ORIGINAL REPORTS: EPIDEMIOLOGY

A FURTHER STUDY OF LIFE EXPECTANCY BY SOCIOECONOMIC FACTORS IN THE NATIONAL LONGITUDINAL MORTALITY STUDY

Charles C. Lin, PhD; Eugene Rogot, MA;
Norman J. Johnson, PhD; Paul D. Sorlie, PhD;
Elizabeth Arias, PhD

Objectives: The objective of this article is to provide estimates of life expectancy for White, Black, and Hispanic populations by socioeconomic factors. Effects of educational, income, employment, and marital status on life expectancy are presented and interpreted.

Design: The National Longitudinal Mortality Study, consisting of a number of Current Population Surveys (CPS) linked to mortality information obtained from the National Death Index, provides data to construct life tables for various socioeconomic and demographic groups. Probabilities of death are estimated using a person-year approach to accommodate the aging of the population over 11 years of follow up.

Results: Across various ethnicity-race-sex groups, longer life expectancy was observed for individuals with higher levels of education and income, and for those who were married and employed. The differences in life expectancy between levels of the socioeconomic characteristics tended to be larger for men than for women. Also, differences were found to be larger for the non-Hispanic Black population compared to the non-Hispanic White population. Hispanic White men exhibited patterns similar to those of non-Hispanic White and Black men.

Conclusions: For selected ethnicity-race-sex groups, the impact of socioeconomic variables on life expectancy is dramatic. The shorter life expectancy observed among the poor, the less educated, the unmarried, and those not in the labor force, highlights the impact of socioeconomic disadvantage on survival. Further, the substantial 14-year differential favoring the employed over those not in the labor force may be partially explained by unemployment due to poor health. Another reason may be that employed individuals have greater access to health care than do those not in the labor force. (*Ethn Dis.* 2003;13:240–247)

Key Words: Life Expectancy, Socioeconomic Factor, Mortality, Longitudinal Study

From the US Census Bureau (CL, ER, NJ); National Heart, Lung, and Blood Institute (PS); National Center for Health Statistics (EA); Washington, DC.

Address correspondence and reprint requests to Charles C. Lin, PhD; US Census Bureau; DSMD Room 3725-3; 4700 Silver Hill Road, Stop 8700; Washington, DC 20233-8700; 301-763-1978; 301-457-3766 (fax); charles.c.lin@census.gov

INTRODUCTION

Estimates of life expectancy for various levels of education were reported by Kitagawa and Hauser[1] for White men and White women in the United States in 1960. These estimates were based on abridged life tables these researchers constructed from their now classic cross-sectional study of mortality in the United States. A comparison of the findings from the National Longitudinal Mortality Study (NLMS) to those of the Kitagawa-Hauser study was reported by Rogot, Sorlie, and Johnson.[2] In that paper, the Kitagawa-Hauser estimates of life expectancy by education were compared to the corresponding estimates generated from the NLMS. In addition, life expectancies for various levels of income and employment status for White men and White women were estimated from the NLMS. Estimates of life expectancy by income for the White and Black populations, published in the *Health, United States, 1998*[3] report, were provided by the NLMS.

In this report, our main objectives are to extend the results of Rogot, Sorlie, and Johnson[2] with an additional 4 years of follow up, to estimate life expectancies for White, Black, and Hispanic populations according to education, family income, employment status,

and marital status, and to assess differences in life expectancy for these race-ethnicity groups, and between various socioeconomic strata.

METHODS

The study sample consists of 569,384 persons who were aged 25 years and over at the start of follow up (Table 1), pulled from a total of 822,347 persons of all ages who were part of the NLMS, a prospective study of mortality in the United States.[4] NLMS data consists of selected samples drawn from the Current Population Surveys (CPS) of March 1979, March 1981, March 1982, March 1983, March 1984, March 1985, and April, August, and December of 1980. These 9 samples were designated as cohorts for mortality follow up. Mortality status was ascertained by matching NLMS records to the National Death Index (NDI)[5] for the 11-year period from January 1, 1979 through December 31, 1989.

The CPS is a household and telephone interview survey, conducted by the US Census Bureau, consisting of probability cluster samples of households chosen from the civilian non-institutionalized population of the United States.[6] This survey has a response rate of approximately 96%. The primary purpose of the CPS is to provide estimates of monthly labor force participation. The CPS also provides data on various socioeconomic and demographic

Table 1. Study population age 25+ by sex, race, and Hispanic status, NLMS, 1979–89 follow-up

	Males		Females	
	N	D	N	D
White*	237,748	27,397	265,433	23,226
Hispanic	15,325	927	17,586	657
Not Hispanic	213,870	25,846	241,409	22,036
Black*	21,271	2,960	28,832	2,724
Hispanic	272	16	374	14
Not Hispanic	20,475	2,933	28,184	2,694
All races*†	266,546	30,908	302,838	26,308
Hispanic†	15,769	955	18,185	677
Not Hispanic†	241,496	29,315	277,857	25,079

Note: N=numbers of persons at start of follow-up; D=deaths in 1979–89 period.
* Includes unknown on Hispanic status.
† Includes other races and unknown races.

factors, and includes data required for record linkage with the NDI.

The record linking procedures and related methods used to determine mortality in the NLMS have been described in earlier reports.[4,7–9] For this study, NLMS records were matched to the NDI for the years 1979–1989. A total of 57,216 deaths have been identified for the 11-year follow-up period. These are broken down into sex, race, and ethnic origin categories, as described in Table 1. The responses collected on the CPS for variables such as sex, race, and Hispanic status, are obtained from the head of household for each member of the household. The respondent is given a predetermined list for each variable, and asked to identify which best describes each household member.

Life tables were constructed using 1-year probabilities of death for single years of age to estimate life expectancy (e_x) for the socioeconomic groups of interest. These probabilities were estimated using a person-year approach. Life tables were constructed for ages 25–95. The practice of using the age of 95 as the closing life expectancy in each table was taken from the US Decennial Life Tables in 1979–81 for the relevant sex-race group.[10–11] For some subgroups, the life tables were shortened because there were no deaths at the older ages to pro-

vide estimates. As a result, closing life expectancy values of ages less than 95 years were derived from the estimate of life expectancy of a comparable subgroup. For example, the closing life expectancy value for Hispanic White men in the labor force was obtained from the estimate of life expectancy for non-Hispanic White men in the labor force. Standard errors of e_x were computed following Chiang.[12] Two-sided tests of significance were conducted at the 1% level to safeguard significant results for multiple comparisons.

Variables studied include employment status, educational level, income level, and marital status. Employment status is derived from the detailed employment history obtained by the CPS. For analyses in this paper, the categories of "employed," "not employed," and "not in the labor force" are used. The category of "not employed" is for unemployed persons who were seeking work. The category of "not in the labor force" includes persons engaged in their own housework, those who are going to school, those unable to work, and "other," a category that includes retired persons or persons not working for any other reason. Education level is defined as the highest grade completed, and is presented in 3 categories: less than high school, high school, and greater than

high school. Family income is defined as the combined income of all members of the family, adjusted to 1980 income levels using the Consumer Price Index,[13] and given in 3 categories: income below $10,000, $10,000–$24,999, and $25,000 and over. There are insufficient data to provide finer categories of income. Marital status is presented as 3 categories: "married," "previously married," and "never married." The "previously married" category includes separated, widowed, and divorced. Although marital status is not strictly a socioeconomic status variable, it is an important social factor, and is consistently shown to have an effect on mortality, whereby married individuals have lower mortality rates than do unmarried individuals. Marriage may have a direct effect on mortality by conferring psychological and/or social support that mitigates illness. An additional hypothesis is that persons who marry may be healthier to begin with than those who do not marry. In other words, marital status could be a function of health status.[20]

There were too few individuals in the Hispanic Black category to be included in this study (see Table 1). Estimated life expectancies for subgroups with insufficient data (fewer than 100 deaths) were not computed.

RESULTS

The NLMS study group compared the average life expectancy for all ages with those for US White males, US Black males, US White females, and US Black females. Overall estimates of expectancies are given in Table 2 for ages 25, 45, and 65.

As shown in Table 2, life expectancy estimates from the NLMS were consistently greater than those given in the US life tables, by about 1 to 2 years for Whites, and 1 to 4 years for Blacks. The principal reason for this difference between the data sources is that the CPS
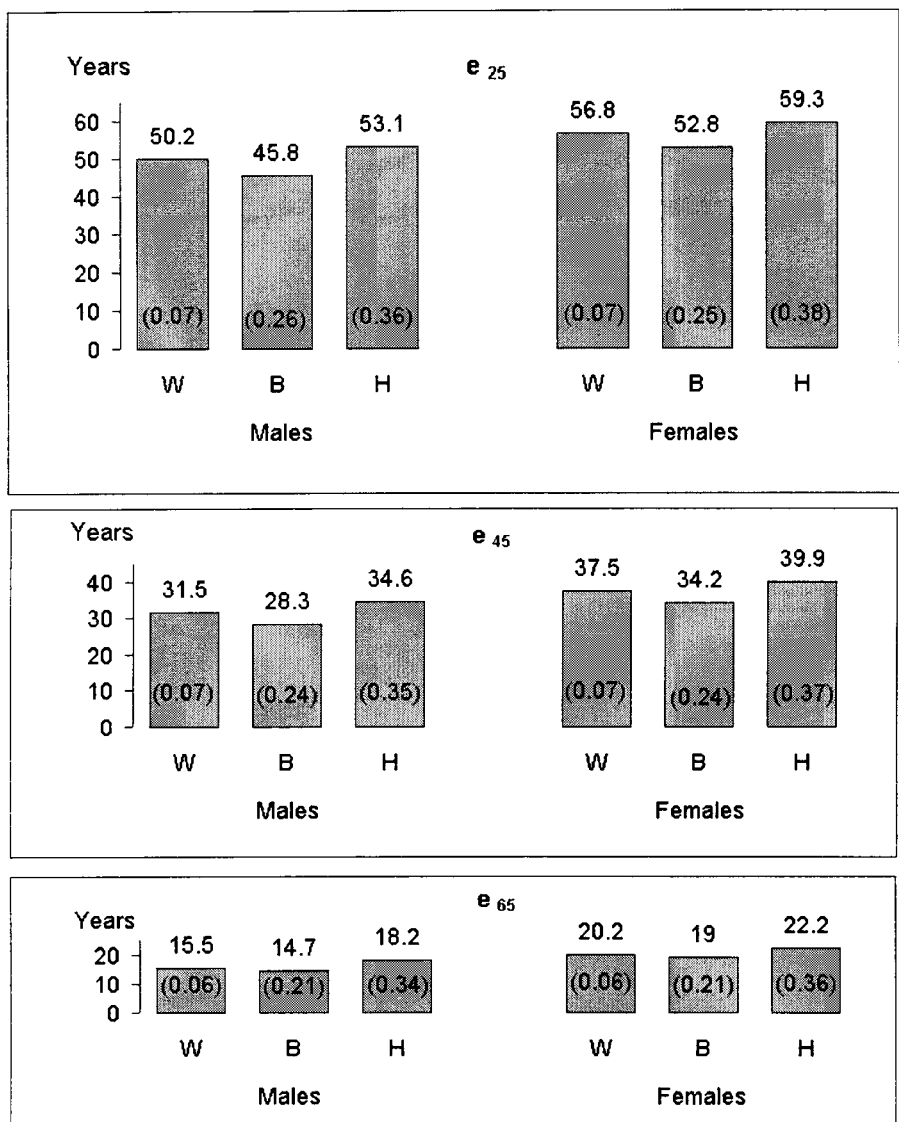
Table 2. Comparison of estimated life expectancies in years at age 25, 45, and 65 for White men, White women, Black men, and Black women: NLMS, 1979–89 vs US, 1985*

Age (years)	NLMS, 1979–89	US, 1985*	Difference
White men			
25	50.2	48.6	1.6
45	31.5	30.3	1.2
65	15.5	14.8	.7
White women			
25	56.8	55.1	1.7
45	37.5	35.9	1.6
65	20.2	18.8	1.4
Black men			
25	45.8	42.2	3.6
45	28.3	25.9	2.4
65	14.7	13.3	1.4
Black women			
25	52.8	50.4	2.4
45	34.2	32.3	1.9
65	19.0	17.3	1.7

* Average of 1979–81 and 1989–91 values (see references 10 and 11).

Fig 1. Estimated life expectancies for populations of White (W), Black (B), and Hispanic (H) by sex at age 25, 45, and 65: NLMS, all ages, 1979–89 follow-up (standard errors are shown in parentheses)

samples only the non-institutionalized US population. In addition, there may be some lack of ascertainment of death in matching NLMS records to those of the National Death Index. However, this is thought to be a minor problem since social security numbers were available to allow for matching records for the vast majority of persons followed (86% of those aged 25 years and older) by the NLMS. In a validation study by Calle and Terrell,[14] 3% of the deaths were missed by using the NLMS matching algorithm when social security numbers were available.

The NLMS data found women to have a substantially greater life expectancy compared at various ages to men. These differences are similar to those found for the United States. For example, at age 25, the difference for White individuals was 6.6 years in the NLMS, compared with 6.5 years in the United States; the difference for Black individuals was 7.0 years in the NLMS, compared with 8.2 years in the United States.

Figure 1 presents life expectancy estimates obtained from NLMS data for White, Black, and Hispanic groups by sex at ages 25, 45, and 65 years. Figure 1 compares estimates for Hispanic groups to those for the White and Black groups presented in Table 2. In Figure 1, White Hispanic individuals were also included in the "White" category, so that the "White" and "Hispanic" categories are not mutually exclusive. Simi-

larly, the "Black" and "Hispanic" categories are not mutually exclusive. For each age-sex group, the Hispanic group had the longest life expectancy, followed by the White group, with the Black group having the shortest life expectancy. For example, at age 25, Hispanic men lived an average of 2.9 years longer than White males, and White males lived an average of 4.4 years longer than Black males. Therefore, at age 25, Hispanic males lived an average of 7.3 years longer than Black males. Similarly, at

For each age-sex group, the Hispanic group had the longest life expectancy, followed by the White group, with the Black group having the shortest life expectancy.

age 25, Hispanic females lived an average of 2.5 years longer than White females, and White females lived an average of 4.0 years longer than Black females. Therefore, at age 25, Hispanic females lived an average of 6.5 years longer than Black females.

Figure 2 shows NLMS life expectancy estimates for persons of both genders aged 25 years and older, for the mutually exclusive ethnicity-race groups of non-Hispanic White, non-Hispanic Black, and Hispanic White, at ages 25, 45, and 65 years. The results are very similar to those shown in Figure 1.

Estimates of life expectancy by socioeconomic characteristics of interest are shown in Tables 3–6. In these tables, estimates of life expectancy at ages 25, 45, and 65 years are shown for each mutually exclusive ethnicity-race-sex group.

Table 3 shows estimates of life expectancy according to education level. Individuals with more than a high school education had a substantially greater life expectancy compared to
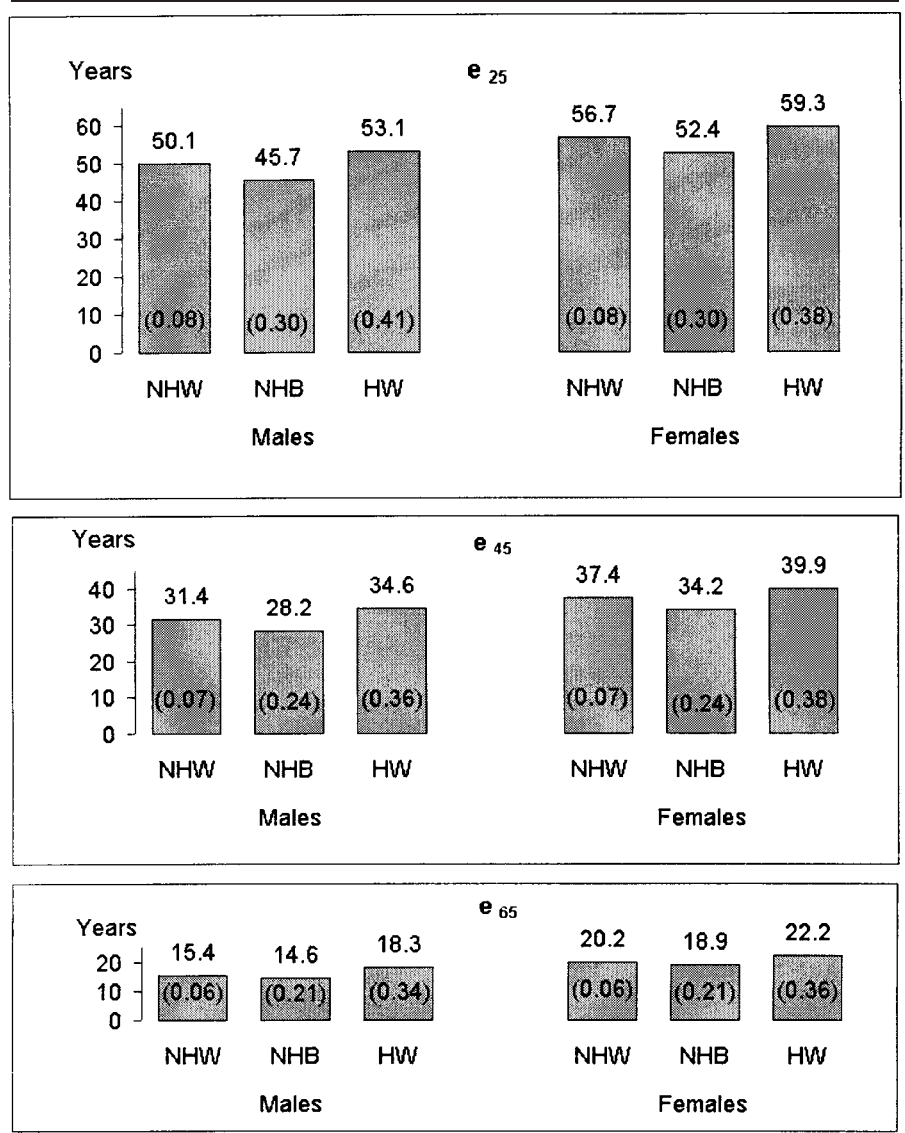

Fig 2. Estimated life expectancies for populations of non-Hispanic White (NHW), non-Hispanic Black (NHB), and Hispanic White (HW) by sex at age 25, 45, and 65: NLMS, ages 25+, 1979–89 follow-up (standard errors are shown in parentheses)

Table 3. Estimated life expectancies in years for selected groups at age 25, 45, and 65 by education: NLMS, age 25+, 1979–89 follow-up (estimated standard errors are shown in parentheses)

Hispanic Status	Race	Sex	e_{25} High Grade Completed			e_{45} Highest Grade Completed			e_{65} Highest Grade Completed		
			<12	12	13+	<12	12	13+	<12	12	13+
Non-Hispanic	White	Male	47.2 (.28)	50.2 (.14)	52.6 (.15)	29.6 (.12)	31.6 (.13)	33.6 (.14)	14.6 (.08)	15.7 (.12)	16.9 (.13)
Non-Hispanic	White	Female	55.1 (.16)	75.1 (.13)	57.9 (.16)	36.1 (.13)	37.9 (.12)	38.6 (.15)	19.6 (.09)	20.4 (.11)	21.1 (.14)
Non-Hispanic	Black	Male	43.5 (.47)	46.5 (.67)	50.2 (.85)	27.0 (.31)	29.2 (.60)	31.7 (.86)	14.4 (.23)	14.8 (.64)	17.0 (.91)
Non-Hispanic	Black	Female	50.2 (.63)	53.6 (.60)	56.1 (.86)	32.9 (.31)	35.1 (.59)	37.5 (.79)	18.7 (.24)	18.8 (.61)	20.7 (.80)
Hispanic	White	Male	52.4 (.62)	53.1 (.90)	*	34.2 (.42)	34.4 (.90)	*	17.9 (.38)	18.6 (.92)	*
Hispanic	White	Female	59.0 (.44)	60.3 (1.05)	*	39.6 (.43)	41.1 (1.04)	*	22.0 (.40)	23.1 (1.06)	*

* Insufficient data.

Table 4. Estimated life expectancies in years for selected groups at ages 25, 45, and 65 by family income: NLMS, age 25+, 1979–89 follow-up (estimated standard errors are shown in parentheses)

Hispanic Status	Race	Sex	e_{25} Family Income (1980 \$)			e_{45} Family Income (1980 \$)			e_{65} Family Income (1980 \$)		
			<10,000	10,000–24,999	25,000+	<10,000	10,000–24,999	25,000+	<10,000	10,000–24,999	25,000+
Non-Hispanic	White	Male	45.0 (.22)	50.2 (.13)	52.9 (.17)	27.0 (.19)	31.6 (.11)	33.9 (.16)	13.8 (.10)	15.8 (.10)	17.1 (.17)
Non-Hispanic	White	Female	54.5 (.18)	56.9 (.14)	57.8 (.19)	35.5 (.16)	37.6 (.12)	38.5 (.18)	19.7 (.09)	20.5 (.11)	20.6 (.19)
Non-Hispanic	Black	Male	41.6 (.47)	47.4 (.53)	50.2 (1.04)	24.7 (.41)	29.7 (.42)	32.5 (1.02)	14.0 (.27)	15.3 (.42)	16.8 (1.14)
Non-Hispanic	Black	Female	50.3 (.48)	53.7 (.49)	55.3 (.97)	32.8 (.33)	34.9 (.47)	36.3 (.96)	18.8 (.25)	18.6 (.46)	19.7 (1.00)
Hispanic	White	Male	50.4 (.66)	54.0 (.75)	55.5 (1.33)	32.1 (.60)	35.7 (.65)	36.4 (1.34)	17.3 (.46)	19.1 (.67)	19.2 (1.44)
Hispanic	White	Female	59.3 (.57)	58.3 (.68)	*	40.1 (.54)	38.8 (.68)	*	22.7 (.48)	21.2 (.69)	*

* Insufficient data.

those with less than a high school education. For example, at age 25, the difference in estimated life expectancy between groups of these 2 educational levels was 5.4 years for non-Hispanic White men, 2.8 years for non-Hispanic White women, 6.7 years for non-Hispanic Black men, and 5.9 years for non-Hispanic Black women. These differences were statistically significant. There were too few individuals in the Hispanic White group with more than a high school education to use for comparison purposes. However, the differences between Hispanic White groups of the 2 lower educational levels were small compared to the differences shown by the non-Hispanic groups. Also, at age 25, among individuals with less than a high school education, Hispanic White men lived an average of 5.2 years longer than the corresponding non-Hispanic White men. At age 25, among individuals hav-

ing more than a high school education, non-Hispanic White men lived an average of 2.4 years longer than non-Hispanic Black men.

Table 4 presents estimates of life expectancy by family income. With few exceptions, individuals with incomes of \$25,000 and over had a substantially greater life expectancy compared to corresponding groups with incomes below \$10,000. For example, at age 25, the difference in estimated life expectancy between groups of these 2 income levels was 7.9 years for non-Hispanic White men, 3.3 years for non-Hispanic White women, 8.6 years for non-Hispanic Black men, 5.0 years for non-Hispanic Black women, and 5.1 years for Hispanic White men. These differences were statistically significant. There were too few Hispanic White women with incomes of \$25,000 and over to allow valid estimates to be made for this group.

The negative differences observed for Hispanic White women at the different age levels were not statistically significant; −1.0 year at age 25, −1.3 years at age 45, and −1.5 years at age 65. In addition, among individuals aged 25 with incomes less than \$25,000, Hispanic White men lived an average of 4 to 5 years longer than non-Hispanic White men. At age 25, among those with incomes of \$25,000 and over, non-Hispanic White men lived an average of only 2.7 years longer than non-Hispanic Black men.

Table 5 presents estimates of life expectancy by employment status. Individuals in the labor force had a substantially longer life expectancy than those not in the labor force. Especially large differences were observed for men. For example, 25-year-old, employed non-Hispanic White men could expect to live 53.0 more years, on average, com-

Table 5. Estimated life expectancies in years for selected groups at age 25, 45, and 65 by employment status: NLMS, age 25+, 1979–89 follow-up (estimated standard errors are shown in parentheses)

Hispanic Status	Race	Sex	e_{25}			e_{45}			e_{65}		
			Employed	Not Employed	Not in Labor Force	Employed	Not Employed	Not in Labor Force	Employed	Not Employed	Not in Labor Force
Non-Hispanic	White	Male	53.0 (.16)	59.3 (.74)	41.6 (.37)	34.2 (.16)	31.7 (.76)	25.2 (.26)	17.8 (.18)	16.8 (.86)*	14.3 (.07)
Non-Hispanic	White	Female	59.5 (.32)	59.8 (1.40)	55.6 (.11)	40.1 (.32)	41.0 (1.37)	36.4 (.10)	22.5 (.34)	23.5 (1.46)	19.9 (.06)
Non-Hispanic	Black	Male	50.5 (.64)	42.9 (1.13)	36.5 (.79)	32.4 (.62)	26.0 (1.12)	22.5 (.54)	18.0 (.74)	13.5 (1.28)	13.6 (.25)
Non-Hispanic	Black	Female	57.6 (.70)	*	48.7 (.52)	38.7 (.70)	*	31.5 (.34)	22.4 (.76)	*	18.3 (.23)
Hispanic	White	Male	57.3 (.83)	*	43.3 (2.10)	38.5 (.84)	*	28.5 (.93)	21.9 (.91)	*	17.0 (.42)
Hispanic	White	Female	*	*	58.4 (.45)	*	*	39.2 (.42)	*	*	21.9 (.38)

* Insufficient data.

pared to an average of only 41.6 more years of life expected for those not in the labor force—a difference of more than 11 years. Differences of 3.9 years for non-Hispanic White women, 14.0 years for non-Hispanic Black men, 8.9 years for non-Hispanic Black women, and 14.0 years for Hispanic White men, were observed when comparing these 2 categories. These differences were statistically significant. There was insufficient data available to allow for comparisons of Hispanic White women in and out of the labor force. At age 25, among non-Hispanic women who were not in the labor force, White women lived an average of almost 7 years longer than Black women.

Table 6 shows estimates of life expectancy by marital status. Married persons were generally observed to live longer than non-married persons. At age 25, the difference in estimates of life expectancy between the married and previously married groups was 5.2 years for non-Hispanic White men, 2.7 years for non-Hispanic White women, 4.9 years for non-Hispanic Black men, 2.6 years for non-Hispanic Black women, and 6.8 years for Hispanic White men. These differences were statistically significant. Small differences were observed for Hispanic White women: .7/year at age 25, .3/year at age 45, and −.5/year at age 65. The differences between the previously married and never married groups were small.

DISCUSSION

Life expectancy, or average remaining years of life, is a summary measure utilizing age-specific death rates. This summary may obscure important age-specific differentials in mortality, but has the advantage of providing a meaningful statement of the cumulative health consequences of social and economic inequalities which occur over a lifetime. The results provided in this paper describe the large effect that these factors

have, with, for example, life expectancy differing by as much as 9 years for those with high compared to low income, and by 14 years for those employed vs those not in the labor force.

In drawing conclusions from these data, it is important to keep in mind that each life table is constructed for persons who were at the given level of a characteristic at the start of follow up. However, one cannot assume individuals remain at the baseline level for the entire follow-up period. By assuming no change from baseline status, observed differences in estimates of life expectancy are underestimated. For example, a person initially classified as being in the labor force, who subsequently left the labor force, would have switched from a group with a low death rate to one with a high death rate. By remaining classified as "in the labor force," this person raises the death rate for those "in the labor force" and lowers the death rate for those "not in the labor force," resulting in an artificially smaller difference in estimates of life expectancy between the 2 groups. Actual movement, of course, can go in the other direction as well, from "not in the labor force" to "in the labor force," also causing the observed effect to be an underestimate of the differences. Of the 4 factors studied, educational level is the least likely to change after age 25, while family income, employment status, and marital status are much more variable.

As seen in Tables 3–6, observed differences in life expectancy estimates according to educational level, income level, employment status, and marital status were substantial, with differences tending to be larger for men than for women; however, differences in life expectancy between educational levels were found to be nearly identical for men and women in the non-Hispanic Black and Hispanic White groups. Differences were also larger for the non-Hispanic Black population than for the non-Hispanic White population. While Hispanic White men exhibited patterns

of life expectancy similar to those of non-Hispanic White and Black men, the differences between both educational and income levels for Hispanic White men were considerably smaller than those observed for non-Hispanic White and Black men. Almost no difference in life expectancy was observed between income levels for Hispanic White women.

The largest differences in life expectancy for the socioeconomic variables considered were observed between employment status categories. For example, as already noted, the difference at age 25 between those employed and those not in the labor force was 14.0 years for non-Hispanic Black men and Hispanic White men. Since those "not in the labor force" also include sick and disabled persons,[15] estimates of life expectancy for employment status may reflect the effects of being healthy compared to being sick, which confounds the causal relationship between labor force participation and mortality outcomes. However, the differences at age 65 were small: 3.5 years for non-Hispanic White men, 4.4 years for non-Hispanic Black men, and 4.9 years for Hispanic White men. These differences might have been larger if individuals reaching retirement ages had been put in the "not in the labor force" group. For example, a person aged 60 at the start of follow up who was employed at baseline might retire at age 65, but would be categorized in this study as "employed."

Hispanic White individuals were observed to have longer life expectancies than non-Hispanic White individuals in all socioeconomic and sex groups, which confirms the low mortality rates for Hispanic White individuals found in other studies. For instance, Sorlie, Backlund, Johnson, et al[16] demonstrated that Hispanic White individuals, as compared to the general US population, exhibited fewer risk factors for cancer and heart disease, the 2 leading causes of death in the United States. Various explanations have been presented in the literature to

Table 6. Estimated life expectancies in years for selected groups at ages 25, 45, and 65 by marital status: NLMS, age 25+, 1979–89 follow-up (estimated standard errors are shown in parentheses)

Hispanic Status	Race	Sex	e_{25} Married	e_{25} Previously Married	e_{25} Never Married	e_{45} Married	e_{45} Previously Married	e_{45} Never Married	e_{65} Married	e_{65} Previously Married	e_{65} Never Married
Non-Hispanic	White	Male	51.0 (.09)	45.8 (.28)	46.2 (.32)	32.0 (.08)	28.0 (.22)	28.1 (.32)	15.7 (.07)	13.6 (.16)	14.1 (.26)
Non-Hispanic	White	Female	57.5 (.11)	54.8 (.23)	55.3 (.36)	38.1 (.11)	35.8 (.15)	36.2 (.34)	20.7 (.11)	19.6 (.09)	19.9 (.25)
Non-Hispanic	Black	Male	47.8 (.49)	42.9 (.53)	42.2 (.89)	29.7 (.30)	25.4 (.45)	26.1 (.91)	15.1 (.27)	13.5 (.37)	15.2 (.92)
Non-Hispanic	Black	Female	54.3 (.57)	51.7 (.42)	50.2 (.98)	36.0 (.48)	33.1 (.33)	32.3 (.98)	20.0 (.49)	18.5 (.26)	18.5 (.94)
Hispanic	White	Male	54.2 (.43)	47.4 (2.77)	*	35.1 (.42)	31.7 (.97)	*	18.4 (.41)	16.9 (.82)	*
Hispanic	White	Female	59.3 (.68)	58.6 (.61)	*	39.8 (.68)	39.5 (.57)	*	21.7 (.71)	22.2 (.48)	*

* Insufficient data.

explain this "Hispanic Mortality Paradox": the healthy migrant effect, the salmon bias effect, and the data artifact effect.[17] The first 2 paradoxes basically argue that the migration process has a direct effect on observed death rates among the Hispanic population in the United States. The healthy migrant effect posits that Hispanic immigrants self select due to good health and are in better health than the general US population, while the salmon bias effect argues that large numbers of Hispanic individuals return to their country of origin following illness, or to retire, thus artificially lowering the Hispanic death rate in the United States. Unfortunately, testing these hypotheses is beyond the purview of this study, and other studies provide little empirical support for these hypotheses.[17,18] The data artifact hy-

. . . observed differences in life expectancy estimates according to educational level, income level, employment status, and marital status were substantial, with differences tending to be larger for men than for women . . .

pothesis posits that mismatches between mortality data (used in the numerator) and census/survey data (used in the denominator) explain the paradox of Hispanics. This problem is not an issue in the NLMS, since only one source of ethnic identification is used to estimate death rates: the self-identified race-ethnicity of the individual collected during the CPS interview. Another frequent explanation of the good health of the Hispanic population is what some call a "cultural effect." Hispanic individuals may behave differently in ways known to affect health, such as smoking less, following healthier diets, and having greater access to family and social support.[16–19]

We further studied whether a difference in ascertainment of death might account for differences in death rates between Hispanic and non-Hispanic populations in the NLMS. To this end, we created a sample of those individuals from the Hispanic White population (76%), and those individuals from the non-Hispanic White population (87%) who had a Social Security Number (SSN), and then estimated the proportion of deaths missed in each group using the estimate of 3% missed with SSN, and 13% missed without SSN, as reported by Calle and Terrell.[14] The results were a 95% ascertainment of death for the Hispanic population vs 96% for the non-Hispanic population. Therefore, only a negligible part of the Hispanic—non-Hispanic difference could

be explained by the smaller proportion of Hispanic population with a SSN.

While the NLMS data are very useful when estimating life expectancy by social and economic characteristics, some limitations exist. The strengths of the NLMS data come from the importance and the intense effort required to conduct the Current Population Survey. The data from the survey are collected by the US Census Bureau for use by the Bureau of Labor Statistics to compute the National Unemployment Index, a leading economic indicator. The interview is collected by highly trained staff who obtain permission from the respondents before conducting the survey, and response rates are greater than 95%. Households in the sample are interviewed monthly on 8 different occasions. There are, however, several limitations to using these CPS data. Respondents' status is obtained only at the time of interview. Individual characteristics are thus frozen for analysis purposes, and changes in individuals will not be captured. More complex dimensions of socioeconomic characteristics are not captured, including accumulated wealth, complex measures of social capital, and other detailed social and behavioral factors.

CONCLUSION

Life expectancy, or average remaining years of life, was used to summarize

mortality experience. Death rates by the economic and social characteristics used in this report have been previously reported to be much higher for the poor, the less educated, the unmarried, and those not in the labor force. Translating these death rates into estimates of life expectancy shows the dramatic impact that individual socioeconomic status has on the average length of life. For those not in the labor force, the average length of life is 14 years less than those employed, emphasizing the health needs of those not working who are possibly not part of employee-based health insurance systems. Differences in life expectancy are as much as 6 to 7 years for lower vs higher education levels for Black men and women, and up to 9 years for lower vs higher income levels for Black men. As indicated by these examples, studying the effect of socioeconomic differentials in terms of life expectancy provides yet another measure for describing the cumulative health consequences of these inequalities.

REFERENCES
1. Kitagawa EM, Hauser PM. *Differential Mortality in the United States: A Study in Socioeconomic Epidemiology.* Cambridge, Mass: Harvard University Press; 1973.
2. Rogot E, Sorlie P, Johnson NJ. Life expectancy by employment status, income, and education in the National Longitudinal Mortality Study. *Public Health Rep.* 1992;107:457–461.
3. Pamuk E, Makuc D, Heck K, Reuben C, Lochner K. *Health, United States, 1998 with Socioeconomic Status and Health Chartbook.* Hyattsville, Md: National Center for Health Statistics; 1998.
4. Rogot E, Sorlie P, Johnson NJ, Glover CS, Treasure DW. *A Mortality Study of One Million Persons by Demographic, Social, and Economic Factors: 1979–1981 Follow-up.* Bethesda, Md: National Institutes of Health; 1988. NIH Publication No 88-2896.
5. National Center for Health Statistics. *National Death Index User's Manual.* Hyattsville, Md: National Center for Health Statistics; 1990. DHHS Publication No. PHS-90-1148.
6. US Bureau of the Census. *The Current Population Survey: Design and Methodology.* Washington, DC: US Government Printing Office; 2000. Technical Paper 63.
7. Rogot E, Sorlie P, Johnson NJ. Probabilistic methods in matching census samples to the National Death Index. *J Chronic Dis.* 1986; 39:719–734.
8. Rogot E, Feinleib M, Ockay KA, Schwartz SH, Bilgrad R, Patterson JE. On the feasibility of linking census samples to the National Death Index for epidemiologic studies: a progress report. *Am J Public Health.* 1983;73:1265–1269.
9. Rogot E, Schwartz SH, O'Conor KV, Olsen CL. The use of probabilistic methods in matching Census samples to the National Death Index. *Proceedings of the Section on Survey Research Methods American Statistical Association, Washington, DC.* 1983:319–324.
10. National Center for Health Statistics. *United States Decennial Life Tables for 1979–1981.* Hyattsville, Md: National Center for Health Statistics; 1985;1(1). DHHS Publication No. PHS-85-1150-1.
11. National Center for Health Statistics. *United States Decennial Life Tables for 1989–1991.* Hyattsville, Md: National Center for Health Statistics; 1997;1(1). DHHS Publication No. PHS-98-1150-1.
12. Chiang CL. *Introduction to Stochastic Processes in Biostatistics.* New York, NY: John Wiley & Sons; 1968:211.
13. US Bureau of the Census. *Statistical Abstract of the United States.* Washington, DC: US Government Printing Office; 1989;109:461–463.
14. Calle EE, Terrell DD. Utility of the National Death Index for ascertainment of mortality among Cancer Prevention Study II participants. *Am J Epidemiol.* 1993;137:235–241.
15. Sorlie PD, Rogot E. Mortality by employment status in the National Longitudinal Mortality Study. *Am J Epidemiol.* 1990;132:983–992.
16. Sorlie PD, Backlund E, Johnson NJ, Rogot E. Mortality by Hispanic status in the United States. *JAMA.* 1993;270:2464–2468.
17. Abraido-Lanza AF, Dohrenwend BP, Ng-Mak DS, Turner JB. The Latino mortality paradox: a test of the "Salmon Bias" and Health Migrant Hypotheses. *Am J Public Health.* 1999;89:1543–1548.
18. Liao Y, Cooper RS, Cao G, et al. Mortality patterns among adult Hispanics: findings from the NHIS, 1986–1990. *Am J Public Health.* 1998;88:227–232.
19. Hummer RA, Rogers RG, Amir SH, Forbes D, Frisbie WP. Adult mortality differentials among Hispanic subgroups and non-Hispanic Whites. *Soc Sci Q.* 2000;81:459–476.
20. Gove WR. Sex, marital status, and mortality. *Am J Sociol.* 1974;79(1):45–67.