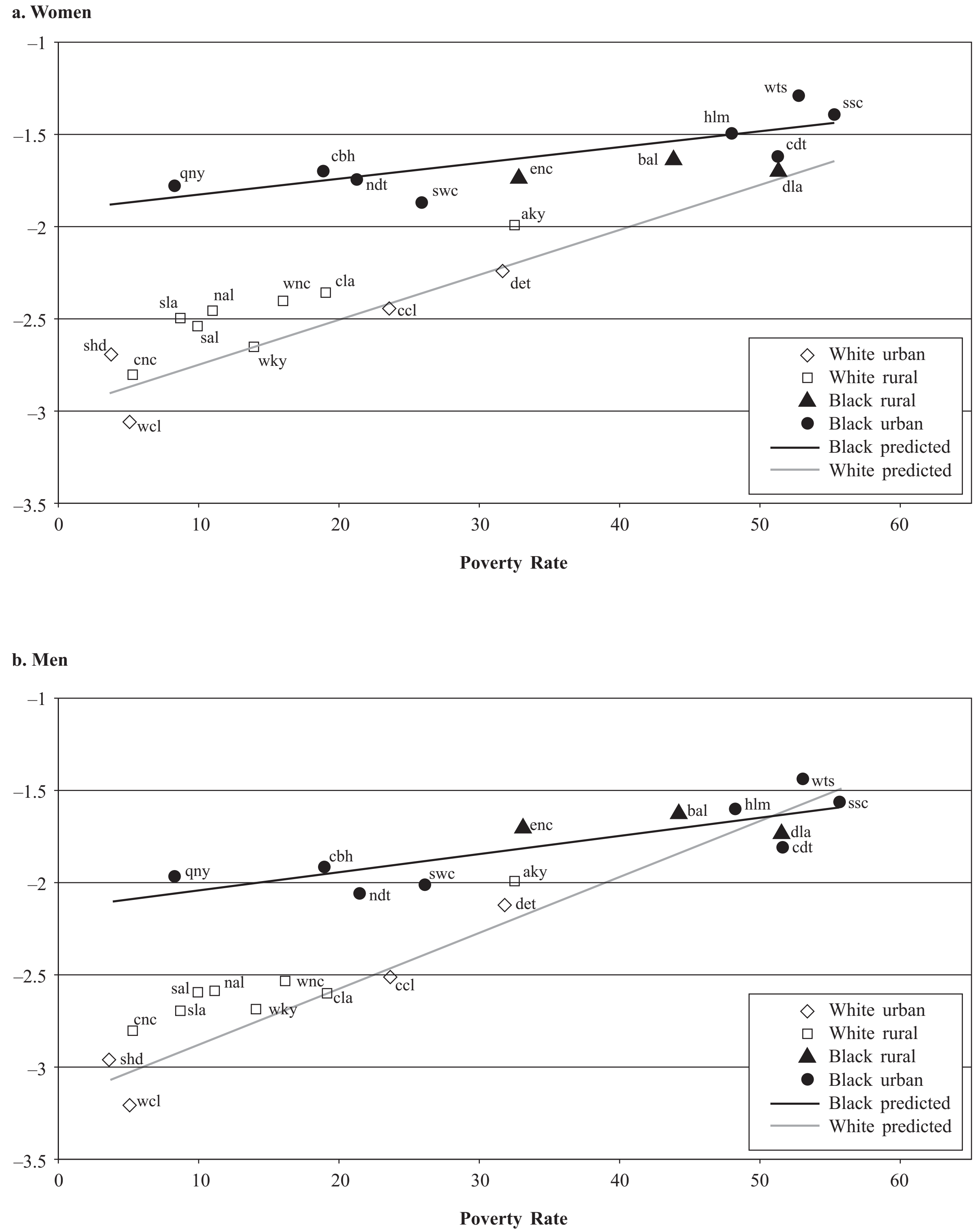


TABLE 7. ACTIVE LIFE EXPECTANCY: BLACKS AGE 16+

	Any Limitation		Mobility or Personal Care Limitation	
	Active Life Expectancy	% of Expected Life Inactive	Active Life Expectancy	% of Expected Life Inactive
Women				
U.S. whites	52	19	57	11
U.S. blacks	43	28	49	18
Poverty areas				
Harlem	39	29	44	20
Central City Detroit	39	31	46	18
South Side Chicago	39	30	43	21
Watts	37	33	43	22
East North Carolina	42	29	49	18
Black Belt Alabama	41	32	49	19
Delta Louisiana	41	30	48	18
Nonpoverty areas				
Queens	50	24	53	19
Northwest Detroit	45	27	50	18
Southwest Chicago	45	24	50	15
Crenshaw/Baldwin Hills	44	27	50	18
Men				
U.S. whites	48	17	54	7
U.S. blacks	39	25	45	14
Poverty areas				
Harlem	32	25	35	16
Central City Detroit	33	27	39	14
South Side Chicago	31	27	36	17
Watts	30	33	36	19
East North Carolina	35	28	41	16
Black Belt Alabama	36	30	42	17
Delta Louisiana	35	31	43	16
Nonpoverty areas				
Queens	45	22	49	15
Northwest Detroit	39	23	45	13
Southwest Chicago	39	21	43	13
Crenshaw/Baldwin Hills	39	24	44	14

Sources: 1990 U.S. Census (Summary Tape Files and 5% PUMS) and State and City Vital Statistics Data 1989–1991.

Note: Population counts are adjusted by local-area undercount estimates.

spend as great a fraction of their lives, or greater, with a disability. African American residents of advantaged urban areas have substantially higher life expectancies than their poor urban counterparts; in some cases their life expectancies approach the white national average. Unlike whites nationwide, however, they spend a large proportion of their lives with a chronic health problem. On average, for example, black female residents of the Queens area have one more year of life expectancy than do whites nationwide; yet their active life expectancies are shorter, and they spend almost twice as great a proportion of their lives with a severe limitation as do white women nationwide.

These relationships are summarized in the second half of Table 4. The regressions show that as the poverty rate increases, active life expectancy decreases; the rate is slightly steeper for men than for women, but is virtually comparable for blacks and for whites. As with disability prevalence, these figures show muted evidence of any interaction between poverty rate and urban/rural residence. Figures 3a (for women) and 3b (for men) summarize the relationship between the poverty rate and active life expectancy across the local populations, based on truncation of active life by the more severe functional limitations in mobility and personal care.

TABLE 8. ACTIVE LIFE EXPECTANCY: WHITES AGE 16+

	Any Limitation		Mobility or Personal Care Limitation	
	Active Life Expectancy	% of Expected Life Inactive	Active Life Expectancy	% of Expected Life Inactive
Women				
U.S. whites	52	19	57	11
U.S. blacks	43	28	49	18
Poverty areas				
Cleveland	46	21	52	12
Detroit	45	23	51	14
Appalachian Kentucky	42	32	51	18
West North Carolina	49	24	56	15
Northeast Alabama	48	24	54	13
South Central Louisiana	49	23	54	14
Nonpoverty areas				
Western Cleveland	55	14	58	9
Sterling Heights	52	19	57	12
Western Kentucky	52	26	59	16
West Central North Carolina	53	18	57	11
Southwest Alabama	51	22	56	13
Southeast Louisiana	51	21	56	14
Men				
U.S. whites	48	17	54	7
U.S. blacks	39	25	45	14
Poverty areas				
Cleveland	40	22	47	8
Detroit	37	25	43	12
Appalachian Kentucky	38	31	47	14
West North Carolina	45	22	52	10
Northeast Alabama	44	20	50	9
South Central Louisiana	42	24	50	9
Nonpoverty areas				
Western Cleveland	51	12	55	5
Sterling Heights	50	16	55	7
Western Kentucky	47	23	55	10
West Central North Carolina	47	18	52	8
Southwest Alabama	45	20	51	9
Southeast Louisiana	48	16	52	8

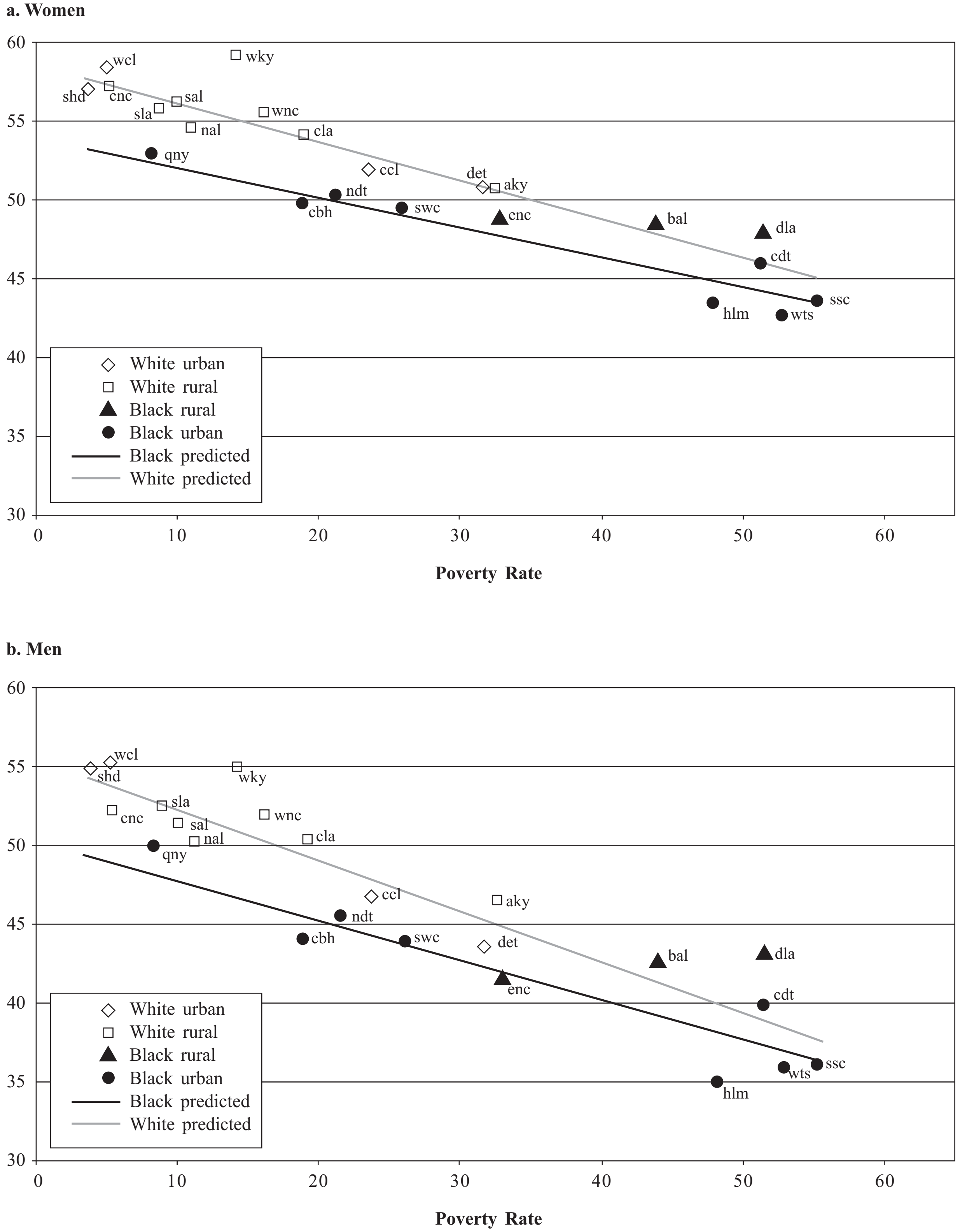
Sources: 1990 U.S. Census (Summary Tape Files and 5% PUMS sample) and State and City Vital Statistics Data 1989–1991.

Note: Population counts are adjusted by local-area undercount estimates.

In summary, when estimated coefficients on the poverty rate variable are compared, the coefficient in the active life expectancy regression is as large for blacks as in the life expectancy regression, and larger (in absolute value) for whites. For white women, for example, the coefficient on the poverty rate for active life expectancy (no limitations) is –33.08; for active life expectancy (no mobility or personal care limitations) it is –24.51; for life expectancy, however, it is only –16.25. This finding implies that the number of years of active life gained for a white female resident of a nonpoor area, compared with a poor area, is greater than the number of total additional years of life expected. Similarly striking results are evident for white men. That is, for both white women and white men, each extra year of life expectancy associated with residence in a nonpoor area, compared with a poor area, has more than a one-for-one effect on the number of active years of life expected.

For black men and women, the coefficients on the poverty rate variable across the outcomes of life expectancy and active life expectancy are roughly comparable. For black

FIGURE 3. ACTIVE LIFE EXPECTANCY AND AREA POVERTY



men, for example, the coefficients respectively are –26.21, –27.49, and –25.48 for regressions on life expectancy, active life expectancy (no limitation), and active life expectancy (no personal care or mobility limitation). That is, each year of life expectancy gained for a black man or woman in a nonpoor area, compared with a poor area, is an active year. Unlike the case for whites, however, years of inactive life are not reduced for a black man or woman resident of a nonpoor area, compared with a poor area. In regard to urban/rural differences, coefficients on the rural variable for the outcome of life expectancy, compared with the outcome of active life expectancy, show that although rural residents' life expectancies are higher than those of urban residents, generally these gains are made primarily (and, in some instances, entirely) in inactive years.

DISCUSSION

These findings describe large disparities in the length and quality of life that Americans can expect to enjoy across localities and populations, by race, and by gender. Life expectancy at age 16 varies across the study populations by as much as 28 years: those at the high end of the distribution live 60% longer than those at the low end. Youths disadvantaged on (male) gender, race, and urban poverty face as little as a 37% chance of surviving to age 65 and a 7% probability of surviving to age 85. For persons advantaged on all these dimensions, the chance of surviving to age 65 is approximately 90%, and the chance of surviving to age 85 is about 40%.

Variations in functional health status, and hence in active life expectancy, are also substantial by race and, within race, by economic characteristics. Twenty-five years of active life separate those who face the shortest and the longest active life expectancy after age 16. Differences by gender are very small; those based on urban/rural location are muted in comparison with differences in mortality profiles along these dimensions. At young adult ages, black residents of poor localities face two to four times as great a rate of disability prevalence as do whites nationwide. Although the differences are reduced in old age, disability prevalence is often 1.5 times as high in disadvantaged populations as in more highly advantaged populations.

Hayward and Heron (1999), who disaggregated national data by gender and race/ethnicity, found that some U.S. populations enjoy long lives with morbidity compressed at the end of life, whereas others face long periods of morbidity. Blacks, on average, suffered the shortest and least healthy lives of the several racial and ethnic groups studied nationwide by these authors. Our analyses revealed heterogeneity in length and quality of life *within* the black and the white populations with respect to their communities' economic characteristics and, to some extent, the location of their residence. We also found evidence of an inverse association between overall life expectancy and years of inactive life. On average, for example, black women residents of poor areas spend about 20% of their adult lives suffering from severe health-induced disabilities that limit their mobility or capacity for personal care, whereas relatively advantaged white women, who live longer, spend only about 12% of their adult lives severely disabled. Among white women, we found that persons age 75 are about 10 times more likely to suffer such disabilities than those age 35, and three times more likely than persons age 55. Among black women, the differences by age are significantly smaller: persons age 75 are only about four times more likely to suffer severe disabilities than those age 35, and only about twice as likely as those age 55. Thus the period of severe disability for white women is not only shorter but also appears to be more compressed at the end of life than for black women; this finding suggests that white women are less likely to experience morbidity throughout the lifespan.

We found a somewhat different social pattern for functional health status than for mortality. Among economically better-off black populations, for example, who have substantially longer life expectancies than poor black populations, functional health status is only modestly better. The greater number of years that black residents of more affluent areas can expect to live, relative to black residents of poor areas, are active years; yet no reduction in the number of inactive years is associated with residence in economically better-off areas. In contrast, we find a steep economic gradient in functional limitation among white populations. For whites, increases in life expectancy across geographic areas are associated not with an increase but with a decrease in the average number of years a person spends in poor health; this echoes similar findings by Bone et al. (1995) for Britain. We also found that in high-poverty populations, particularly African American populations, rural residents have significantly longer life expectancies than urban residents, but their functional status is only modestly better. Gains in life expectancy associated with rural residence, compared with urban residence, are primarily gains in inactive years.

These findings suggest cross-population variation in the relationship between infirmity and the length of life. To date, scholarly discussion of this relationship has focused primarily on the elderly. As a consequence, only individuals age 50 or older are included in samples for data sets from several longitudinal surveys designed with this question in mind. Our current findings suggest the importance of studying younger people as well. For some disadvantaged African American populations, the probability of dying by age 50 is roughly comparable to dying by age 70 for whites nationwide; the probability for black men in high-poverty urban locales is higher. The probability of experiencing a health-induced functional limitation is as high at age 35 in some African American populations as it is at age 55 for whites nationwide; and disability rates at age 55 in some African American populations approach those of 75-year-old whites nationwide. Other descriptive research has documented that substantial proportions of African Americans suffer potentially disabling and life-threatening chronic diseases in young adulthood, even as early as their twenties or early thirties (Geronimus 1994).

Micro-level studies usually find that racial differences in mortality are reduced by controlling for individual income, although they persist (Otten et al. 1990; Sorlie et al. 1995;

Pappas et al. 1993; Williams 1999). We find that areal income accounts for mortality differences between black and white populations. The mechanisms that explain this striking finding deserve continued investigation. The finding suggests that areal income measures tap a broader construct than does micro-level income (Geronimus and Bound 1998; Geronimus, Bound, and Neidert 1996). Communities are more than simple reflections of their residents' socioeconomic conditions (Hayward et al. 1997), and areal income may indicate a more comprehensive package of risks or benefits associated with residence in a specific location than does household income alone. Investigations that illuminate key features of these "packages" would improve our understanding of mortality differences.

Levels of mortality among African American residents of high-poverty areas are heterogeneous with respect to urban/rural location. This finding suggests that urban-area packages may contain elements that undermine longevity or that rural-area packages may include elements that confer protection. For example, high-poverty urban areas are more likely than their rural counterparts to be characterized by densely crowded environments, pervasive ambient stressors, homelessness, decayed or infested housing stock, joblessness, and crime. In turn, social networks in high-poverty rural areas may be less overburdened or may suffer less disruption than those in high-poverty urban areas, and thus may operate more effectively to promote health or to avert death among their members (Hayward et al. 1997; House, Landis, and Umberson 1988). These geographically marked characteristics add plausibility to the view that urban-rural mortality differences reflect salutary characteristics of rural environments or harmful characteristics of urban environments.

This conclusion, however, might be modified—either tempered or reinforced—if significant, systematic health-related migration occurs between impoverished urban and rural areas. Yet we, like other investigators who have adopted this residential perspective, implicitly assume that any health-based difference for migration is not sufficient to alter our general findings. Few investigators have addressed the relationship between migration patterns within the continental United States and the health of local populations. In general, research on this question is scant because few data sets link health with migration. Some researchers have found evidence that the onset of functional disability influences moves among the elderly (Longino et al. 1991; Speare, Avery, and Lawton 1991), but these studies do not distinguish between ethnic or socioeconomic groups or between moves within or across local areas. Findley (1988), using a special supplement to the Health Interview Survey that included information on recent moves, found no association between health and migration in young or middle-adult age groups. We believe that this issue deserves additional empirical investigation, even while we observe that our findings are descriptively valid, regardless of its possible influence. That is, our empirical analyses reveal significant mortality differences by race, location, and economics, regardless of whether health-related migration is a factor.

Our findings raise an array of related questions that cannot be answered with our data and indicate the need for continued investigation. Most notably, these findings highlight the fact that mortality and functional health status are conceptually different indicators of health. Although functional limitations may indicate morbidity processes that are related directly to mortality, they also can indicate morbidity processes (such as arthritis) that are not life-threatening. Thus our findings might be an indication that the ailments suffered by African American residents of high-poverty rural areas are less likely to be life-threatening than those suffered by the their urban counterparts. Alternatively, for populations with functional limitation rates denoting the same morbidity processes (e.g., chronic hypertension), our findings might indicate that members of some populations are in a better position than others to manage these conditions and to lower the resulting risk of mortality. In addition, environmental contingencies influence the extent to which a chronic health condition is experienced as limiting (Verbrugge and Jette 1994). Access to more comprehensive data on morbidity would help to determine how extensively these factors account for our findings.

The findings on African American populations stimulate two questions for continued research. First, why do black residents of economically advantaged areas not appear to enjoy, in equal measure with whites, the expected positive influence of affluence on their health? Second, why do African American residents of poor urban locations seem to convert incidents of chronic disease into case fatality more rapidly than African American residents of poor rural or advantaged urban areas? Again, our data do not permit examination of these issues, but we catalogue possible hypotheses for future work.

Regarding the first question, selective mortality is one possible explanation. Black mortality rates are dramatically higher in impoverished urban areas than in better-off urban areas. If the residents of the poor area who die are those in the worst health, the overall health of the surviving population will be improved and may appear comparable to the health of the better-off population. We cannot reject this possibility with our data; however, the contribution of homicide to excess deaths in impoverished urban African American populations would militate against such a selection process.

Another possible explanation draws on evidence, in the social epidemiological literature, of a high prevalence of stress-related disease among middle-class African Americans (relative to middle-class whites). To explain new cases of hypertension in this population, some epidemiological studies point to the experience of race-related stress and the prolonged use of high-effort mental coping mechanisms among African Americans who succeed in white-collar work environments not previously characterized by racial diversity (James et al. 1992; Light et al. 1995). High-effort coping with such stressors is accompanied by sharp increases in heart rate and blood pressure at regular intervals throughout each day. Over time, such patterned sympathetic arousal can "deregulate" the basic mechanisms that maintain blood pressure within the so-called "normal" range

(James 1994). More speculatively, one might extend this line of thinking to the possible biopsychosocial impact of living in suburban neighborhoods not previously accessible to African Americans.

Investigators find that advantaged African Americans report considerable experience with racial discrimination and racial alienation; in some cases, they report greater experience with racism than do the less advantaged (Bobo and Hutchings 1996; Feagin 1991; Feagin and Sikes 1994; Forman, Williams, and Jackson 1997; Jackson, Williams, and Torres 1996; Schuman et al. 1997). Cose (1993) and Hooks (1995) suggest that these experiences elicit rage in some affluent African Americans. Such race-related stress can be harmful to health (Williams 1999; Williams et al. 1997); this point makes more plausible the interpretation that African Americans of all social classes pay a disproportionately high price in stress-related disease for their membership in American society.

The socioeconomic gradient for mortality, however, indicates that affluent African Americans are less likely than disadvantaged African Americans to pay the additional price of early mortality. One explanation is that more affluent African Americans may have greater access to medical services and resources that help them to avert premature death, despite high morbidity (Link et al. 1998). Another (perhaps complementary) explanation is that African Americans who enjoy socioeconomic success in the face of race-based barriers to their achievement also may be a population singularly determined to cope effectively with chronic disease, among other stressors (James 1994).

Although mechanisms cannot yet be delineated, the current findings suggest substantial population variation in mortality, functional limitation, and active life expectancy across residential lines. They also show relatively small variation in rates of health-induced functional limitation among African Americans. Whether they are rural or urban, male or female, or residents of high-poverty or economically advantaged areas, and whether or not their morbidity results in high rates of excess mortality and relatively short life expectancies, African Americans appear to suffer a heavy burden of poor health throughout adulthood. The factors underlying this disturbing finding call for continued, systematic exploration.

APPENDIX TABLE A1. STUDY POPULATIONS

African American

- Poor
  - Harlem:
    - African Americans living in sections of the Central Harlem Health Center District in New York City.
  - Central City Detroit:
    - African Americans living in the Central, University, Central Business District, Airport, Chene, Kettering, Butzel, Lafayette, Rosa Parks, and Jeffries subcommunities of Detroit, Michigan.
  - South Side Chicago:
    - African Americans living in the Douglas, Oakland, Fuller Park, Grand Boulevard, Kenwood, Washington Park, and Hyde Park community areas of Chicago, Illinois.
  - Watts:
    - African Americans living in the Watts area of South Central Los Angeles, California and adjacent areas to the north, south, and west.
  - East North Carolina:
    - African Americans living in Pitt, Northampton, Halifax, and Edgecombe Counties.
  - Black Belt Alabama:
    - African Americans living in rural counties in and around the Black Belt region of Alabama, including Dallas, Fayette, Greene, Bibb, Sumter, Hale, Lamar, Marengo, Marion, Perry, and Pickens Counties.
  - Delta Louisiana:
    - African Americans living in Caldwell, East Carroll, Franklin, Jackson, Madison, Morehouse, Richland, Tensas, Union, West Carroll, Avoyelles, Catahoula, Concordia, Grant, La Salle, Vernon, and Winn Parishes in Louisiana.

(continued)

- Nonpoverty
  - Queens:
    - African Americans living in sections of the Jamaica East and Flushing Health Center Districts located in eastern Queens, New York City.
  - Northwest Detroit:
    - African Americans living in the McNichols, Harmony Village, Cerveny, Palmer Park, Bagley, Pembroke, and Greenfield subcommunities of Detroit, Michigan.
  - Southwest Chicago:
    - African Americans living in the Roseland, Pullman, and West Pullman community areas of Chicago, Illinois.
  - Crenshaw/Baldwin Hills:
    - African Americans living in areas of suburban Los Angeles, California, including Crenshaw, Ladera Heights, Leimert Park, Hyde Park, Sentous, Baldwin Hills, View Park, and Windsor Hills.

White

- Poor
  - Cleveland:
    - Non-Hispanic whites living in subcommunities in the west-central area of Cleveland, Ohio, including Ohio City/Near West Side, Detroit-Shoreway, Tremont, Clark-Fulton, Stockyards, Brooklyn Centre, and Old Brooklyn.
  - Detroit:
    - Non-Hispanic whites living in subcommunities on the northeastern and southernwestern periphery of Detroit, Michigan, including Burbank, Mt. Olivet, Connor, Grant, Pershing, Nolan, Airport, Clark Park, Delray, Springwell, Tireman, Condon, and Chadsey.

(continued)

(Table A1, continued)

Appalachia:
Whites living in the Appalachian region of Kentucky, including Lee, Leslie, Owsley, Wolfe, Breathitt, Knott, Letcher, and Perry Counties.
West North Carolina:
Whites living in Alleghany, Ashe, Avery, Mitchell, Watauga, Wilkes, and Yancey Counties.
Northeast Alabama:
Whites living in DeKalb, Jackson, and Marshall Counties.
South Central Louisiana
Whites living in Acadia and Vermilion Parishes.
Nonpoverty
Western Cleveland:
Whites living in the suburbs of Bay Village, Fairview Park, Lakewood, North Olmstead, Rocky River, and Westlake in the greater Cleveland, Ohio metropolitan area.
Sterling Heights:
Whites living in this northern suburb of Detroit, Michigan.
Western Kentucky:
Whites living in Ballard, Calloway, Fulton, Graves, Hickman, Marshall, McCracken, and Carlisle Counties.
West Central North Carolina:
Whites living in Iredell and Lincoln Counties.
Southwest Alabama:
Whites living in Dallas, Marengo, Perry, Sumpter, Clarke, Choctaw, Conecuh, Monroe, Washington, and Wilcox Counties.
Southeast Louisiana:
Whites living in St. Charles, St. John the Baptist, St. James, and Assumption Parishes.

APPENDIX TABLE A2. SUMMARY DATA ON LOCAL STUDY AREAS, 1990

	Local Populations						
	Black				White		
	Population Size	Mean Family Income	% Families in Poverty		Population Size	Mean Family Income	% Families in Poverty
Poor				Poor			
Harlem				Cleveland			
Mortality area	92,926	24,129	33.1	Mortality area	78,973	26,434	17.8
PUMA (5108)	92,926	24,129	33.1	PUMA (3902)	78,973	26,434	17.8
Central City Detroit				Detroit			
Mortality area	70,288	22,844	38.0	Mortality area	76,278	27,819	23.0
PUMA (3301)	88,586	21,602	40.8	PUMA (3303,3306)	89,394	27,414	24.7
South Side Chicago				Appalachian Kentucky			
Mortality area	120,328	21,882	49.9	Mortality area	122,296	22,428	32.9
PUMA (3016)	120,328	21,882	49.9	PUMA (900)	122,296	22,428	32.9
Watts				West North Carolina			
Mortality area	122,441	23,493	35.8	Mortality area	167,524	30,675	12.0
PUMA (6503)	103,995	21,832	38.6	PUMA (500)	167,524	30,675	12.0
East North Carolina				Northeast Alabama			
Mortality area	107,573	20,802	32.8	Mortality area	167,037	30,480	13.6
PUMA (2900,4000)	107,573	20,802	32.8	PUMA (2200)	167,037	30,480	13.6
Black Belt Alabama				South Central Louisiana			
Mortality area	93,695	17,222	48.7	Mortality area	87,682	29,274	18.9
PUMA (300,500)	93,695	17,222	48.7	PUMA (800)	87,682	29,274	18.9
Delta Louisiana							
Mortality area	101,928	15,524	48.1				
PUMA (400,500)	101,928	15,524	48.1				

(continued)

(Table A2, continued)

	Local Populations						
	Black				White		
	Population Size	Mean Family Income	% Families in Poverty		Population Size	Mean Family Income	% Families in Poverty
Nonpoverty							
Queens				Western Cleveland			
Mortality area	91,692	57,177	4.0	Mortality area	171,677	57,167	3.2
PUMA (5413)	91,692	57,177	4.0	PUMA (4000)	171,677	57,167	3.2
Northwest Detroit				Sterling Heights			
Mortality area	104,337	39,804	15.5	Mortality area	113,452	54,424	2.7
PUMA (3304)	103,864	38,298	17.5	PUMA (4000)	113,452	54,424	2.7
Southwest Chicago				Western Kentucky			
Mortality area	111,239	34,096	21.2	Mortality area	169,357	33,281	12.5
PUMA (3019)	111,239	34,096	21.2	PUMA (100)	169,357	33,281	12.5
Crenshaw/Baldwin Hills				West Central North Carolina			
Mortality area	100,825	38,645	16.0	Mortality area	122,920	39,933	5.1
PUMA (6504)	109,644	34,709	18.2	PUMA (1000)	122,920	39,933	5.1
				Southwest Alabama			
				Mortality area	102,527	36,500	8.6
				PUMA (500,600)	102,527	36,500	8.6
				Southeast Louisiana			
				Mortality area	82,569	39,985	6.9
				PUMA (1700)	82,569	39,985	6.9

Sources: U.S. Census of Population and Housing, 1990: Population and Housing Characteristics for Census Tracts and Block Numbering Areas: various cities. (CPH-3); Social and Economic Characteristics: various states (CP-2). Washington, DC: U.S. Government Printing Office, 1993.

Note: Mean incomes and poverty rates are for families.

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