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Race/Ethnicity and Income Disparities in US Adult Mortality

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Author's contribution

The sole author designed, analyzed, interpreted, and prepared the manuscript.

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ABSTRACT

Objectives: The objectives of the study were to investigate associations between socioeconomic status and all-cause mortality in the United States, and racial/ethnic differences in this association. We stratify analysis by race/ethnicity to test whether the consequences of SES variables are more pronounced among certain racial/ethnic groups than others.
Methods: Data employed were obtained from the National Longitudinal Mortality Study. It is a study of respondents in the Current Population Surveys of the early 1980s whose mortality experiences were followed through the 1990s. The sample includes 707169 individuals aged 18 and above at baseline of which 88489 had died at the end of the 11 year follow-up period. Proportional hazards regression models were fitted to the data.
Results: The socioeconomic variables education and income were strongly associated with all-cause mortality. Persons with less than high school education were 64% (ARR=1.64, 95% CI=1.58, 1.70) more likely to die than those with graduate or professional education. Individuals making less than $10,000 per year were 59% more likely to die during the follow up period than their counterparts making $60,000 or more (ARR=1.59, 95% CI=1.54, 1.65). Persons without health insurance were 14% as likely to die as those with health insurance (ARR=1.14, 95% CI=1.13, 1.16).
Conclusion: Results were generally consistent with past studies on the contribution of SES to mortality. This was the first study to note that the effects of SES on mortality vary significantly by

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racial/ethnic groups. Although college education is a much stronger predictor of mortality among whites, it is not a strong mortality covariate among African Americans and Hispanics. Among African Americans, low income has more devastating consequences than it does among Whites. Future studies on the SES-mortality relationship ought to stratify samples by race in order to get a more accurate understanding of the effects of SES.

Keywords: Mortality; income; education; race/ethnicity; health insurance.

1. INTRODUCTION

In the United States, it is not an exaggeration to note that for almost every disease (whether infectious or degenerative), and for every cause of death, the poor are overrepresented in the outcome regardless of race or ethnicity. Kposowa & Bideshi [1] found that for the ten leading causes of death in the United States, persons making the lowest income (below the poverty threshold) experienced higher mortality rates than those with incomes above the poverty threshold. Kposowa [2] observed that persons in poverty were nearly 49% more likely to be in poorer health status than their counterparts above poverty.

The observation that social factors contribute to morbidity and mortality is not new, but has a long tradition in social demography. Indeed, Durkheim's [3] celebrated work *Le Suicide* posited a purely sociological explanation for disparities in suicide among social groups. Durkheim argued that suicide rates tend to be high among social groups that exhibit low levels of domestic integration. As he famously indicated, ''suicide varies inversely with the degree of integration of the social groups of which the individual forms a part. As collective force is one of the obstacles best calculated to restrain suicide, its weakening involves a development of suicide'' [3, p. 246].

In the North Atlantic on the 15th of April 1912, survival experiences of passengers on the *Titanic* illustrated one of the terrible consequences of social and income inequality, as lower class persons were overrepresented among those that perished, while upper class individuals dominated the ranks of survivors [4]. In more modern times, Antonovky's [5] ground breaking work ranks among the first to systematically investigate the relationship between social class, life expectancy, and mortality. Using data from several countries in the Western world, he found an inverse relationship between income and mortality among males and females, among foreign born and native born, and among those that rent and those that own homes. He also found strong occupational disparities in mortality, with persons in low status occupations having higher death rates than their counterparts in the managerial occupations. A notable observation from Antonovky's research was that death rates at higher ages tend to converge regardless of income and race.

An accumulating body of research has supported Antonovky's key finding that socioeconomic differences exist in morbidity and mortality [1,6-8]. What is even more fascinating is that the relationship between socioeconomic status (SES) and death appears to be cross-national [9]. Typically the poor and persons with lower socioeconomic status tend to have higher morbidity and mortality rates than their counterparts further up in the socioeconomic status ladder.

Although overall mortality rates in the United States have declined over the past half century, the drop has not been uniform across racial/ethnic groups [10]. Members of some minority groups, especially African Americans continue to experience higher incidence and prevalence of chronic diseases and higher mortality than whites [11-13].

Numerous studies have been done on the link between income and other measures of socioeconomic status and mortality. In the biomedical literature the focus on disease etiology and mortality is often on biological and genetic factors [14-16]. Socioeconomic status is often viewed as 'noise' or a potentially 'confounding' variable, but not a proximate cause of morbidity or mortality [7,17]. This medical model with its disease and mortality explanation rooted in biology and genetics has been criticized by researchers in the sociological sciences and in social epidemiology, where there is accumulating evidence that social factors can no longer be ignored as fundamental causes of disease and death [1,7, 12,18-19].

Past studies examining SES effects on mortality have not adequately stratified samples by race. Thus, it is unknown whether the protective effects of higher SES variables are more pronounced among certain racial/ethnic groups than others. With few exceptions, most studies to date have also relied on cross-sectional data. Yet longitudinal data may be best suited for a fuller accounting of the SES-mortality relationship. The objectives of the study were to investigate associations between income and education on all-cause mortality in the United States, and determine whether racial stratification accounts for the SES differences. Specifically the following questions are addressed: (1) Do indicators of socioeconomic status, such as income and education affect mortality? (2) Does the effect persist once controls are made for race/ethnicity? (3) Are the presumed protective effects of higher economic status (income, and education) invariant across racial/ethnic groups?

2. MATERIALS AND METHODS

2.1 Data Source

Data were derived from the latest edition of The U.S. National Longitudinal Mortality Study (NLMS) [20]. The NLMS is a prospective study of mortality among the non-institutionalized population in the United States and it was conducted by the National Heart, Lung, and Blood Institute (NHLBI) in collaboration with the National Center for Health Statistics and the U.S. Bureau of the Census [20]. The samples were derived from the Current Population Surveys (CPS), which are sponsored by the U.S. Bureau of the Census and the Bureau of Labor Statistics (BLS). The survey is the primary source of labor force statistics for the entire US population (50 states and the District of Columbia), covering information on national unemployment, employment, earnings, labor market conditions, and demography [21]. In the Current Population Surveys, a probability sample of households is surveyed monthly through personal and telephone interviews to obtain information on social, economic, and demographic characteristics about the U.S. population [21]. A detailed history and nature of the Current Population Surveys, including variables and coverage have been presented elsewhere (http://www.census.gov/cps/) [21].

The public use data file employed in the present study consisted of a cohort of 11 national samples derived from the Current Population Surveys conducted 1980 through 1983 inclusive. These samples were then designated as 'cohorts' for mortality follow-up and survival analysis. The individuals were known to be alive on the survey date and, therefore, eligible for follow-up with regard to survivorship from that date on. Mortality experiences of cohort members were studied until 1994. Data from death certificates on the fact and cause of death were combined with the socioeconomic and demographic characteristics of the 1983 population cohorts using the National Death Index (NDI) to link the two databases. A more detailed description of the NLMS data collection process, including cohort selection has been presented elsewhere [21].

2.1.1 Variables and measures

The dependent variable was the risk of all-cause mortality. Causes of death were identified using the International Classification of Diseases, 9th Revision, Clinical Modification [22]. In estimating the risk of overall mortality, all persons surviving beyond the 11-year follow-up were treated as right censored observations.

The sample comprised 707,169 individuals 18 years and above at the beginning of the study, of whom 88,489 had died from all causes by the end of the eleven-year follow-up period. The present analysis was restricted to mortality among non-Hispanic white, non-Hispanic African American, Hispanic males and females, Asian and Pacific Islanders, Native Hawaiians and persons of multiple races. The risk of mortality was estimated as a function of socioeconomic status, indexed by educational attainment and income.

Education was measured by a series of dummy variables, one for less than high school education, one for high school education (12 years completed), and one for some college (13 to 15 years). Individuals with 16 or more years of education constituted the reference group.

Income was indexed by annual family income (adjusted for inflation) It was indexed by 6 dummy variables, one each for less than $10,000, $10,000-$19,999, $20,000-29,999, $30,000-$39,999, one for $40,000-$49,999, one for $50,000-$59,999 and one for unknown income. Those with family income of $60,000 or more were the omitted group.

Race/ethnicity was defined in terms of 5 dummy variables, one for non-Hispanic African Americans, one for Asian and Pacific Islanders/Native Hawaiians, one for Native Americans and Alaskan natives, one for individuals of other non-white races, and one for Hispanics. Non-Hispanic whites constituted the reference group.

Marital status was measured by three dummy variables, one for single, one for widows, and one for those separated or divorced. Those married at the beginning of the study constituted the reference category.

Place of residence was measured in terms of whether an individual lived in an urban or rural area. Those living in urbanized areas (2,500 or more people) were coded 1, and persons living in rural areas were the reference group.

Health Insurance Availability was measured as a dummy variable. Persons that had no health insurance of any kind (public or private) were coded 1, and the reference group comprised individuals with health insurance.

Central City Residence was measured as a dummy variable. Individuals living in central cities of urbanized areas were coded 1, and those living outside the central city (e.g. suburbs) were the reference category.

Age at the baseline was captured by defining it in terms of series of dummy variables, one each for age groups 25-29, 30-39, 40-49, 50-59, 60-69, and 70 or above. The age group 18-24 served as the reference category.

Region of residence was measured as a dummy variable with Southern residence coded 1, and other states coded 0. The South was based on the US Census classification of the major regions of the United States [20]. In that scheme, code 3 (South) was employed, and all states within it were defined as Southern states. Investigations based on aggregates in the social sciences have observed a positive association between residence in these states and mortality [23]. One theory that has been advanced to explain the higher mortality in the South is the prevalence and persistence of poverty. The inclusion of the variable (region of residence) is to determine if the aggregate results can be reproduced at the level of the individual. *Sex* was measured as a dummy variable with males coded 1; women were the reference group for comparison.

2.1.1.1 Statistical methods

Cox's [24] proportional hazards model was applied to the NLMS data to compare the risk of mortality among socioeconomic groups while controlling for confounders. The Cox model may be specified as:

$$h(t) = h_0(t)\exp(\Sigma_k ß_k X_k) \quad (1)$$

Where $h(t)$ is the hazard or risk of mortality at time t, $ß_k$'s are a set of unknown parameters to be estimated and X_k's are k covariates. $h_0(t)$ is a baseline hazard function and is defined when all the covariates in the model are set to zero. The proportionality of hazards assumption inherent in the Cox model was tested by inspecting the plots of $\ln[-\ln\{S(t)\}]$ against survival time t for the various covariate categories. The plots were found to be approximately parallel and so the proportionality assumption was taken to be satisfied by the data. The parameters in the Cox model were estimated by the method of partial maximum likelihood using the PHREG procedure available within SAS, version 9.3 [25].

In addition, sub-analysis was performed by comparing models using the likelihood ratio test [26,27]. For example a constrained model (with a limited number of covariates) would be compared to a saturated model (with more or specified covariates or even interactions) in order to determine whether some set of additional variables improve significantly to overall model fit. The rationale for such model comparisons is well known in the statistical literature, and has been presented in works by Kposowa [26,28] and Kleinbaum [27].

$$\Delta LRS = LL_R - LL_E \quad (2)$$

Where

ΔLRS = Change in log likelihood (Likelihood ratio statistic)
LL_R = log likelihood for reduced model (with fewer covariates)
LL_E = log likelihood for the expanded model (with more covariates) Statistical significance is based on whether the change in log likelihood exceeds a threshold, determined by degrees of freedom obtained by subtracting the number of covariates in the reduced model from the number in the expanded model. Under the assumption that the expanded model is correct or provides a better fit the calculated value is distributed approximately as a χ^2. One then compares the calculated value

to the reference value based on degrees of freedom and a previously chosen alpha [26,27].

3. RESULTS

Results of multivariate hazards analysis are presented below. I first show findings on the association between socioeconomic position (measured by education, family household income) and all-cause mortality. Relevant results are shown in Table 1. As may be observed, educational attainment was strongly associated with mortality net of other covariates in the model. Indeed, a dose-response relationship was found. Persons with some college education (Associate Degrees, Bachelors) were [(RR-1)*100] 28% more likely to die during follow-up than those with graduate or professional degrees. Individuals with high school education were nearly 1.4 times as likely to die during the follow-up period as their counterparts with graduate or professional education. Persons with less than high school education were 64% as likely to die as those with graduate or professional degrees [(1.64-1)*100].

Findings also showed that the higher the income level, the lower the risk of mortality during the 11 year follow-up period. For example, persons making less than $10,000 a year were 59% more likely to die than those with incomes $60,000 or more. Persons making $20,000 to $29,999 per year were not far behind; they were over 50% as likely to die as their counterparts in the $60,000 or more income bracket. Individuals in the income group $50,000 to $59,999 were only 6% as likely to die as those in the reference group. These findings provide evidence to suggest that there are detrimental consequences to individual socioeconomic inequality.

When health insurance was considered, findings showed that persons without health insurance coverage were 14% more likely to die during the follow-up period than those with health insurance. As expected, persons not married experienced higher mortality risks than those married. For instance, divorced or separated individuals were 29% as likely to die during follow-up as the married. Similarly, single/never married persons were 1.3 times more likely to die than the married. Likewise, widowed individuals were 95% more likely to die than the married. Men generally had higher mortality than women. Male respondents were 96% more likely to die during the follow-up period than their female counterparts, even after adjusting for socioeconomic status, health insurance, race, and other model covariates.

Findings show racial/ethnic disparities in all-cause mortality, but they do not appear to be as strong as previous studies have suggested [1, 29-31). The most likely explanation is that the model includes all covariates whose effects somewhat explain the associations between race and mortality. This issue was further explored by entering covariates as a block, and then calculating change in the log likelihood. The log likelihood change test helps determine whether a given model provides a better fit to the data than another model [26,27]. Typically, one model is considered a baseline with fewer covariates, and the second is considered an expanded version with more variables or interaction terms. For the formula used to perform the log likelihood test, please see equation 2. Results of model comparisons are shown in Table 2.

First, the baseline model included only race/ethnicity, adjusted for only age. The idea behind the model comparisons was to determine whether socioeconomic status variables made contributions to explaining mortality over and beyond race/ethnicity. It was also critical to find out whether the effect of race was reduced or eliminated by including socioeconomic factors. Findings in model 1 show substantial racial/ethnic differentials in mortality risk. For instance, Non-Hispanic African Americans were 27% more likely to die than their Non-Hispanic white counterparts (RR=1.27; 95% CI=1.23,1.29). Hispanics were 27% less likely to die during follow up than Non-Hispanic whites [(0.73-1)*100]. Asian and Pacific Islanders were 39% more likely to die than Non-Hispanic whites. At the same time, Native Americans were 1.3 times as likely to die as their Non-Hispanic white counterparts. We added sex, marital status, and place of residence, SMSA residence, and lack of health insurance to the baseline model to form Model 2. As may be observed, adding these variables made a significant improvement to the previous model. The change in log likelihood was statistically significant (χ^2 = 9700, df=7, α=.01). Furthermore a close look at the racial/ethnic groups shows reductions in relative risks. The relative risk for African American race went from 1.27 to 1.17, reflecting a decline of 7.87%. Despite slight reductions, all racial covariate categories still remained statistically significant.

Table 1. Multivariate hazards regression results of the effects of income and education on all-cause mortality, 1983-1994

Covariate	Event	Population at risk	β	RR	95% CI
Educational attainment					
Graduate/Prof. Sch.	2980	46064	Reference	1.00	Reference
Less high school	47017	189190	0.494**	1.64	1.58, 1.70
High school	24920	278357	0.321**	1.38	1.32, 1.43
Some college	13572	193558	0.244**	1.28	1.22, 1.33
Education unknown	133	3148	-0.425**	0.65	0.55, 0.77
Income					
$60,000+	4844	76115	Reference	1.00	Reference
$50,000-$59,999	6437	103211	0.057**	1.06	1.02, 1.10
$40,000-$49,999	3102	40302	0.112**	1.12	1.07, 1.17
$30,000-$39,999	8137	103681	0.166**	1.18	1.14, 1.22
$20,000-$29,999	15336	142749	0.270**	1.31	1.27, 1.35
$10,000-$19,999	23809	125844	0.411**	1.51	1.46, 1.56
< $10,000	26824	112165	0.464**	1.59	1.54, 1.65
Income unknown	3404	24478	-0.284**	0.75	0.72, 0.78
Health insurance					
Has health insurance	37182	287540	Reference	1.00	Reference
Lack health insurance	51307	419629	0.134**	1.14	1.13, 1.16
Race/ethnicity					
Non hispanic White	75460	577780	Reference	1.00	Reference
Non-hispanic Afri Amer	8708	63058	0.026**	1.03	1.00, 1.05
Asian/pacific Islander	722	12657	-0.539**	0.58	0.54, 0.63
Native American	521	5158	0.087*	1.09	1.00, 1.19
Hispanic	2835	45452	-0.473**	0.62	0.60, 0.65
Other non-white race	243	3064	-0.011	0.89	0.79, 1.01
Sex					
Female	41285	375780	Reference	1.00	Reference
Male	47204	331389	0.670**	1.96	1.93, 1.98
Marital status					
Married	51224	448092	Reference	1.00	Reference
Widowed	23445	48277	0.291**	1.95	1.31, 1.36
Divorced/separated	6879	63491	0.255**	1.29	1.26, 1.32
Single/never married	6779	143668	0.283**	1.33	1.29, 1.36
Place of residence					
Rural	27844	229435	Reference	1.00	Reference
Urban	60645	477734	0.086**	1.09	1.07, 1.11
SMSA status					
Outside central city	63112	516355	Reference	1.00	Reference
Central city	25377	190814	0.029**	1.03	1.01, 1.04
Region of residence					
Outside the South	78248	637346	Reference	1.00	Reference
In the South	10241	69823	0.035**	1.04	1.01, 1.06
Age					
18-24	87242	579566	Reference	1.00	Reference
25-29	1247	127603	0.371**	1.45	1.34,1.57
30-39	3081	154388	0.955**	2.60	2.43, 2.78
40-49	5363	105210	1.925**	6.85	6.43, 7.31
50-59	12948	95194	2.906**	18.30	17.21,19.45
60-69	22998	72697	3.770**	43.37	40.85, 46.06
70+	41731	60733	4.761**	116.88	110.08,124.11
LRS			207965**		
Df			30		
Events			88489		
Population at risk			707169		

Table 2. Regression results of the effects of race, insurance coverage and income on all-cause mortality, 1983-1994: block regression

Covariate	Model 1a		Model 2b		Model 3c	
	RR	95% CI	RR	95% CI	RR	95% CI
Race/ethnicity						
Non hispanic white	1.00	Ref	1.00	Ref	1.00	Ref
Non-hispanic Afri Am	1.27	1.23, 1.29	1.16	1.15,1.20	1.04	1.01,1.06
Asian/pacific islander	0.61	0.57, 0.66	0.57	0.53,0.61	0.62	0.60,0.65
Native American	1.30	1.19, 1.41	1.23	1.12,1.34	1.09+	0.99,1.19
Hispanic	0.73	0.71, 0.76	0.71	0.68,0.74	0.62	0.60,0.65
Other non-white	0.86	0.76, 0.98	0.89+	0.78,1.01	0.89+	0.78,1.01
Sex						
Female			1.00	Ref	1.00	Ref
Male			1.92	1.89,1.95	1.95	1.92,1.98
Marital status						
Married			1.00	Ref	1.00	Ref
Widowed			1.46	1.43,1.48	1.34	1.31,1.36
Divorced/separated			1.44	1.40,1.47	1.29	1.25,1.32
Single/nev. married			1.41	1.37,1.44	1.32	1.28,1.36
Place of residence						
Rural			1.00	Ref	1.00	Ref
Urban			1.01^{+}	0.99,1.03	1.09	1.07,1.10
SMSA status						
Outside central city			1.00	Ref	1.00	Ref
Central city			1.04	1.02,1.22	1.03	1.01,1.04
Health insurance						
Has insurance			1.00	Ref	1.00	Ref
Lack insurance			1.21	1.19,1.22	1.15	1.13,1.16
Age						
18-24	1.00	Ref	1.00	Ref	1.00	Ref
25-29	1.26	1.16,1.37	1.43	1.32,1.54	1.45	1.33,1.57
30-39	2.06	1.93,2.20	2.48	2.32,2.65	2.59	2.42,2.78
40-49	5.35	5.03,5.69	6.61	6.19,7.05	6.87	6.43,7.31
50-59	14.91	14.07,15.81	18.54	17.44,19.71	18.30	17.22,19.45
60-69	39.68	36.54,40.95	48.43	45.61,51.43	43.38	40.85,46.06
70+	116.52	110.14,123	142.14	133.93,150	116.89	110.09,124
Educational attain.						
Grad/Prof. Sch.					1.00	Ref
Less High School					1.64	1.57,1.70
High School					1.38	1.33,1.43
Some College					1.27	1.23,1.33
Education Unk.					0.65	0.55,0.77
Income						
$60,000+					1.00	Ref
$50,000-$59,999					1.06	1.02,1.10
$40,000-$49,999					1.12	1.07,1.17
$30,000-$39,999					1.18	1.14,1.22
$20,000-$29,999					1.31	1.27,1.35
$10,000-$19,999					1.51	1.46,1.56
< $10,000					1.59	1.54,1.65
Income unknown					0.75	0.72,0.78
-2LogL		2177631		2167931		2164202
LRS		194527**		204227**		207955**
df		11		18		29
δLL				9700**		3729**
df_{δ}				7		11
Reference χ^2 (α=.01)				18.475		24.725
Event		88489		88489		88489
Population at Risk		707169		707169		707169

*[a] Race/Ethnicity, controlled for age only; [b] Model 1 plus sex, marital status, insurance coverage, place of residence, SMSA status, and region of residence; [c] Model 3 controls for education and income. Note: a CI that encompasses 1 illustrates a statistically non significant Covariate category. RR=Relative Risk/Hazard Ratio; CI=95% confidence interval. ΔLL=change in log likelihood; **Significant at p=.01; + coefficient not statistically significant*

Table 3. Effect of socio economic status on all-cause mortality stratified by race/ethnicity: The national longitudinal mortality study, 1983-1994

	Black RR@	95% CI	White RR@	95% CI	Hispanic RR@	95% CI
Educational attain						
Graduate/prof degree	1.00	Reference	1.00	Reference	1.00	Reference
Less high school	1.35**	1.15,1.59	1.63**	1.57, 1.70	1.46**	1.09, 1.94
High school	1.12	0.94,1.32	1.38**	1.32, 1.43	1.30	0.97, 1.74
Some college	1.01	0.85,1.21	1.28**	1.32, 1.34	1.17	0.85, 1.59
Family income						
$60,000 +	1.00	Reference	1.00	Reference	1.00	Reference
$50,000-$59,999	1.24	1.02, 1.50	1.05*	1.01, 1.09	1.02	0.80, 1.31
$40,000-$49,999	1.24	1.00, 1.53	1.10**	1.05, 1.15	1.20	0.92, 1.54
$30,000-$39,999	1.29**	1.08, 1.54	1.16**	1.11, 1.20	1.25	1.01, 1.56
$20,000-$29,999	1.50**	1.27, 1.77	1.27**	1.23, 1.32	1.22	0.99, 1.49
$10,000-$19,999	1.74**	1.47, 2.05	1.45**	1.40, 1.50	1.45**	1.19, 1.77
Less than $10,000	1.98**	1.68, 2.34	1.53**	1.47, 1.58	1.49**	1.23, 1.83
Deaths: population at risk	8708	63058	75460	577780	2835	45452
LRS df		16095.2**23		179974.1** 23		6470.3** 23

*@ Model adjusted for age, marital status, central city residence, lack of insurance, and sex. LRS = likelihood ratio statistic or Model Chi-square; df = degrees of freedom; RR = relative risk (or hazard ratio); CI = confidence interval. *significant at p<.05; **significant at p<.01*

Model 2 was next used as baseline (or reduced model), and the socioeconomic variables, educational attainment and income were added to the model. Relevant results are shown in model 3. As may be observed, the change in log likelihood was statistically significant (χ^2 = 3729, df=11, α=.01), indicating that the model with education and income was a better fit than the previous (model 2). When racial/ethnic groups were considered, it was observed that mortality differentials had been substantially reduced, and in two cases (Native Americans and other non-white races), the coefficients lost statistical significance. The relative risk for African Americans, which was 1.27 in Model 1 reduced to 1.04, an 18% decline.

3.1 Sub-group Analysis

Given that the main focus of this research was on associations between socioeconomic status and mortality, and how these associations play out across racial groups, the next stage of the analysis was to compare the effects of covariate categories of education and income by ethnic groups. Two tacks may be adopted for comparing groups in this context. One may rely on the effect modification (statistical interactions) approach, and determine whether the effect of a given covariate on the outcome variable depends on the level or value of the other (crossed) covariate. For this paper, given the relatively large number of categories on both education and family income, employing interaction terms was ruled out as the resulting effect modifiers would be too numerous and difficult to interpret. A second approach that achieves the same result was adopted, and that was stratification. Analysis was performed on each racial/ethnic group separately, and the resulting hazards ratios were then examined within each group. I focused on Non-Hispanic Whites, Non-Hispanic African Americans, and Hispanics for performing the sub-group (stratification) analysis. Relevant results are presented in Table 3.

Results suggest that there are remarkable differences in mortality risk of having less than high school education among Black, White, and Hispanic cohort members. The effect of education on mortality is significant, but consistently so only among Whites. In that group, education elevates mortality risk at every level, with the highest risk observed among Whites with less than high school education. Among Black and Hispanic cohort members, however, only less than high school education increased the risk of mortality. High school education and also college education were not significantly associated with mortality among Blacks and Hispanics.

When income was considered, there were no significant differences in effect on mortality

among Whites, Blacks and Hispanics except in the lowest income strata. Results suggest that the consequences of low income on mortality are more severe among Blacks than whites. This is borne out by the sizes of the relative risks. Whereas Whites making $10,000-$19,999 were 45% more likely to die compared to their counterparts making $60,000 or more per year, among Blacks, those making $10,000-$19,999 were nearly 74% more likely to die than their counterparts making $60,000 or more per year. In the Hispanic group, persons in that same family income bracket were 45% as likely to die as their counterparts in the $60,000 or more categories. The racial disparities are even more startling when we look at persons in the income group below $10,000. Whites in that group were 53% more likely to die compared to their counterparts making $60,000 or more, but Blacks in the same group (earning less than $10,000 per year) were 98% more likely to die than their counterparts in the income group $60,000 or more. As for Hispanics, those with family income below $10,000 per year were 49% as likely to die as their counterparts in the $60,000 plus income category. In the Hispanic group, only two income categories approached statistical significance: $20,000-$29,999, and less than $10,000. In the Black group, four categories were statistically significant, all of which were $39,999 or below; the lower the family income, the higher the mortality risk. Among whites, a dose-response relationship was observed with those at the bottom of the income strata experiencing the highest mortality risk, which then reduces as income increases. Despite this, the sizes of the hazards ratios among Whites are much lower than among Blacks.

4. DISCUSSION

The primary objective of this study was to add to the existing literature on the impact of socioeconomic status on adult mortality. The study also aimed at contributing to the literature by determining whether the effect of SES depends on race/ethnicity. Results from this study demonstrate that socioeconomic position is an enduring predictor of mortality in the latest release of the US National Longitudinal Mortality Study. The lower the educational attainment the higher the mortality risk, and the lower the income the higher the mortality risk. Findings on education are consistent with those reported by Miech et al. [13], although that study used a limited age group (40-64 years). Income was also not included in the Miech et al. [13] research, and it is unknown whether its absence could have led to an overestimation of the influence of education on mortality.

Results from the present study also showed racial/ethnic disparities in mortality, but the differentials were not as some past studies have observed [32-35]. It was found that disparities in mortality based on income and education were stronger than those based on race/ethnicity. In other words, SES is a stronger risk factor for death than race or ethnicity. It was observed, for example that the effects of race/ethnicity on all-cause mortality were reduced considerably when SES variables were taken into account.

A unique contribution of this study to the existing literature was our use of stratification to compare the relative effects of SES variables on mortality by race. To our knowledge, there is paucity of studies that have performed such an analysis in a systematic way. Stratification using sub-group analysis showed that the impact of socioeconomic variables on mortality varies significantly between Non-Hispanic African Americans, Non-Hispanic Whites, and Hispanics. More specifically, it was observed that the consequences of education on mortality are more severe among whites than African Americans and Hispanics, but the effects of low income on mortality are more deleterious for Blacks than Whites or Hispanics. Indeed, neither high school education nor college education was a significant risk factor for Blacks and Hispanics, but both of these covariates were significantly associated with white adult mortality.

Findings showed that lack of health insurance is a significant risk factor for death. Both fundamental cause theory [7,17] and social disadvantage theory [36,37] posit that deployment of resources protect people from disease and death. Given that there is no universal health insurance coverage in the United States, possessing insurance is a critical resource. Individuals that fail to deploy it face higher risk of early death.

The study has limitations. The first is that although the data utilized constitute a prospective study of mortality, items in the Current Population Surveys were not structured to take advantage of the time-varying nature of some of the variables. Variables such as education, income, marital status and even health insurance potentially vary with time. The NLMS collected information on individuals only at

baseline (day of the interview). It is, therefore, unknown what happened to cohort member characteristics from the time of the survey until death or censoring. The second limitation is that due to the restrictive nature of the data, we were unable to link individual information to city, neighborhood or even county characteristics. Yet as has become increasingly evident in social and epidemiologic research, most individual event outcomes are nested in larger social units [38,39]. Individual outcomes, including mortality are affected not only by personal characteristics, but environmental and structural factors. Thus, a person living in a low income neighborhood wracked by poverty, lacking access to grocery stores, facing high levels of environmental pollution may experience higher odds of early death not just because of his or her individual socioeconomic position, but due to the socioeconomic condition of the neighborhood.

Despite the above limitations, however, the present study has added to our understanding of the influence of education, income, and health insurance on adult mortality, using the latest release of the US National Longitudinal Mortality Study.

5. CONCLUSION

One of the main findings of the study is that socioeconomic status is a much stronger covariate of mortality than race/ethnicity. An especially noteworthy and troubling finding is that the consequences of education on death are more severe among whites than African Americans and Hispanics. However, the effects of low income on mortality risk are far more detrimental for Blacks/African Americans than Whites or Hispanics. Results provide evidence to suggest that further gains in reducing Black mortality are likely to be slow unless credible efforts are made to close the income gap between them and Whites. Education alone is not the answer.

CONSENT

Not applicable.

ETHICAL APPROVAL

Institutional Review Board approval was not needed for this research as it utilized an existing publicly available, but restricted data set. Permission to use the data was granted to the author by the National Heart, Lung, Blood Institute under contract.

An earlier version of the paper was presented at the Annual Meeting of the Association of Black Sociologists in Denver, Colorado, USA in August 2012. The paper is not under review at another journal.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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