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Socioeconomic and Behavioral Risk Factors for Mortality in a National 19-Year Prospective Study of U.S. Adults

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Abstract

Many demographic, socioeconomic, and behavioral risk factors predict mortality in the United States. However, very few population-based longitudinal studies are able to investigate simultaneously the impact of a variety of social factors on mortality. We investigated the degree to which demographic characteristics, socioeconomic variables and major health risk factors were associated with mortality in a nationally-representative sample of 3,617 U.S. adults from 1986-2005, using data from the 4 waves of the Americans' Changing Lives study. Cox proportional hazard models with time-varying covariates were employed to predict all-cause mortality verified through the National Death Index and death certificate review. The results revealed that low educational attainment was not associated with mortality when income and health risk behaviors were included in the model. The association of low-income with mortality remained after controlling for major behavioral risks. Compared to those in the "normal" weight category, neither overweight nor obesity was significantly associated with the risk of mortality. Among adults age 55 and older at baseline, the risk of mortality was actually reduced for those who were overweight (hazard rate ratio=0.83, 95% C.I. = 0.71 – 0.98) and those who were obese (hazard rate ratio=0.68, 95% C.I. = 0.55 – 0.84), controlling for other health risk behaviors and health status. Having a low level of physical activity was a significant risk factor for mortality (hazard rate ratio=1.58, 95% C.I. = 1.20 – 2.07). The results from this national longitudinal study underscore the need for health policies and clinical interventions focusing on the social and behavioral determinants of health, with a particular focus on income security, smoking prevention/cessation, and physical activity.

Keywords

Mortality; socioeconomic factors; health behavior; Unites States; obesity

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Introduction

Several decades of research conclude that mortality is strongly patterned by a number of sociodemographic variables including gender, race/ethnicity, and residential setting (Sorlie, Backlund & Keller, 1995; Adler & Ostrove, 1999; Geronimus, Colen, Shochet, Ingber, & James, 2006). Prior research has also shown that socioeconomic position—meaning the social and economic factors that influence the positions/roles individuals hold within the structure of society, and as measured by education, income, occupational status, and/or wealth—is strongly associated with mortality (Lauderdale, 2001; Davey Smith, Shipley, & Rose, 1990; Gerdtam & Johannesson, 2004; Kallan, 1997). Across countries, socioeconomic patterns are seen for all-cause mortality and for specific causes of death, including cardiovascular disease and cancer (Fried, Kronmal, Newman, et al., 1998; Faggiano, Partanen, Kogevians & Boffetta, 1997).

Socioeconomic position is theorized to be a “fundamental cause” of health, whereby higher socioeconomic status confers the intrapersonal, interpersonal, and contextual resources needed to more effectively produce and maintain health over the life course (Phelan, Link, Diez-Roux, Kawachi, & Levin, 2004; Adler & Newman, 2002). As a fundamental driver of the way in which societies shape health-related exposures and resources, socioeconomic position is purportedly related to mortality risk through multiple mechanisms at both the individual and contextual level. This includes income, wealth, education, occupation, medical care, and other resources that allow people to identify and avoid environmental and personal health risks.

A prominent hypothesis in attempting to explain socioeconomic disparities in mortality is that people of lower socioeconomic position have worse health in large part because they are more likely to engage in risky health behaviors that help people to avoid or reduce these risks (Phelan et al., 2004; Adler & Newman, 2002; Syme, 2008). That is, socioeconomic position produces disparities in knowledge, cognition, exposures, resources and social relationships that in turn lead to different behavior and risk factor profiles across social strata.

Personal health risk factors such as smoking, alcohol abuse, sedentary lifestyle, poor nutrition, and morbid obesity have indeed been found to increase overall mortality risks and to be more prevalent among those of lower socioeconomic position (Maragume, Yamamoto, Yoshimi, Sobue, et al., 2007; Flegal, Williamson, Pamuk, & Rosenberg, 2004; Rehm & Monterio, 2005; Makamal, 2006). However, prior research from longitudinal studies suggests that the higher prevalence of health risk factors in socially disadvantaged populations explains some but not all observed socioeconomic differentials in health status and mortality (Arendt and Lauridsen, 2008; Feinglass, Lin, Thompson, Sudano, et al., 2007; Bassuk, Berkman, & Amick, 2002; Lantz, House, Lepkoski, Mero, & Chen, 1997). In addition, it is not always the case that groups in lower strata have higher rates of health risk behaviors. For example, Rosero-Bixby and Dow (2009) found in a longitudinal study of elderly Costa Ricans that high calorie diets, obesity and hypertension were most prevalent in higher socioeconomic groups.

Although there is a significant amount of prior population-based research regarding the socioeconomic determinants of mortality, there are some limitations in prior work, including research that aims to better understand these phenomena in the United States. First, although there are several longitudinal mortality studies of population-based samples, most have limited generalizability in that they are restricted to a specific age group (e.g., the Health and Retirement Study) or geographic area (e.g., the Alameda County Study) (Feinglass, Lin,

Thompson, et al., 2007; Frank, Cohen, Yen, Balfour, & Smith, 2003; Wulsin, Evans, Vasana, Murabito, Kelly-Hayes, & Benjamin, 2005).

Second, much of the published social epidemiological literature on mortality focuses on one particular social characteristic (e.g. race, education, gender) and/or one cause of death at a time (Wilcox, He, Chen, Yano, et al., 2006; Mutaner, Hadden, & Kravets, 2004; Miller & Wolinsky, 2007; Mehrotra, Kermah, Fried, Adler, & Norris, 2008; Meara, Richards, & Cutler, 2008). This can lead to myopic or even erroneous conclusions about the important drivers of mortality. For example, it is difficult to measure and understand educational disparities in mortality without simultaneously considering income; and a growing body of literature suggests that education and income influence health in related yet different ways (Zimmer & House, 2003; Herd, Goesling, & House, 2007). Nonetheless, many mortality studies focus exclusively on education as a single marker of socioeconomic status (Elo & Preston, 1996; Meara, Richards & Cutler, 2008; Avendano, Kunst, Huisman, Lenthe, et al., 2006).

Third, many studies investigate a broad array of demographic and socioeconomic differentials in mortality but do not include any information on health risk behaviors/exposures or just focus on one factor at a time (Lin, Rogot, Johnson et al., 2003). For example, many of the studies estimating the impact of obesity on mortality risk likely overestimate risk because they do not control for other factors that are strongly correlated with obesity, such as physical activity and socioeconomic status (Sui, LaMonte, Laditka, Hardin, Chase, Hooker, & Blair, 2007; Freedman, Ron, Ballard-Barbash, Doodhy, & Linet, 2006).

Related to the hypothesis that socioeconomic disparities in behavioral risk factors are the driving force behind disparities in mortality, the literature for the U.S. experience is in fact quite limited. The two main studies on this topic that use nationally-representative, longitudinal samples are from the Health and Retirement Study (Feinglass et al., 2007) which focuses on an older population, and an older study from the American Changing Lives Study (Lantz, House, Lepkoski, Mero, & Chen, 1997) focusing on mortality between 1986 and 1994.

In this research, we extend prior research from the longitudinal, population-based Americans' Changing Lives (ACL) Study to investigate the interplay between major socioeconomic and behavioral factors that influence individuals' risk of mortality across the life course. Research questions included: 1) what are the demographic and socioeconomic patterns in adult all-cause mortality in the United States between 1986-2005 when all are controlled for simultaneously?; 2) to what extent are health risk behaviors related to mortality risk, and do these behaviors explain the observed demographic and socioeconomic disparities in mortality?; and 3) do socioeconomic and behavioral risk factors for mortality vary across younger and older age groups?.

This work builds upon and significantly extends prior mortality research using the ACL data from 7.5 years to 19 years of follow-up (Lantz, House, Lepkoski, Mero, & Chen, 1997). The main findings include that low income (but not low education or race) remained predictive of mortality when controlling for major health risk behaviors. In addition, the risk of death is not associated with obesity or overweight; and among those age 55 and older at baseline, mortality rates were significantly *reduced* for those who were overweight or obese. Physical activity—even at relatively low levels—provided a protective effect against mortality. Our results add new and important findings to the extant literature and current public discourse regarding obesity. In addition, our results confirm and strengthen the evidence base of prior

findings using a study design with a relatively long follow-up period and a nationally-representative sample.

METHODS

Study Design and Sample

Data were from the Americans' Changing Lives (ACL) longitudinal study, which was designed to investigate social patterns of health and aging in the United States. The ACL used a stratified, multistage area sample of noninstitutionalized adults age 25 and older residing in the United States in 1986. African Americans and persons age 60 and older were oversampled at baseline. The first wave of data collection (1986) used face-to-face interviews with 3,617 subjects, representing a 68% response rate. Three subsequent waves of data collection were conducted in 1989, 1994, and 2001/2002, with response rates among survivors of 83%, 83% and 74% respectively. Additional information on the organization and methods of the ACL survey are documented elsewhere (House, Lepkowski, Kinney, Mero, et al., 1994; House, Herd, & Lantz, 2005).

Dependent Variable—The dependent variable in this study is mortality between Wave 1 (1986) and December 31, 2005. Information on deaths among sample members was obtained primarily from the National Death Index and secondarily from informant reports, with deaths validated with death certificates from state vital registration offices (Sesso, Paffenbarger, & Lee, 2000). Between Wave 1 and the end of 2005, 1,409 ACL respondents died (38.9%, or 26.0% of the weighted sample), with 98% certified with a death certificate. The remaining 25 deaths were carefully reviewed, and death appears certain in all cases even though a death certificate could not be located. For these cases, the timing of death was based on informant reports.

Independent Variable—All independent variables were operationalized in ways consistent with prior cross-sectional and longitudinal analyses based on the ACL data (House, Lepkowski, Kinney, et al., 1994; House, Herd, and Lantz, 2005; Lantz, House, Lepkowski, et al., 1998). Three independent variables were based on self-reported information obtained from the ACL Wave 1 in-person interviews in 1986. This included gender (male versus female); and education (measured as completed years of schooling at Wave 1, grouped into the three categories 0-11 years, 12-15 years, and 16 or more years). Race/ethnicity was coded as non-Hispanic white versus other. A limitation of the ACL is that only 16.5% of the weighted sample is non-white (with the majority being African American) or Hispanic. There are not enough Hispanics (n=43), Asian/Pacific Islanders (n=30) or American Indians (n=47) to consider them in separate categories. Descriptive analysis reveals that these 120 people look a lot more like the African Americans in the ACL sample than the non-Hispanic whites in terms of socioeconomic position, health risk factors and health status at baseline. Thus in our work, and in fact in a variety of published work by a large number of researchers using the ACL data, the variable of race/ethnicity was dichotomized into non-Hispanic white versus other.

Additional independent variables—age, residence, income, smoking, drinking, BMI, physical activity, physical impairment, and self-rated health—were all treated as time-varying covariates, with information taken from each ACL wave as available. Age was grouped into 6 categories: 25-34 years, 35-44 years, 45-54 years, 55-64 years, 65-74 years, and 75 years and older. Time-varying place of residence was measured using addresses that were geocoded and converted to rural, suburban, or central city categories.

Time-varying income was measured as the combined income from all sources of the respondent and his/her spouse or partner in each respective wave, grouped into three

categories (\$0-\$9999, \$10000-\$29999, and \$30000 or more). The income measures were inflation-adjusted using the Consumer Price Index so that they represent real 1986 dollars and are comparable over time. More refined categories of income and adding a control for household size were investigated but did not alter the results. Missing information on income in a particular wave was imputed on the basis of regression procedures including income from other ACL waves and sociodemographic variables as available.

Four health risk factors/behaviors were included in the analysis as time-varying covariates, taking advantage of information available over the 4 waves of the study. Cigarette smoking status was a 3-category variable measured as never, current, or former smoker. Alcohol consumption was measured as a count of alcoholic drinks consumed in the past month, with respondents categorized as non-drinkers (0 drinks in the past month), moderate drinkers (1-79 drinks in the past month), and heavy drinkers (80 or more drinks in the past month).

There is debate in the social science and clinical literatures regarding whether obesity is a disease, an illness, a health condition and/or a behavioral risk factor. (de Vries, 2007; Campos, Saguy, Ernsberger, Oliver, & Gaisser, 2006) Recognizing the legitimacy of this debate, we considered body weight and the condition of obesity to be a health risk behavior rather than a “disease” or a health status in this research. Body weight was measured by calculating the body mass index (BMI) as self-reported weight in kilograms/self-reported height in meters². Using established cut-points in the BMI distribution, respondents were categorized as being obese (BMI of 30 or higher), overweight (BMI of 25.0 to 29.9), average weight (BMI of 18.6 to 24.9), and underweight (BMI less than or equal to 18.5).

A physical activity index was derived from answers to survey questions regarding engagement in exercise, active sports, gardening/yard work, household chores, and walking. Scores on this index were divided into quintiles to create 5 sub-groups of comparable size (House, Lepkowski, Kinney, Mero, et al., 1994). When the sample is weighted, the group in the top quintile of physical activity represents the 20% of the sample that is the most physically active, and the bottom quintile represents the 20% that is least physically active and considered as sedentary.

Two time-varying variables were included in the analysis to control for health status. Self-rated health is a 3-category variable, with respondents classified as assessing their current health status as excellent or very good, good, or fair or poor. The degree of impairment in physical functioning was measured using an index based on answers to several survey questions regarding physical mobility and capabilities. Respondents were classified as having no impairment, some impairment, or moderate/severe impairment (House, Lepkowski, Kinney, Mero, et al., 1994; House, Herd, & Lantz, 2005).

If a surviving subject was missing at a wave, this time segment was collapsed with the prior segment, and all time-varying covariates values were assumed to be the same value as the prior wave. Through Wave 4, 70% of the original cohort had either participated in all four waves or all waves prior to their death. Another 17% of the original sample were non-respondents at only one wave up through Wave 4 or their death, with just 5% of the original sample interviewed only in 1986 and surviving to Wave 4.

Statistical Analysis—In all analyses, data were weighted to adjust for differential response rates and the sampling design. Post-stratification weights adjust the sample to U.S. Bureau of the Census population estimates by age, sex, and region for July 1, 1986. Cox proportional hazards models with time-varying covariates were used to assess the relative risk of mortality over the 19-year follow-up period. A set of mortality models were analyzed that controlled for: 1) demographic and socioeconomic variables; 2) demographic,

socioeconomic and behavioral risk factor variables; and 3) demographic, socioeconomic, behavioral and health status variables.

In additional analyses, the sample was stratified into two groups: those who were under age 55 at baseline and those who were age 55 or older. In the younger age group, those who died during the 19-year follow up period did so before age 75, which is approximately the average age of death in the sample and is increasingly considered the defining age for premature death in developed countries. The standard errors for all of the Cox proportional hazards models were estimated with first-order Taylor series linear approximation to account for the ACL's complex sample design. All analyses were conducted using Stata 10.0.

RESULTS

The weighted sample at baseline (Table 1) was 52.9% female and 83.5% non-Hispanic white. A significant portion of the weighted sample could be characterized as socioeconomically disadvantaged, with 25.6% reporting less than a high school education and 19.2% reporting a household income of less than \$10,000 in the previous year in 1986.

In terms of health risk behaviors at baseline (Table 1), 30.4% reported that they currently smoked, 4.3% were categorized as heavy drinkers, and 14.4% had a BMI in the obese range. Previous research using data from ACL Wave 1 has shown that the four health risk variables under study were significantly more prevalent in low-education and low-income populations, even after adjusting for differences in the age distribution across education and income strata (blinded for review). For example, after adjusting for age, the prevalence of smoking and overweight in the lowest income category was 37.7% and 24.4% respectively, compared with 27.4% and 14.0% in the highest income category (results not shown).

During the 19 year follow-up period, 1,409 study subjects died (26.0% of the weighted sample) (Table 1). The mean age at death was 73.9 years, with significant differences across sociodemographic groups. The mean age at death was 70.8 years for men versus 77.1 for women ($p<.001$), and 75.0 for non-Hispanic whites versus 68.1 for others ($p<.001$). Of the 1,409 people who died between 1986 and 2005, 4.9% were <45 years of age, 19.1% were between 45 and 65 years, 21.3% were between 65 and 74 years, and 54.6% were 75 years or older at the time of death.

The results of Cox proportional hazards models including demographic and socioeconomic characteristics as covariates revealed that mortality was significantly associated with age, gender, race, and place of residence. As expected, the hazard rate ratio (HRR) of mortality increased dramatically with age, and was lower for females compared to males (Table 2, Model 1). Non-Hispanic whites had a lower rate of mortality after controlling for other sociodemographic characteristics (HRR=0.86, 95% C.I. 0.71-1.05), but this was not statistically significant in any of the models. In addition, the mortality rate for those living in central cities was significantly higher than those residing in suburban and rural areas, controlling for sociodemographic characteristics, health risk behaviors, and health status (Table 2, Models 1-3).

Controlling for demographic factors, income was significantly related to mortality (Table 2, Model 1). Compared to the highest income group, the HRR for the middle income group was 1.50 (95% C.I.=1.11-1.99) and 2.12 (95% C.I.=1.60-2.81) for the lowest income group. Education was significantly associated with mortality in Model 1, with a HRR of 1.40 (95% C.I.=1.05-1.85) for those with less than a high school education controlling for income and other sociodemographic characteristics. When health risk variables were added to the model, the education effect attenuated to non-significance (Table 2, Model 3). Supplemental

analyses revealed that when income was omitted from the model, the education effect was strong and significant across the models. This finding suggests that education indirectly influences mortality through its strong association with income.

Income remained a strong and significant predictor of 19-year mortality after controlling for health risk behaviors (Table 2, Models 1 and 2), although there was a slight attenuation in the HRR for lower income groups when controlling for risk behaviors. Controlling for demographic characteristics and the 4 risk behaviors, the mortality HRR was 1.76 (95% C.I.=1.28-2.41) for the lowest income group and 1.42 (95% C.I.= 1.05-1.92) for the middle income group (Table 2, Model 2). The mortality disadvantage for the lower income group remained significant in a model controlling for sociodemographics, health risk behaviors and health status (Table 2, Model 3). These results suggest that even though there is indeed a higher prevalence of major health risk behaviors among people in the lowest income group, this does not account for the majority of the relationship between income and mortality.

Many of the health risk factors under study were predictive of mortality in the ACL sample. Those subjects who were current or former smokers, non-drinkers, severely underweight (BMI<18.5), and in the lowest quintile for physical activity were all at a significantly higher risk of mortality during the 19-year study period (Table 2, Model 2). These relationships all remained significant when baseline health status was added to the model (Table 2, Model 3).

Those categorized as obese (BMI=30+) did not have an elevated mortality risk; in fact their risk was significantly *lower* than those with normal weight in a model controlling for other health risk behaviors and health status (HRR=0.79; 95% C.I.=0.64-0.97). Analyses (not shown) focusing on those with morbid obesity (BMI > 35) also did not reveal a significantly elevated mortality rate, although the sample size for this group was small (baseline N=202, average age=48.4 years). Physical activity, however, was associated with lower mortality risk, with those in the lowest activity group (i.e., those with a sedentary lifestyle) having a significantly elevated rate of mortality (HRR=1.58; 95% 1.20-2.07) controlling for other health risk behaviors and health status (Table 2, Model 3).

Age-Stratified Results

Analyses stratifying the ACL sample into those <55 and those 55+ years at baseline revealed similarities to and differences from the results for the full sample (Table 3). The female mortality advantage was significant in the two age groups; and education was not significantly related to mortality in either group.

Notable differences between the two age groups included results related to income, smoking and BMI. In regard to income, an elevated risk of mortality among those with low incomes was only observed for those age 55+ at baseline when controlling for health risk behaviors and health status (Table 3, Models 1b and 2b). The mortality risks for current smoker were larger among those in the young age group (<55 at baseline). This could be the result of a cohort effect, or because competing mortality risks for smokers increase as they age.

Obesity (BMI=30+) was not predictive of mortality in either age group (Table 3). However, being overweight or obese was significantly *protective* against mortality for those ages 55 and older in 1986. Specifically, those 55 and older who were obese had a 27% lower rate of mortality in a model controlling for other health risk behaviors (Table 3, Model 2a) and a 32% lower rate of mortality when controlling for health risk behaviors and health status (Table 3, Model 2b). In addition, those respondents age 55+ who were overweight (but not obese) also experienced a reduced risk of dying. These results suggest that being overweight or obese conferred a protection or benefit in terms of mortality for those who were age 55

and older in 1986, when considering sociodemographic characteristics, health behaviors and health status indicators simultaneously.

In the older age group, those in the lowest quintile of physical activity had a significantly elevated risk of mortality (HRR=1.88, 95% C.I.=1.41-2.50; Table 3, Model 2b). These results demonstrated that, for those Americans age 55 and older, a lack of physical activity was significantly associated with increased the risk of mortality over the next 19 years while obesity itself was not a risk factor. These results also suggest that any amount of physical activity, relative to the most sedentary group, had a positive benefit in terms of mortality.

BMI and Physical Activity

We conducted additional analyses to investigate the impact of BMI and physical activity on mortality without the other variable in the model, since these two variables are correlated. The results (not shown) for physical activity were robust to whether or not a control for BMI (measured both categorically and continuously) was in the model. For BMI, the HRR for obesity in a full model including physical activity was 0.79 (95% CI=0.64-0.97), although this protective effect attenuated to insignificance when physical activity was excluded from the model (HRR=0.88, 95% CI=0.70-1.10). Thus, for the full sample, the significant protective effect of obesity is not observed in a model excluding physical activity. This is because the relationship between obesity on mortality is upwardly biased when physical activity is not included in the model.

In addition, age-stratified analyses reveal similar effects of BMI with and without physical activity in the model for study subjects who were age 55 or older at baseline. As shown in Table 4 (models 2a and 2b), being obese was significantly protective against mortality for those in the older subsample both with physical activity included in (HRR=0.68, 95% CI=0.55-0.84) and excluded from the analysis (HRR=0.79, 95% CI=0.64-0.98). The results of all of these analyses suggest that the effects of overweight/obesity are upwardly biased when physical activity is not considered simultaneously.

Other Sensitivity Analysis

We conducted additional analysis to make sure that our results were not sensitive to how categorical independent variables were operationalized. This included: a) using 6 categories for education and income; b) including a control for number of people dependent upon the household income; c) using a variety of different cut-points for alcohol consumption, including different cut-points for “heavy drinking” and for males versus females; d) using different categorizations of race. In summary, the results reported above are robust to different measurement approaches for the independent variables (myriad results not shown). The main results and conclusions hold across different specifications without exception.

COMMENT

The Americans’ Changing Lives is a nationally-representative, longitudinal study that has data on a broad array of socioeconomic and behavioral risk factors for mortality. The results demonstrate that, for the population of non-institutionalized adults ages 25+ who were living in the U.S. in 1986, the risk of dying over the next 19 years was significantly related to a number of demographic, socioeconomic and behavioral factors. This extends—from 7.5 years to 19 years of follow-up—prior ACL analysis of the role of health risk factors in understanding socioeconomic disparities in mortality (Lantz, House, Lepkowski, Williams, et al., 1998). The extended follow-up period allowed stratified analysis by age which revealed some differences in social and behavioral determinants of mortality. In addition, confirming that key results from prior work holds over a much longer follow-up period provides more evidence of the scientific reliability and thus the policy relevance of these findings.

Our results reaffirm that although the prevalence of health risk behaviors is significantly higher in low-income and low-education subpopulations, this higher prevalence does not appear to be the complete explanation for their higher risk of mortality. That is, socioeconomic disparities in mortality are not simply the outcome of the higher prevalence of health risk behaviors among those of lower socioeconomic position. Our results also underscore the important role that the risk behaviors of smoking and lack of physical activity play in mortality risk across all social strata (Doll, Peto, Boreham, & Sutherland, 2004). As Khang and colleagues concluded in a national study of mortality inequalities in South Korea, “absolute socioeconomic mortality inequalities could be substantially reduced if behavioral risk factors were reduced in the whole population” (Khang, Lynch, Yang, Harper, Yun, Jung-Choi, Kim, 2009).

Another important finding from this study is that, when controlling for income and health risk behaviors in the analysis, education is not significantly related to all-cause mortality in the U.S. This result counters conventional wisdom that education is fundamentally predictive of life expectancy (Elo & Preston, 1996; Meara, Richards & Cutler, 2009). However, education is strongly associated with and predictive of income. Thus, our findings should not be interpreted as suggesting that education is not related to mortality. Rather, our findings suggest that the *mechanism* by which education influences mortality risk is through its strong relationship with income and other more proximate determinants. These results are consistent with recent findings from the Health and Retirement Study and from trajectory analyses of ACL data that show that education is strongly related to a delay in the *onset* of morbidity or limitations in physical functioning, while income is more consequential for the *course or progression* of health problems once they appear, up to and including death (Feinglass, Lin, Thompson, et al., 2007; Zimmer & House, 2003; Herd, Goesling & House, 2007).

A provocative finding from the ACL mortality results is the lack of a significant effect of obesity on all-cause mortality, a finding that is consistent with several population-based longitudinal studies in developed countries (Feinglass et al., 2007; Troiano, Frongillo, Sobal, & Levitsky, 1996; Durazo-Arvizu, McGee, Cooper Liao, & Luke, 1998; Campos, Saguy, Ernsberger, Oliver, & Gaisser, 2006; Flegal, Graubard, Williamson, & Gail, 2005). There is concern that the mortality risk from obesity has been overestimated in prior research and overdramatized in public discourse (Sui, LaMonte, Laditka, Hardin, Chase, Hooker, & Blair, 2007; Freedman, Ron, Ballard-Barbash, Doody, & Linet, 2006; Campos, Saguy, Ernsberger, Oliver, & Gaisser, 2006; Flegal, Graubard, Williamson, & Gail, 2005). Our results suggest that, when socioeconomic and other risk factors are controlled for, obesity is not a significant risk factor for mortality; and that for those 55 or older, both overweight and obesity confer a significant *decreased* risk of mortality. The lack of a significant mortality risk observed in the ACL sample joins a growing body of literature suggesting that the relationship between obesity and mortality is complex, and likely quite different from the relationship between obesity and the incidence/chronicity of a number of health conditions (Freedman, Ron, Ballard-Barbash, Doody, & Linet, 2006; Campos, Saguy, Ernsberger, Oliver, & Gaisser, 2006).

Our age-stratified results are similar to those presented by Flegal and colleagues from their analyses of 2005 National Health and Nutrition Examination Survey data, which concluded that U.S. adults who were overweight but not obese had a relatively lower mortality rate than those of normal weight, and that the mortality risk for obesity was primarily driven by those who were morbidly obese (BMI=35+). (Flegal et al., 2005) An important difference between these two analyses is that our approach includes a control for physical activity level, which may explain why our results showed that both overweight and obesity confer a mortality benefit for those age 55 and older while Flegal et al. (2005) found no statistically

significant relationship between non-morbid obesity and mortality. These findings suggest that population-based analyses that do not simultaneously consider physical activity may be overestimating the mortality risks and public health burdens associated with obesity. Our results are also strikingly similar to recent results from a 12-year longitudinal study of Canadian adults age 25 and older. Orpana and colleagues (2009) found that underweight and morbid obesity (BMI>35) were associated with an increased risk of mortality, while obesity in the range of BMI 30-35 did not have a significant effect. The Canadian study also revealed that overweight individuals (BMI 25 to <30) had a significantly *decreased* risk of mortality, adjusting for many other factors (Orpana, Berthelot, Kaplan, et al., 2009).

It is plausible that obesity, net of physical activity, confers a protective effect among older adults. Prior research has found that obesity in older populations may afford some protection against health shocks or conditions that lead to frailty, wasting and other processes associated with senescence (Freedman et al., 2006; Oreopolous, Padwal, Kalantz-Sadeh, Fonarrow, Norris, & McAlister, 2008; Janssen, 2007). Nonetheless, our results should not be interpreted to mean that obesity is not a significant public health problem or an important issue related to social disparities in morbidity and the costs of medical care. If the prevalence of obesity and morbid obesity continues to increase among children and young adults, especially among those in socially disadvantaged groups, so may its negative impact on future mortality and mortality disparities (Flegal et al., 2005). Also, BMI may not be the best measure of obesity in terms of its relationship to mortality. A recent analysis of National Health and Nutrition Examination Survey data found that ratio measures of abdominal adiposity, in particular the waist-to-thigh ratio in both men and women, and the waist-to-hip ratio in women, were more predictive of mortality than was BMI (Reis, Araneta, Wingard, Macera, et al., 2009).

Another important implication of our results is that a sedentary lifestyle appears to be more important than body weight in terms of general mortality risk. Our study subjects who had very little to no physical activity had an approximately 60% higher mortality rate, controlling for health status. This finding is consistent with prior research suggesting that fitness is relatively more important than “fatness” in predicting mortality (Sui et al., 2007; Haapanen-Niemi, Miilunpalo, Pasanen, Vuori, Oja, & Malmberg, 2000; Babor, Brown, & Delboca, 1990). Sui et al. (2007) reported that physical fitness rather than abdominal adiposity was a primary driver of mortality among adults age 60 and older, and concluded that clinicians “should consider the importance of preserving functional capacity by recommending regular physical activity for older individuals, normal-weight and overweight alike.” Our results echo Sui et al.’s findings and a key implication for clinicians, health educators, and public health strategists: moving patients from a sedentary to non-sedentary lifestyle has real benefits in terms of reducing mortality risk. Our results suggest that simply not being sedentary confers a significant mortality benefit, regardless of obesity status, with the corresponding clinical and public health message that “just getting off the couch” and engaging in some type of activity can be beneficial.

A limitation of the data used for these analyses is that all the information except mortality is based on respondent self report. Regarding health risk behaviors, although prior research shows that self reports are generally valid for behaviors that are not illegal, there is likely some underreporting of the behaviors under study; and this could lead to an underestimation of their effects on mortality (Cohen & Vinson, 1995; Durante & Ainsworth, 1996). As with most observational studies, ours is also susceptible to omitted variable bias; that is, additional social and behavioral variables (both observable and unobservable) may account for some of the associations observed in our analysis. This could include contextual factors such as neighborhood factors or community socioeconomic context, or additional information regarding health status (Cummins, Curtis, Diez-Roux, & Macintyre, 2007).

Another limitation is that this study did not investigate the extent to which reduced mortality actually translated into a healthy, disability-free life expectancy (Matthews, Jagger, Hancock, 2006). Nonetheless, the strengths of this study include that the ACL study is nationally-representative and longitudinal with almost two decades of follow-up, and that data extend beyond basic sociodemographic characteristics.

In summary, this study followed a representative sample of the 1986 U.S. adult population (age 25 and older) and elucidated some of the factors that influenced mortality over the next 19 years. The results confirm that that mortality is strongly patterned by key social characteristics and prevalent health risk factors, and underscore the current emphasis on the need for health policy and clinical interventions focusing on the social determinants of health, especially ones that focus on income security, smoking prevention/cessation, and physical activity.

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Table 1

Baseline Characteristics of Americans' Changing Lives Sample (N=3,617), 1986

Variable	Unweighted N (3617)	Unweighted Percent	Weighted Percent	Males Weighted Percent	Females Weighted Percent
Gender					
Male	1358	37.5	47.1		
Female	2259	62.5	52.9		
Race					
Non-Hispanic White	2322	64.2	83.5	23.4	84.3
Other	1295	35.8	16.5	48.0	15.7
Residence					
City	1204	33.3	24.4	28.5	25.2
Suburb	1346	37.2	47.0	28.5	46.2
Rural	1067	29.5	28.6		28.6
Education, years					
0-11	1349	37.3	25.6	24.8	26.2
12-15	1768	48.9	54.7	51.1	57.9
>15	500	13.8	19.7	24.1	15.9
Income, \$					
<\$10000	1176	32.5	19.2	14.4	23.5
\$10000 – 29,999	1475	40.8	40.5	40.8	40.3
\$30,000+	966	26.7	40.3	44.4	36.2
Smoking					
Current	1060	29.3	30.4	31.9	29.1
Former	941	26.0	27.5	35.3	20.5
Never	1616	44.7	42.1	32.8	50.4
Alcohol, drinks/month					
None	1837	50.8	41.2	29.6	51.5
Moderate (1-79)	1650	45.6	54.5	61.7	48.0

Variable	Unweighted N (3617)	Unweighted Percent	Weighted Percent	Males Weighted Percent	Females Weighted Percent
Heavy (80+)	130	3.6	4.3	8.7	0.5
Body Mass Index					
Obese	644	17.8	14.4	13.7	15.0
Overweight	1248	34.5	34.3	41.2	28.2
Normal	1635	45.2	49.0	44.2	53.3
Underweight	90	2.5	2.3	0.9	3.5
Physical Activity					
Quintile 1 (low)	1037	28.7	21.3	16.7	25.4
Quintile 2	540	14.9	14.9	14.9	14.8
Quintile 3	952	26.3	27.4	27.1	27.6
Quintile 4	439	12.1	15.2	16.7	13.8
Quintile 5	649	17.9	21.3	24.5	18.4
Mortality through 2005					
Alive	2208	61.1	74.0	71.7	76.0
Dead	1409	38.9	26.0	28.3	24.0

Table 2

Mortality Hazard Rate Ratios (95% Confidence Intervals) for Americans' Changing Lives Full Sample (n=3,617), 1986-2005

Variable	Model 1 Hazard Rate Ratio (95% CI) Full sample (n=3,617)	Model 2 Hazard Rate Ratio (95% CI) Full Sample (n=3,617)	Model 3 Hazard Rate Ratio (95% CI) Full Sample (n=3,617)
Age at baseline			
25-34 years	1.00	1.00	1.00
35-44	0.95 (0.45 – 2.04)	0.94 (0.44 – 1.99)	0.84 (0.39 – 1.91)
45-54	1.91 (0.83 – 4.40)	1.90 (0.82 – 4.43)	1.66 (0.71 – 3.90)
55-64	5.80 (2.84 – 11.9)	5.80 (2.87 – 11.7)	4.81 (2.38 – 9.73)
65-74	10.2 (5.03 – 20.5)	10.4 (5.08 – 21.3)	8.58 (4.19 – 17.6)
75+	26.3 (12.8 – 53.8)	26.6 (13.1 – 54.0)	20.7 (10.2 – 41.8)
Gender			
Male	1.00	1.00	1.00
Female	0.51 (0.43 – 0.60)	0.45 (0.38 – 0.55)	0.46 (0.38 – 0.56)
Race			
Other	1.00	1.00	1.00
Non-Hispanic White	0.86 (0.71 – 1.05)	0.90 (0.73 – 1.05)	0.90 (0.74 – 1.09)
Residence			
Rural	1.00	1.00	1.00
Suburban	1.18 (0.99 – 1.41)	1.22 (1.03 – 1.44)	1.23 (1.04 – 1.46)
Central City	1.34 (1.12 – 1.60)	1.30 (1.09 – 1.56)	1.35 (1.13 – 1.61)
Education in years			
16+	1.00	1.00	1.00
12-15	1.13 (0.83 – 1.54)	1.02 (0.73 – 1.41)	1.04 (0.74 – 1.45)
0-11	1.40 (1.05 – 1.85)	1.21 (0.88 – 1.65)	1.16 (0.83 – 1.61)
Inflation-adjusted income			
\$30000+	1.00	1.00	1.00
\$10000-29999	1.50 (1.11 – 1.99)	1.42 (1.05 – 1.92)	1.30 (0.96 – 1.76)
<\$10000	2.12 (1.60 – 2.81)	1.76 (1.28 – 2.41)	1.53 (1.12 – 2.10)
Smoking			
Never		1.00	1.00
Current		1.77 (1.47 – 2.13)	1.74 (1.44 – 2.11)
Former		1.30 (1.06 – 1.59)	1.26 (1.04 – 1.53)
Drinks past month			
Moderate. (1-79)		1.00	1.00
None		1.24 (1.07 – 1.44)	1.16 (1.01 – 1.32)
Heavy (80+)		0.99 (0.62 – 1.61)	1.13 (0.68 – 1.88)

Variable	Model 1 Hazard Rate Ratio (95% CI) Full sample (n=3,617)	Model 2 Hazard Rate Ratio (95% CI) Full Sample (n=3,617)	Model 3 Hazard Rate Ratio (95% CI) Full Sample (n=3,617)
Body Mass Index			
Normal		1.00	1.00
Underweight		2.09 (1.44 – 3.04)	1.88 (1.33 – 2.66)
Overweight		0.86 (0.73 – 1.03)	0.88 (0.76 – 1.04)
Obese BMI=30+		0.84 (0.68 – 1.04)	0.79 (0.64 – 0.97)
Physical Activity			
Quintile 5 (high)		1.00	1.00
Quintile 4		1.13 (0.82 – 1.55)	1.16 (0.83 – 1.50)
Quintile 3		1.19 (0.89 – 1.60)	1.08 (0.83 – 1.43)
Quintile 2		1.36 (0.99 – 1.85)	1.17 (0.85 – 1.61)
Quintile 1 (low)		2.22 (1.71 – 2.87)	1.58 (1.20 – 2.07)
Physical Impairment:			
None			1.00
Some			1.56 (1.24 – 1.96)
Moderate/severe			2.04 (1.49 – 2.79)
Self-rated Health			
Excellent/Very Good			1.00
Good			1.16 (0.97 – 1.40)
Fair/Poor			1.58 (1.28 – 1.96)

Table 3

Mortality Hazard Rate Ratios (95% Confidence Intervals) for Americans' Changing Lives Sample Stratified by Age, 1986-2005

Variable	Model 1a Hazard Rate Ratio (95% CI) <55 at Baseline	Model 1b Hazard Rate Ratio (95% CI) <55 at Baseline	Model 2a Hazard Rate Ratio (95% CI) 55+ at Baseline	Model 2b Hazard Rate Ratio (95% CI) 55+ at Baseline
Gender				
Male	1.00	1.00	1.00	1.00
Female	0.55 (0.34 – 0.86)	0.51 (0.31 – 0.83)	0.42 (0.36 – 0.50)	0.43 (0.36 – 0.52)
Race				
Other	1.00	1.00	1.00	1.00
Non-Hispanic White	0.80 (0.48 – 1.34)	0.82 (0.49 – 1.36)	0.92 (0.76 – 1.11)	0.92 (0.76 – 1.12)
Residence				
Rural	1.00	1.00	1.00	1.00
Suburban	1.30 (0.77 – 2.18)	1.31 (0.77 – 2.23)	1.19 (0.98 – 1.42)	1.20 (1.02 – 1.41)
Central City	1.73 (1.18 – 2.67)	1.71 (1.09 – 2.69)	1.20 (0.96 – 1.50)	1.24 (1.01 – 1.52)
Education (years)				
16+	1.00	1.00	1.00	1.00
12-15	1.05 (0.59 – 1.87)	1.02 (0.55 – 1.88)	0.90 (0.69 – 1.16)	0.95 (0.73 – 1.25)
0-11	0.99 (0.51 – 1.94)	0.91 (0.45 – 1.84)	1.12 (0.85 – 1.46)	1.13 (0.84 – 1.51)
Inflation-adjusted income				
\$30000+	1.00	1.00	1.00	1.00
\$10000-29999	1.05 (0.63 – 1.74)	1.06 (0.63 – 1.76)	1.44 (1.05 – 1.97)	1.30 (0.95 – 1.78)
<\$10000	2.28 (1.25 – 4.14)	1.52 (0.74 – 3.12)	1.60 (1.13 – 2.27)	1.45 (1.03 – 2.05)
Smoking				
Never	1.00	1.00	1.00	1.00
Current	3.22 (2.03 – 5.11)	2.97 (1.81 – 4.83)	1.43 (1.10 – 1.85)	1.43 (1.10 – 1.87)
Former	1.98 (1.18 – 3.34)	1.98 (1.17 – 3.36)	1.18 (0.98 – 1.41)	1.13 (0.95 – 1.35)
Drinks past month				
Mod (1-79)	1.00	1.00	1.00	1.00
None	1.12 (0.65 – 1.95)	1.00 (0.57 – 1.75)	1.29 (1.08 – 1.54)	1.21 (1.01 – 1.44)
Heavy (80+)	1.14 (0.51 – 2.55)	1.16 (0.50 – 2.69)	0.93 (0.51 – 1.68)	1.07 (0.59 – 1.96)
Body Mass Index				
Normal	1.00	1.00	1.00	1.00
Underweight	2.33 (0.60 – 9.04)	1.97 (0.53 – 7.39)	2.21 (1.68 – 2.89)	2.00 (1.53 – 2.62)
Overweight	1.15 (0.71 – 1.84)	1.09 (0.69 – 1.73)	0.81 (0.69 – 0.96)	0.83 (0.71 – 0.98)
Obese BMI=30+	1.50 (0.89 – 2.54)	1.29 (0.77 – 2.18)	0.73 (0.59 – 0.90)	0.68 (0.55 – 0.84)
Physical Activity				
Quintile 5	1.00	1.00	1.00	1.00

Variable	Model 1a Hazard Rate Ratio (95% CI) <55 at Baseline	Model 1b Hazard Rate Ratio (95% CI) <55 at Baseline	Model 2a Hazard Rate Ratio (95% CI) 55+ at Baseline	Model 2b Hazard Rate Ratio (95% CI) 55+ at Baseline
Quintile 4	0.59 (0.28 – 1.26)	0.57 (0.23 – 1.24)	1.35 (0.86 – 2.12)	1.32 (0.86 – 2.03)
Quintile 3	0.73 (0.42 – 1.26)	0.68 (0.39 – 1.15)	1.41 (1.04 – 1.91)	1.28 (0.96 – 1.81)
Quintile 2	1.04 (0.55 – 1.94)	0.88 (0.47 – 1.66)	1.53 (1.12 – 2.10)	1.32 (0.96 – 1.81)
Quintile 1 (low)	1.33 (0.75 – 2.36)	1.06 (0.57 – 1.98)	2.65 (2.01 – 3.49)	1.88 (1.41 – 2.50)
Physical Impairment:				
None		1.00		1.00
Some		1.41 (0.74 – 2.67)		1.54 (1.28 – 1.87)
Moderate/severe		2.03 (0.76 – 5.38)		2.04 (1.62 – 2.56)
Self-rated Health				
Exc/Very Good		1.00		1.00
Good		1.61 (1.05 – 2.46)		1.04 (0.85 – 1.26)
Fair/Poor		2.65 (1.51 – 4.66)		1.35 (1.07 – 1.71)

Table 4

Mortality Hazard Rate Ratios (95% Confidence Intervals) for Body Weight and Physical Activity, Americans' Changing Lives Sample Stratified by Age, 1986-2005

Variable	Model 1a Hazard Rate Ratio (95% CI) <55 at Baseline	Model 1b Hazard Rate Ratio (95% CI) <55 at Baseline	Model 2a Hazard Rate Ratio (95% CI) 55+ at Baseline	Model 2b Hazard Rate Ratio (95% CI) 55+ at Baseline
Body Mass Index				
Normal	1.00	1.00	1.00	1.00
Underweight	1.97 (0.53 – 7.39)	2.57 (0.79 – 8.36)	2.00 (1.53 – 2.62)	2.12 (1.63 – 2.75)
Overweight	1.09 (0.69 – 1.73)	1.10 (0.67 – 1.80)	0.83 (0.71 – 0.98)	0.88 (0.75 – 1.04)
Obese BMI=30+	1.29 (0.77 – 2.18)	1.35 (0.77 – 2.38)	0.68 (0.55 – 0.84)	0.79 (0.64 – 0.98)
Physical Activity				
Quintile 5	1.00		1.00	
Quintile 4	0.57 (0.23 – 1.24)		1.32 (0.86 – 2.03)	
Quintile 3	0.68 (0.39 – 1.15)		1.28 (0.96 – 1.81)	
Quintile 2	0.88 (0.47 – 1.66)		1.32 (0.96 – 1.81)	
Quintile 1 (low)	1.06 (0.57 – 1.98)		1.88 (1.41 -2.50)	

Models control for age, gender, race, residence, education, income, smoking, alcohol use, and health status