# Healthy Lifestyle Changes among Middle-Aged Americans: Education Differences in Changes and Adherence

Rachel Margolis[1]

## Abstract

There are well documented differences in morbidity and mortality by socioeconomic status in the U.S. This may be due in part to early life conditions and in part to later life circumstances. Research on SES differences in health behaviors and health outcomes has not fully addressed the role of health behavior change. In this analysis, I examine which middle-aged and older Americans make changes in health behaviors after reporting new chronic conditions for which lifestyle changes are important for the management of the conditions. I examine patterns of behavior change for smoking, drinking, and exercise as well as adherence to these changes and analyze education differences in behavior change and adherence. I find that no education differences in quitting smoking when reporting new chronic conditions or adherence to smoking cessation. Education is negatively associated with both healthy changes in alcohol consumption and adherence to this lifestyle change. Only the college educated are more likely to start exercising when reporting new conditions, and conditional on starting to exercise, education is positively associated with making exercise a sustained lifestyle change.

[1] Population Studies Center and Department of Sociology, University of Pennsylvania, 3718 Locust Walk, Philadelphia, PA 19104.

**BACKGROUND**

It is well established that many mortality and morbidity outcomes vary by most measures of socioeconomic status in developed societies (Adler et al. 1994). However, the factors that explain these associations are not well understood (Cutler et al. 2006; Hayward et al. 2000; Smith 1999; Preston & Taubman 1994). Some explanations for the SES gradient in health focus on access to care (Bindman 1995; Andrulis 1998), the quality of medical care (Fiscella et al. 2000), and the result of long-term impacts of early childhood circumstances (Costa 1993; Elo & Preston 1992; Haas 2007; Hayward & Gorman 2004). Another explanation focuses on the management of chronic conditions. Goldman and Smith (2002) find that among patients with conditions difficult to manage such as diabetes and HIV, better educated patients were more likely to adhere to therapies and improve their health than less educated patients. Another important explanation is health behaviors and the fact that smoking, excessive drinking, obesity, and lack of exercise are all more prevalent among the least educated in the U.S. (Lantz 2001; Cutler and Lleras-Muney 2007). Health behaviors have been estimated to be a substantial source of SES differences in mortality, between 20 and 30 percent (Davey Smith et al. 1990; Hirdes & Forbes 1992; Lantz et al. 1998; Lynch et al. 1996; Marmot et al. 1997).

Recent work drawing on the life course framework argues that health behaviors might explain more of the SES gradient in health if we measure health behaviors over the life course rather than at one point in time (Preston and Wang 2006). Similarly, medical researchers have examined which programs are most successful in influencing healthy lifestyle changes among their patients (Dawood et al. 2008), motivated by the fact that changes in health behaviors have short and longer term effects on health and mortality (Keenan 2009; King et al. 2007; King et al. 2009; Picone and Sloan 2003). Most research on healthy lifestyle changes use medical samples

and tries to evaluation which lifestyle change programs are most effective, but they do not address the question of how common these changes are at the population level or about subgroup differences (for exceptions see Keenan 2009, Picone and Sloan 2003, and Wray et al. 1998). In this paper, I contribute to both demographic and medical literature by examining the prevalence of healthy lifestyle changes and health behavior trajectories.

I examine whether people with different levels of education change their health behaviors to a different extent when they are told about new chronic conditions for which changes in health behaviors are necessary for disease management. Specifically, I study three lifestyle changes-smoking cessation, cessation or decrease in alcohol consumption, and starting exercise. The chronic conditions for which these behavior changes are important are hypertension, heart disease, diabetes, lung disease, stroke, and cancer. Patients with each condition are urged to quit smoking and limit alcohol consumption. Similarly, patients with hypertension, heart disease, and diabetes are recommended to start exercising or increase exercise (ACCF/AHA Expert Consensus Document. 2009). In addition to examining behavior change, I employ survival analysis to chart adherence to each of the above three behavior changes.

Similar to other demographic and health literature (Herd et al. 2007; Wray et al. 1998), I focus on a specific disease stage, in this case the period after a doctor has told the individual of a new chronic condition. This period is a logical time period to study because diagnosis[1] offers an opportunity for a turning point in lifestyle and health behaviors. A person is faced with new information about his or her health, the recommended lifestyle changes, and the ways in which the health behavior changes can improve disease management. Moreover, a new disease could be the beginning of long-term interactions with the health care system with either worsening or

---

[1] Diagnosis refers to whether the doctor ever told the respondent that he or she has a certain condition.

improving health. Turning points are relevant for this study in that for each disease that I examine there are behavioral components to the treatment guidelines.

I focus on educational attainment, rather than income or wealth for two reasons. The ways in which education is thought to affect health are particularly important for health behavior changes. For example, the better educated have higher health literacy, self-efficacy, and are more likely to have lucrative and health-sustaining occupations (Mirowsky and Ross 1998; Ross and Wu 1996). Second, income and wealth can be volatile over the life course, partially because they are affected by changes in health status (Smith 1999).

This paper adds to the literature in several ways. Prior research on disease onset and progression has not addressed the role of behavior change. This paper examines the prevalence of behavior change and adherence to change for three health behaviors over a 16-year period. A better understanding of who makes healthy lifestyle changes and when they are made can provide information for targeting health interventions. Second, an analysis of health behavior trajectories and changes may allow us to better understand the role of health behaviors in SES differences in morbidity and mortality.

**RESEARCH QUESTIONS**

In this paper, I address the following research questions:

*Research Question 1*: How common are the following health behavior and lifestyle changes among middle-aged and older Americans following a new health event: Smoking cessation, cessation or large decrease in alcohol consumption, and starting exercise?

*Research Question 2*: Do these healthy lifestyle changes vary by educational attainment?

*Research Question 3*: Does adherence to healthy lifestyle changes over the short to medium term vary by educational attainment?

**DATA**

This analysis is based on the Health and Retirement Study (HRS). The HRS is a national panel study which collected data on physical, mental, and financial well-being for a nationally representative sample of persons in the U.S. in 1992 and subsequently surveys participants biannually. In this analysis, I will focus on the members of the "HRS" cohort, those born between 1931 and 1941, who were 51 to 61 years old at baseline in 1992. One advantage of using the HRS is that it is possible to analyze health behavior changes and adherence to those changes over a 16-year period. A second advantage is that I can take into account confounding factors such as health status, existing chronic conditions, and changes in marital status and work hours, which in prior studies have been linked to behavioral change (Evenson et al. 2002; Umberson 2002). An additional advantage is that we observe respondents from the time they are in their 50s, when most are still relatively healthy, into their 60s and early 70s, a period during which many report new chronic conditions, making it possible to observe whether how they change their health behaviors. Moreover, the HRS includes detailed information on health conditions, allowing me to control for health conditions that respondents may already have.

The sample used in the analysis includes individuals who were interviewed in 1992 until consecutive interviews cease, either because of death, attrition, or a missing or proxy[2] survey wave. Of the 9,283 members of the HRS birth cohort (1931-1941) that participated in the baseline study in 1992 with a non-proxy interview, I exclude 743 because they completed less than 2 consecutive non-proxy interviews, and 153 because of missing data on key variables. Thus, the analytic sample consists of 8387 respondents, 90 percent of the age-eligible respondents who participated in the baseline study.

---

[2] Proxy interviews are excluded because of the potential bias in reporting of health behaviors.

I use the eight waves of the HRS from 1992 through 2006.  Each interview wave comprises an observation, such that the data set for the analysis contains 54,074 total observations for 8,387 respondents.  Fifty nine percent of the analytic sample is interviewed all 8 waves, 14 percent participated in six or seven consecutive waves, 14 percent in four or five consecutive waves, and 18 percent in two or three consecutive waves (shown in Table 1).  More than three quarters are alive throughout their time in the study, 11 percent are confirmed dead with the National Death Index matching, and 9 percent are said to have died but have imperfect or no match at the NDI.

Organizing the data in this manner allows the possibility of observing more than one behavior change of each type for an individual.  Fifteen percent of respondents quit smoking one or more times during the study.  Almost all of these (12.4 of respondents) stop only once, while 1.9% quit twice and 0.2% quit three times.  We observe healthy changes in alcohol consumption for 39 percent of respondents.  Most of them (29% of respondents) make one healthy change, 9.4 percent make two, and 1.5 percent make three or four.  We observe 62 percent of respondents starting exercise.  For most of these, we observe only one healthy change (45% of respondents), however for 15 percent of respondents we observe starting exercise twice, and 1.9 percent start three times.

**Dependent Variables**

I examine healthy lifestyle changes for smoking, alcohol consumption, and exercise. Smoking cessation is defined by whether the respondent reported smoking in one interview, but reported not smoking[3] in the subsequent interview.  Defining a healthy change in alcohol consumption is more difficult, as prior research has found that light to moderate drinking is associated with lower mortality than abstinence or heavy drinking (Fuchs et al. 1995; Thun et al.

---

[3] Questions about smoking refer to cigarette smoking, but exclude pipes or cigars.

1997).  Therefore in this study, I define a healthy change in alcohol consumption as drinking cessation or a decrease from heavy drinking in one interview to moderate drinking or less in the subsequent interview.  Drinking refers to beer, wine or liquor.  I define moderate drinking as two drinks per day[4].  Starting exercise is defined as reporting doing "vigorous exercise" in an interview, but not having done so in the previous interview.  Between 1992 and 2002, vigorous exercise is defined as whether the respondent reported doing vigorous physical activity three times a week or more.  For these waves, vigorous exercise is defined as "vigorous physical activity or exercise- i.e. sports, heavy housework, or a job that involves physical labor."  In 2004 and 2006, vigorous exercise is defined slightly differently because of changes in the questionnaire wording.  It is coded as taking part in vigorous exercise more than once a week or more.  In these waves, vigorous exercise is defined as "sports or activities that are vigorous, such as running or jogging, swimming, cycling, aerobics or gym workout, tennis, or digging with a spade or shovel."

I examine healthy behavior changes in the same period as the new reported chronic conditions because I conceptualize a new diagnosis as a turning point for behavior change.  I hypothesize that if new health events affect health behavior changes, then it is most likely than the changes would happen immediately or very soon after the new information, while the event is fresh.  The data support this hypothesis, in that health behavior change is no more likely in the period before, when respondents may notice symptoms, or after reporting a new chronic condition, than it is among those with no new chronic conditions (Results not shown).

---

[4] Survey questions about alcohol consumption differ between waves.  In 1992 and 1994, respondents were asked whether they ever drink alcohol, and how many drinks they drink per day.  Moderate drinking is coded as 1-2 drinks per day or less.  Heavy drinking is coded as 3-4 drinks a day or more.  In 1996 and onwards, respondents were asked if they ever drink, how many days per week they drink, and how many they have when they drink.  Moderate drinking is coded as an average of 2 drinks per day during the week.  Heavy drinking is defines as more than 2 drinks per day on average, or 15 or more per week.

The measurement of behavior changes are limited by the fact that we only observe behaviors at each survey wave, at approximately every two years, but not changes that occur between survey waves. Moreover, we do not observe the exact dates of diagnosis and health behavior changes, making us unable to confirm that diagnosis came before the health behavior change. We also cannot confirm that diagnosis did actually occur, as we rely on self-reported information. Despite these limitations, the HRS offers the most extensive data source for health behavior change over time among a representative sample of middle-aged Americans.

In addition to studying behavior change, I examine adherence to the three health behavior changes discussed above. Adherence is measured from the time that respondents report the healthy behavior change until the time when they report that they either began smoking, started drinking again, or stopped exercising, or until they are censored because of death or attrition from the study or end of the follow-up period.

**Explanatory Variables**

The two key explanatory variables in my analysis are a new chronic condition and educational attainment. I include the following chronic conditions for which healthy lifestyle changes are important for disease management as suggested by treatment guidelines: hypertension, heart disease, diabetes, lung disease, stroke, and cancer. New reported chronic conditions are coded from questions that ask if a doctor ever told the respondent that they had the conditions listed above. If the condition is reported for the first time in a given wave after the baseline interview, it is coded as a new chronic condition. I include all six conditions in the analysis of smoking and alcohol consumption, but I limit them to three, hypertension, heart disease, and diabetes, for the analysis of exercise. Exercise is important for the management of these conditions and they do not necessarily inhibit the ability to engage in exercise. Educational

attainment is coded as: less than high school, high school degree or GED, some college, or college degree.

Three sets of variables are potential confounders in the relationship between a new chronic condition, educational attainment, and making healthy lifestyle changes. The first are demographic characteristics- age and sex. The second is health status. Respondents in poor health with many chronic conditions in the interview before receiving a new diagnosis may not be able to start exercising as easily as respondents in good health with few chronic conditions. I measure health status by self-reported health, which is coded as good/very good/excellent or fair/poor. In addition, I control for the total number of the examined chronic conditions that the respondent had before reporting the new chronic condition. The third set of potential confounders includes changes in partnership status and labor force participation. Prior research has found that changes in partnership status, especially divorce, are negatively associated with healthy behavior changes because of stress or lack of social control (Umberson 1992). Partnership status is measured as married/partnered or not partnered (separated, divorced, widowed, and never married). A change in partnership status from one wave to the next is coded as: no change, gained a partner, and lost partner. Labor force participation is also thought to affect healthy lifestyle changes. For example, it has been hypothesized that people may be more likely to exercise after they retire (Evenson et al. 2002). Labor force participation is coded as either: not working, working part-time, or working full-time. A change in labor force participation is coded as either no change, worked more, or worked less than reported in the previous interview. Both variables measure changes in the same period as behavior change.

**METHODS**

First I examine how common healthy lifestyle changes are among middle-aged Americans following a new health event. I examine whether each of the three healthy lifestyle changes are significantly more common among respondents who report a new chronic condition than among those who do not, using a Pearson ChiSquare test. I perform this analysis for each of the six chronic conditions listed above.

The second research question addresses whether there are education differences in healthy behavior changes when reporting a new chronic condition. To answer this, I estimate a series of nested logistic regression models to predict the odds of healthy behavior change for smoking cessation, decreased alcohol consumption, and starting exercise. Model 1 shows the bivariate relationships between my key explanatory variables, e.g. a new chronic condition and educational attainment, and healthy lifestyle change. Model 2 explores whether the relationship between a new chronic condition, educational attainment, and healthy lifestyle changes differs when controlling for age and sex, health status, and changes in partnership status and labor force participation. In Model 3, I test whether behavior change varies by educational attainment in the presence of a new chronic condition. It includes all the controls in Model 2 and an interaction term for education and the new chronic condition. All models use robust clustered standard errors, to account for the fact that the multiple waves of data for each person are not independent.

The last research question addresses whether there are education differences in adherence to healthy lifestyle changes over the short to medium term. I calculate adherence to smoking cessation, changes in alcohol consumption, and starting exercise using the Kaplan-Meier estimator to estimate the survivor function of healthy behavior change (Kaplan and Meier 1958). Adherence begins at the date of interview at which respondents report the new healthy health

10

behavior and ends at the date of the interview when reporting the unhealthy health behavior, censoring individuals at the date of death if known, or at last interview. I use the logrank test to test whether the survival curves are significantly different by educational attainment (Cleves et al. 2008). In future analysis, I will examine other factors that may mediate the relationship between education and adherence to behavior changes.

**RESULTS**

Table 1 presents descriptive statistics for the analytic sample, weighted to be representative of the individuals in the 1931-1941 birth cohort that were alive in 1992. At first interview, the analytic sample had a mean age of 55.6 (sd 3.3) and was 55 percent female. Most respondents practiced unhealthy health behaviors at some point during the study period (1992-2006). For example, 29 percent of respondents reported smoking cigarettes. Most respondents (72%) reported drinking alcoholic beverages, however less than ten percent reported drinking heavily. Few respondents (5%) reported exercising at every interview. Therefore the vast majority (95%) did not always exercise, and were therefore at risk of making this healthy lifestyle change.

Healthy health behavior changes are common among the middle-aged members of this birth cohort. Fourteen percent of respondents stopped smoking during the study. This is half of the number of respondents who reported smoking in any interview. Forty percent made a healthy change in alcohol consumption, either stopping drinking or cutting back from heavy to moderate drinking or less. Starting exercise is the most common health behavior change. Sixty two percent of respondents start exercising at least once during the study.

Among those who change their health behaviors, unhealthy changes are also common, although less so than healthy changes. We observe seven percent of respondents starting to smoke, after not smoking in the previous interview, one quarter of respondents starting to drink after abstaining, and more than half (56%) stopping exercise. The frequencies of respondents who do not change behaviors, make healthy changes, and make unhealthy changes do not add to one hundred percent because respondents who change behaviors can make more than one over the course of the study.

The respondents in the analytic sample are relatively healthy at first interview. More than half (55%) have no chronic conditions, 31 percent have only one, and less than 15 percent have two or more chronic conditions. Eighty percent report being in excellent, very good, or good health at baseline and only twenty percent reports being in fair or poor health. However, during the study period of 16 years, half of respondents report one or more of the following new chronic conditions- hypertension, heart disease, diabetes, lung disease, cancer, and stroke. Hypertension is the most common new conditions, with almost one quarter (24%) of respondents reporting the new condition during the study. Fifteen percent report new heart disease, 12 percent report new diabetes, 10 percent report new cancer, seven percent report new lung disease, and five percent report stroke.

Healthy lifestyle changes for smoking often occur at the same time as respondents report new chronic conditions for which behavior change is important for disease management. For twenty seven percent of instances where we observe respondents stopping smoking, they also report a new chronic condition. Sixteen percent of observed healthy changes in alcohol consumption occur simultaneously with new reported chronic conditions. A lower percentage of healthy changes for exercise occur when reporting new chronic condition (8%).

The educational attainment of the respondents in the sample is varied. Almost one fifth (19%) has a college degree, another fifth (20%) completed some college, 39 percent has a high school degree, and 22 percent have less than a high school education. We observe a moderate amount of changes in partnership status and labor force participation. While 84 percent of respondents experience no changes in their partnership status, 6 percent gain a partner and 13 percent lose a partner in the study, either due to widowhood or divorce. Changes in labor force participation are more common. While only 38 percent experience no changes in the degree of labor force participation, almost 60 percent works less than before, and 27 percent experience an increase in working hours.

The education composition of unhealthy health behaviors in our sample is not equal across health behaviors. Table 2 presents the unhealthy health behaviors of interest by educational attainment. Health behaviors are measured at baseline. The population of smokers is more heavily weighted to respondents with less than a high school education and less heavily weighted to respondents with college degrees than the analytic sample. Light to moderate drinking is common among respondents, with 57 percent of the analytic sample in this category. Among this category, the least educated are underrepresented and respondents with some or all college are overrepresented. Heavy drinking is much less common, but more representative of the overall population. Similarly, the population not exercising at baseline is similar to the analytic sample overall.

**Healthy Lifestyle Changes**

First I examine how common healthy lifestyle changes are following a new health event. Figures 1, 2, and 3 present the percentages of respondents practicing unhealthy health behaviors that make a healthy lifestyle change by each new chronic condition. For example, in Figure 1,

the black bars represent the percentage of smokers who stop when they report each new chronic condition.  The gray bars represent the percentage of smokers who stop in waves when they do not report that new condition.  I also report the percentage of smokers who stop when reporting any of the six examined conditions compared to those who report none.

Figure 1 shows that for all of the six chronic conditions examined, respondents who report each new condition are significantly more likely to stop smoking at that time than those who do not report the condition.  The percentage of smoking cessation, however, varies by condition.  Almost half of smokers who report new heart disease (44%) stopped smoking in that time period, followed by cancer (39%), stroke (31%), diabetes (30%), lung disease (27%), and hypertension (25%).  Moreover, 30 percent of those reporting any of these new conditions stopped smoking, compared to 15 percent who did not report any of them at that time.

I next examine the frequency of healthy changes in alcohol consumption are when respondents report new chronic conditions.  Figure 2 shows that healthy changes in alcohol consumption are also more common when people report new chronic conditions, compared to when they do not report any.  Forty two percent of respondents that report a new stroke, also report stopping smoking or decreasing from heavy to moderate drinking or less.  This is followed by 32 percent of people reporting new diabetes, 29 percent with new lung disease, 28 percent with new heart disease, 25 percent with new cancer, and 22 percent with new hypertension. Overall, 27 percent of those with any of these new conditions limits alcohol consumption, compared to 18 percent with none of these new conditions.  The degree of behavior change for alcohol consumption does not line up with the severity of the recommendation for the treatment of the condition, suggesting both medical and social explanations.  For example, alcohol restriction is very important for dietary change for the treatment of diabetes, however it is less

important for stroke and cancer.  It may be that people change their alcohol consumption when other things in their lives change, such as social routines.  This may explain why those who report new strokes are the most likely to change their alcohol consumption.

Figure 5 presents the frequency of starting exercise among those who did not formerly exercise, by new chronic condition.  The chronic conditions for which exercise is an extremely important part of disease management are hypertension, diabetes, and heart disease.  For all of these conditions, those who report the new conditions are no more likely to start exercising than those who do not report the new condition.  In fact, those who report new hypertension and diabetes are even less likely to start exercising than those who do not report these new conditions.  This could be because those who report new chronic conditions are already in poor health and are not able to start exercising.  However, even when restricting the sample to those who reported being in good, very good, or excellent health, those with these new conditions are no more likely to start exercising than those with no conditions (results not shown).  It could also be that those reporting new conditions are different on unobservable characteristics than those with new conditions, such as degree to which they care about their health.

**Education Differences in Healthy Lifestyle Changes**

I next examine whether healthy lifestyle changes following a new health event vary by educational attainment.  First, I will examine education differences in smoking cessation.  Figure 4 presents smoking cessation by any of the six new chronic conditions and educational attainment.  The levels of smoking cessation with and without a chronic condition differ by education.  Those with some college or a college degree have higher rates of smoking cessation than those with a high school education or less.  While 35 percent of respondents with at least some college stop smoking with a new chronic condition, only 27 to 28 percent of respondents

with high school or less when reporting a new condition.  However, respondents with at least

some college are also more likely to stop smoking when not reporting a new condition (16

percent of those with at least some college compared to 12 percent with high school or less).

To explore whether the relationships between education, new chronic conditions, and

smoking cessation differs when accounting for confounding factors, I turn to the results shown in

Table 3.  Model 1 reports the bivariate associations between each key factor and smoking

cessation.  Similar to Figure 4, a new chronic condition is associated with more than twice the

odds of smoking cessation, and those with at least some college are more likely than those with

less education to stop smoking.  In Models 2 and 3, I also control for demographic

characteristics, the number of existing chronic conditions, self-reported health, and changes in

partnership status and labor force participation.  Even when controlling for these potentially

confounding factors, both the new chronic condition and at least some college are both positively

associated with higher odds of smoking cessation.  In Model 3, I test whether there is a

differential impact of a new chronic condition for respondents with different educational

attainment with an interaction term for a new chronic condition and educational attainment.

While the odds ratios are in the expected direction, I find no statistically significant interaction.

I next examine healthy changes in alcohol consumption.  Figure 5 presents changes in

alcohol consumption by any new chronic condition and educational attainment.  There is a

negative association between healthy changes in alcohol consumption and educational

attainment, where the least educated are most likely to restrict alcohol consumption both with

(60%) and without (28%) new chronic conditions.  This negative association between education

and changes in alcohol consumption may be due to education differences in drinking habits or

may be due to the ways in which people limit drinking.  The least educated are most likely to be

binge drinkers, however the well educated are just as likely to consume moderate to high amount of alcohol in social situations, without approaching binge drinking levels (results not shown). It may also be that people with less education have a higher propensity to stop drinking altogether than cutting back, than more educated people, although it is unclear why this is.

To examine whether the relationship between education, new conditions, and changes in alcohol consumption changes when accounting for health status and other changes, I turn to the results from logistic regression models in Table 4. As shown in Model 1, reporting a new chronic condition is associated with higher odds of making a healthy change in alcohol consumption. Similar to Figure 5, those with higher education are less likely to make these changes. The relationships stay virtually the same in Model 2, when accounting for prior health status, demographic factors, and changes in partnership status and labor force participation. In Model 3, I test whether the relationship between a new chronic condition and a change in alcohol is different at different education levels. Those with a college degree are significantly less likely to stop smoking or cut back from heavy to moderate drinking, upon diagnosis, than less educated respondents.

I now turn to education differences in starting exercise. Figure 6 shows the frequency of starting exercise by a new chronic condition (hypertension, heart disease, and diabetes) and educational attainment. None of the education groups is significantly more likely to start exercising when reporting a new condition, than those without. However, those with a high school education or less are significantly less likely to start exercising when reporting a new condition. However, for those with at least some college, there is no difference. Moreover, those with high school or less have lower rates of starting exercise, either with or without a new condition. One possible explanation is that those with less education are already in poorer health

and are less able to start exercise. I therefore move to the results shown in Table 5. In Model 1, those reporting chronic conditions are less likely to start exercise than those who report no new conditions. And education is positively correlated with starting exercise. However, when including controls in Model 2, there is no relationship between education and starting exercise, suggesting that health status is also an important factor. In Model 3, I test whether people with different education levels react differently to new chronic conditions in their exercise behavior. Those with a college degree are more likely to start to exercise than those with the least education, when reporting a new chronic condition.

**Adherence to Healthy Lifestyle Changes**

In the last section of the paper, I address whether adherence to healthy lifestyle changes over the short to medium term vary by educational attainment[5]. Figure 7 presents adherence to smoking cessation by educational attainment. Of those who stop smoking, more than a quarter report smoking again at the next interview. However, after four years, relapse slows and about half of people who stop smoking continue to stay quit. Although Figure 4 showed differences by education in smoking cessation, Figure 7 shows no significant differences in adherence to smoking cessation by educational attainment.

Figure 8 presents adherence to healthy changes in drinking cessation by education. Changes in alcohol consumption are not as well sustained in the short to medium term as changes in smoking cessation. Between 25 and 50 percent of people who stop drinking alcohol or decrease alcohol consumption report starting again at the next interview. Between 25 and 50 percent sustain these healthy changes between four and eight years. However by ten years, only

---

[5] Adherence is measured from the first healthy behavior change to the first relapse for each person that makes a healthy change. The sample is not limited to those who change behavior when reporting a new chronic condition.

about a quarter sustain the healthy changes in alcohol consumption.  Similar to the findings

above for healthy changes in alcohol consumption, education is also negatively associated with

adherence to these changes.

Adherence to exercise is shown in Figure 9.  This survival curve is the steepest of the

three whereby only about one quarter of those who start exercising are still doing so after six

years.  However, exercise cessation may not be because of lack of will but because of health

limitations.  As hypothesized, education is positively associated with adherence to exercise, with

a well-defined gradient throughout the survival curve.


**DISCUSSION**

Health behaviors are often cited as one reason for the SES gradient in health and

mortality (Davey Smith et al. 1990; Hirdes & Forbes 1992; Lantz et al. 1998; Lynch et al. 1996;

Marmot et al. 1997).  While the social science literature has measured smoking over the life

course and its relationship to mortality, we have largely ignored health behavior changes for

alcohol consumption and exercise.  With this analysis, I attempt to bridge the medical literature

on behavior changes with a population perspective to understand the prevalence of healthy

lifestyle changes and adherence to those changes in middle age.

In this analysis, I examine the frequency of healthy lifestyle changes at the population

level.  I measure changes in smoking, alcohol consumption, and vigorous exercise over a 16 year

period for a representative sample of middle-aged Americans.  I next examine how common

lifestyle changes are, when respondents report new chronic conditions for which lifestyle

changes are important for disease management.  The analysis focuses on the period when the

respondent reports a new condition because the interaction offers a turning point when engaging

with the health care system and receiving information about their health and how to manage their chronic conditions. I then analyze adherence to healthy lifestyle changes using survival analysis. I examine whether health behavior changes and adherence to those changes vary by education.

I found that healthy lifestyle changes in middle age are quite common. Fourteen percent of the sample stopped smoking during the study, 40 percent stopped drinking alcohol or changed from heavy drinking to light or moderate drinking, and almost two thirds started vigorous exercise. Moreover, behavior change is especially common when respondents report new chronic conditions for which behavior change is important for the management of their conditions. Thirty percent of smokers and a quarter of drinkers report abstaining or cutting back (drinking) in the wave when they report any of the following conditions- heart disease, diabetes, hypertension, lung disease, cancer, and stroke. However, respondents are no more likely to start exercising when they have a new condition than at other times. In fact, they are slightly less likely to start exercising when reporting new conditions than when reporting no new conditions.

I examined education differences in healthy behavior changes and adherence to those changes. Similar to other literature on smoking cessation (Escobedo and Peddicord 1996; Wray et al. 1998), there is a positive association between education and smoking cessation, with or without reporting a new chronic condition. The fact that the more educated have better health literacy and locus of control may explain why those with more education are more likely to stop smoking. However, the more educated are not statistically more likely to quit smoking when reporting new chronic conditions, than those with less education. I also find no significant association between education and adherence to smoking cessation.

These unexpected null findings may be due to the education composition of smokers, their unobserved preferences for cigarettes, and the highly addictive nature of smoking.

20

Compared to the cohort at large, smokers in middle age are more likely to have less than a high school education and are less likely to have a college degree. Smoking was very common among this cohort at younger ages (Preston and Wang 2006) and approximately one third of the cohort is a former smoker. The more educated with weak preferences for smoking may have been more likely to quit earlier on, leaving smokers in middle age who get the most pleasure out of smoking or who are the most addicted.

Unlike smoking cessation, I find a negative relationship between education and drinking changes and adherence to changes in alcohol consumption. The less educated drink heavily more often than more educated (Lantz et al. 1998), but seem to make drastic changes with new chronic conditions and adhere to those changes better than those the college educated. This may be because behavior changes go hand in hand (Picone and Sloane 2003), or it may be that it may be more socially acceptable to quit than to moderate alcohol consumption (Drinking cessation comprises the vast majority of healthy changes in alcohol consumption).

The reverse SES gradient in healthy changes in alcohol consumption is also unexpected. It may be due to differences in norms by social class about managing disease. While treatment guidelines recommend cutting back on alcohol consumption, there is also literature showing a correlation between light to moderate drinking and lower mortality. Perhaps the most educated read this literature as well and do not let alcohol consumption get in the way of managing their conditions, which they do with other means. More research is need to verify and further explain this finding.

Unlike smoking and drinking, starting exercise seems to be unrelated to new chronic conditions. The fact that respondents were no more likely to start exercising upon finding out about a new chronic condition suggests that exercise is not a behavior that is easy to change, but

that it requires new habits that are difficult to begin and often limited by poor health, physical space, or resources to get access to exercise space. The more educated are more likely to start exercising in general. Moreover, controlling for health status, the college educated are more likely to start exercising upon reporting a new chronic condition. Education is also positively associated with adherence to exercise over time. The reasons for education differences in exercise are unclear. It may be that the more educated better understand the need for exercise as a treatment for disease or prevention, have better access to safe space to exercise, more assets to hire help in exercising, or may have greater social support. In future work, I will examine some of these explanations.

This analysis is limited by the frequency and quality of the measurement of health behaviors. With biannual interviews, I assess health behavior changes by comparing reported current health behaviors at each wave. However, we do not observe changes that occur between waves but are not reported, such as very short term smoking cessations. We also do not know about the exact timing of behavior change and new chronic conditions. I measure behavior change in the same time period as the individuals report receiving a new diagnosis with a chronic condition because the time immediately following the new diagnosis is most likely to lead to behavior change. The data do not allow us to know whether the diagnosis or the behavior change came first. In this paper, I assume that behavior changes are a response to the new reported chronic condition, or to the symptoms patients notice preceding diagnosis. More detailed data on timing is necessary to analyze whether behavior change is a response to new health information. Another limitation is that because I examine health behavior changes in middle age, I only observe changes among those who practice the unhealthy health behavior at this point in life. The analysis does not capture health behaviors throughout the life course and

does not account for selection into the sample, affected by both mortality and the practice of health behaviors.

In moving forward with this research, I will address some of the bigger questions surrounding this analysis. First, I will model adherence to behavior change, taking into account some of the covariates that might explain why we see strong education gradients for alcohol consumption and exercise, but not smoking. Second, I hope to work on how health behavior trajectories are related to mortality.

Despite these limitations, this paper presents a detailed description of healthy behavior changes among middle-aged Americans over a 16 year period. It contributes to our understanding about how people respond to new information about their health with healthy lifestyle changes and documents education differences in changes in smoking, drinking, and exercise behavior. Since health behaviors are one important way in which patients manage chronic conditions, then understanding and encouraging healthy behavior changes are essential to understanding SES differences in mortality and health and improving the health of low mortality populations.

# TABLES AND FIGURES

Table 1.  Weighted Sample Characteristics, Health and Retirement Study, HRS Cohort (N=8,387) [1]

| Variable | Mean (sd) or % | Variable | Mean (sd) or % |
|---|---|---|---|
| **Unhealthy Health Behaviors** [2] | | **Educational Attainment** | |
| Smokers | 29.2 | College degree | 18.9 |
| Consuming Any Alcohol | 72.6 | Some college | 20.2 |
| Heavy Drinkers | 9.8 | High school degree | 38.9 |
| Not Exercising | 94.8 | Less than high school | 21.9 |
| **Health Behavior Changes** | | **Socio-Demographic Controls** | |
| Healthy Behavior Change [3] | | Age [4] | 55.6 (3.3) |
| Smoking | 14.5 | Female [4] | 55.0 |
| Alcohol Consumption | 39.8 | Partnership Changes [3] | |
| Exercise | 62.5 | No change | 84.1 |
| No Change in Behavior [3] | | Gained partner | 5.8 |
| Smoking | 84.2 | Lost partner | 13.1 |
| Alcohol Consumption | 56.81 | Labor Force Participation Change [3] | |
| Exercise | 29.8 | No change | 38.2 |
| Unhealthy Behavior Change [3] | | Worked Less | 58.9 |
| Smoking | 7.0 | Worked More | 27.4 |
| Alcohol Consumption | 25.0 | **Health Status** | |
| Exercise | 56.6 | Self-rated health [4] | |
| **New Chronic Conditions** | | Excellent | 24.3 |
| Number New Chronic Conditions [3] | | Very good | 30.5 |
| None | 49.7 | Good | 26.3 |
| One | 32.1 | Fair or poor | 19.0 |
| Two | 13.8 | Number chronic conditions [4] | |
| Three or more | 4.4 | None | 55.0 |
| New Chronic Conditions Reported [3] | | One | 31.3 |
| Hypertension | 24.0 | Two | 10.4 |
| Heart disease | 15.4 | Three or more | 3.2 |
| Diabetes | 11.9 | **Sample Characteristics** | |
| Lung disease | 7.2 | Vital Status Throughout Study | |
| Cancer | 10.4 | Alive | 79.6 |
| Stroke | 5.1 | NDI confirmed death | 11.2 |
| **% of Healthy Changes Occurring with New Reported Chronic Condition** | | Imperfect or no match | 9.2 |
| Smoking | 27.2 | Number of consecutive waves | |
| Alcohol Consumption | 16.3 | Eight | 58.9 |
| Exercise | 8.3 | Six or seven | 9.0 |
| | | Four or five | 13.7 |
| | | Two or three | 18.3 |

[1] 8,387 respondents are followed over time for a total panel of 54,074 episodes.
[2] Percentage that ever exhibited the unhealthy behavior during the study, and therefore are at risk of making a healthy behavior change
[3] Reported 1994-2006
[4] Measured at baseline (1992)

Table 2. Weighted Sample Characteristics, Health Behaviors by Educational Attainment, HRS 1992

| Educational Attainment | Analytic Sample | Smokers | Light/Moderate Alcohol Consumption | Heavy Alcohol Consumption | Do Not Exercise |
|---|---|---|---|---|---|
| | (N=8,387) | (N=2,244) | (N=4,758) | (N=402) | (N=6,604) |
| Less than High School | 21.9 | 30.5 | 16.0 | 24.5 | 22.2 |
| High School Degree | 38.9 | 39.5 | 37.5 | 36.3 | 39.7 |
| Some College | 20.2 | 19.5 | 23.1 | 20.2 | 19.9 |
| College Degree | 18.9 | 10.6 | 23.4 | 19.1 | 18.2 |

Table 3. Odds Ratios from Logistic Regression Models Predicting Smoking Cessation (N=2,436) [1]

| Smoking Cessation | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| New Chronic Condition  (No New Chronic Condition) | 2.61 *** | 2.54 *** | 2.56 *** |
| Education (Less than HS) | | | |
|   High School Degree | 1.01 | 1.04 | 1.05 |
|   Some College | 1.30 *** | 1.35 *** | 1.34 *** |
|   College Degree | 1.31 ** | 1.35 *** | 1.32 ** |
| Interaction Education * New Condition | - | - | |
|   High School * New Chronic Condition | | | 0.94 |
|   Some College * New Chronic Condition | | | 1.03 |
|   College Degree * New Chronic Condition | | | 1.11 |

*** p<.01 **p<.05 * p<.10

[1] 2,436 smokers are followed over time for a total panel of 8,756 episodes.

*Models 2 and 3 include controls for age, sex, health status, and changes in partnership status and labor force participation.

Table 4. Odds Ratios from Logistic Regression Models Predicting Drinking Cessation and Decrease (N=5,726) [1]

| Healthy Changes in Alcohol Consumption | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| New Chronic Condition  (No New Chronic Condition) | 1.62 *** | 1.65 *** | 1.71 *** |
| Education (Less than HS) | | | |
|   High School Degree | 0.60 *** | 0.67 *** | - |
|   Some College | 0.44 *** | 0.50 *** | - |
|   College Degree | 0.34 *** | 0.41 *** | 0.63 *** |
| Interaction Education * New Condition | - | - | |
|   College Degree * New Chronic Condition | | | 0.78 * |

*** p<.01 **p<.05 * p<.10

[1] 5,726 drinkers are followed over time for a total panel of 23,353 episodes.

*Models 2 and 3 include controls for age, sex, health status, and changes in partnership status and labor force participation.

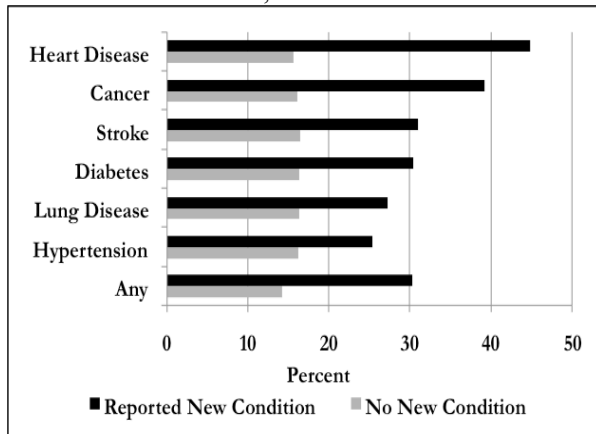Table 5. Odds Ratios from Logistic Regression Models Predicting Starting Exercise (N=7,744) [1]

| Starting Exercise | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| New Chronic Condition  (No New Chronic Condition) | 0.84 *** | 0.84 *** | 0.77 ** |
| Education (Less than HS) | | | |
|   High School Degree | 1.19 *** | 1.01 | 1.01 |
|   Some College | 1.33 *** | 1.06 | 1.05 |
|   College Degree | 1.30 *** | 0.94 | 0.92 |
| Interaction Education * New Condition | - | - | |
|   High School * New Chronic Condition | | | 1.02 |
|   Some College * New Chronic Condition | | | 1.18 |
|   College Degree * New Chronic Condition | | | 1.31 * |

*** p<.01 **p<.05 * p<.10

[1] 7,744 respondents who do not exercise are followed over time for a total panel of 27,912 episodes.
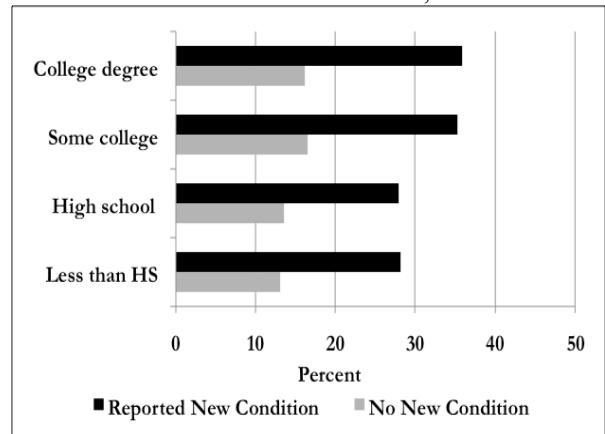
*Models 2 and 3 include controls for age, sex, health status, and changes in partnership status and labor force participation.

Figure 1.  Smoking Cessation by Type of
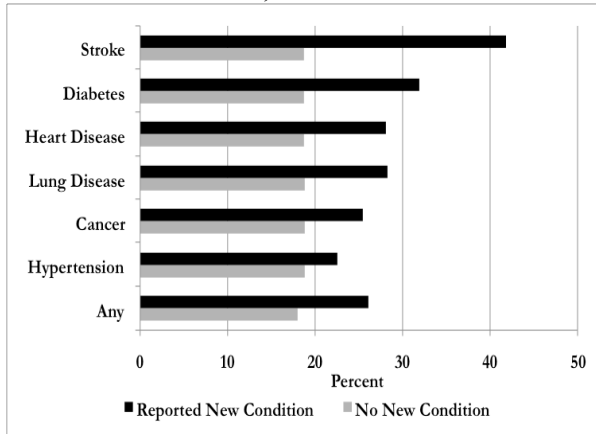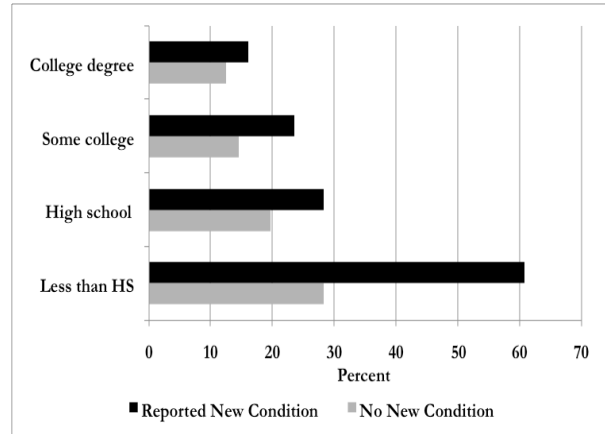New Chronic Condition, HRS 1992-2006



*All differences statistically significant p<.01

Figure 2.   Drinking Cessation and Decrease by Type of
New Chronic Condition, HRS 1992-2006
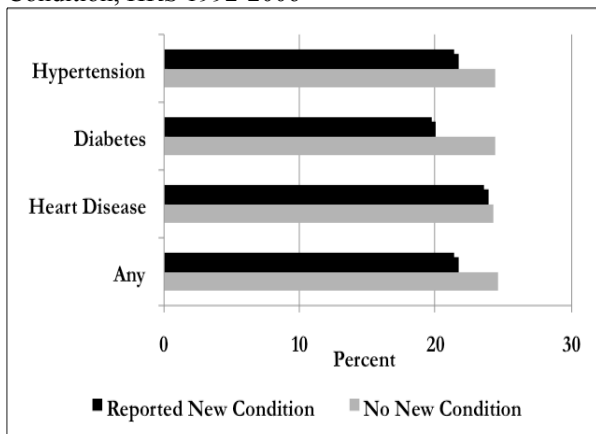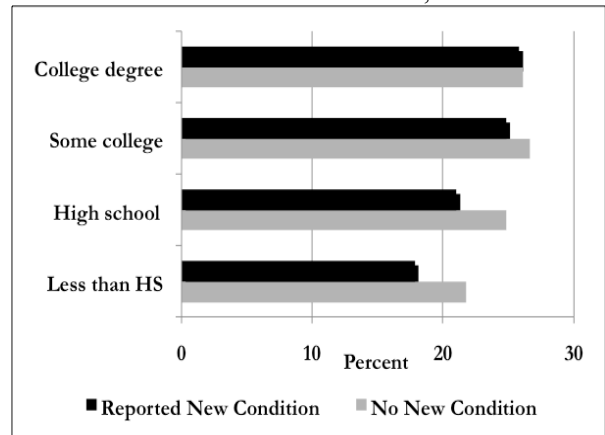


*All differences statistically significant p<.01

Figure 3.  Starting Exercise by Type of New Chronic
Condition, HRS 1992-2006



* Differences for any condition, diabetes, and hypertension
statistically significant p<.05.  No difference for heart disease

Figure 4.  Smoking Cessation by Any New Chronic
Condition and Educational Attainment, HRS 1992-2006



*All differences statistically significant p<.01

Figure 5. Drinking Cessation and Decrease by Any New
Chronic Condition and Educational Attainment, HRS
1992-2006



*All differences statistically significant p<.01

Figure 6.  Starting Exercise by Any New Chronic
Condition and Educational Attainment, HRS 1992-2006



 * Differences for high school and less than high school statistically
significant p<.05. No difference for some college or all college

Figure 7.  Adherence to Smoking Cessation by Educational Attainment
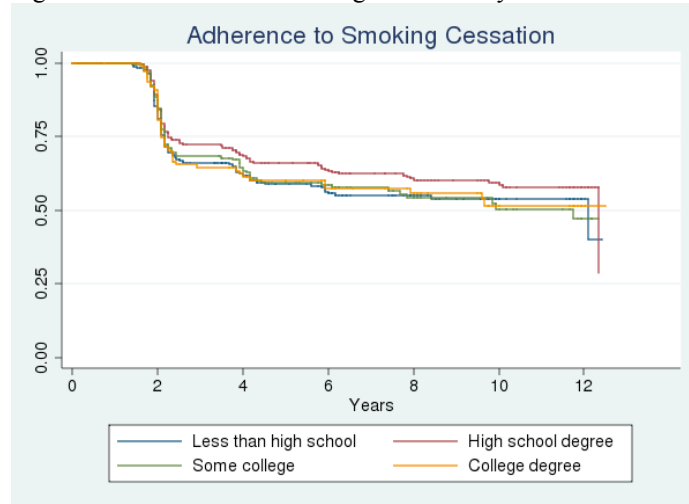


* No statistically significant differences in adherence by education.

Figure 8.  Adherence to Healthy Changes in Alcohol Consumption by Educational Attainment
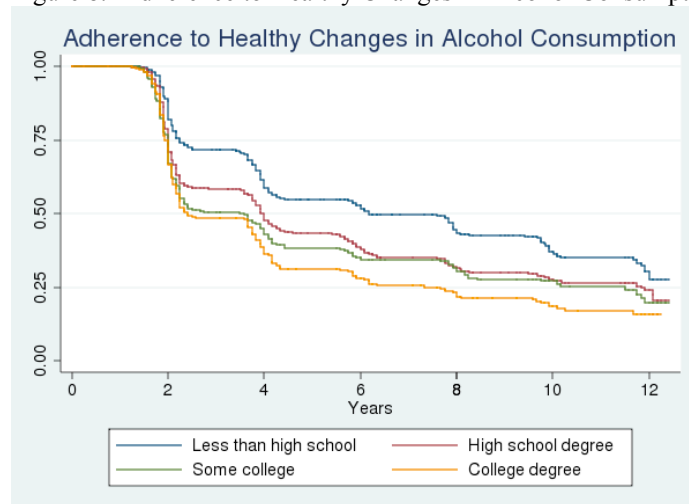


* Differences in adherence by education statistically significant p<.01

Figure 9.  Adherence to Exercise Starting by Educational Attainment
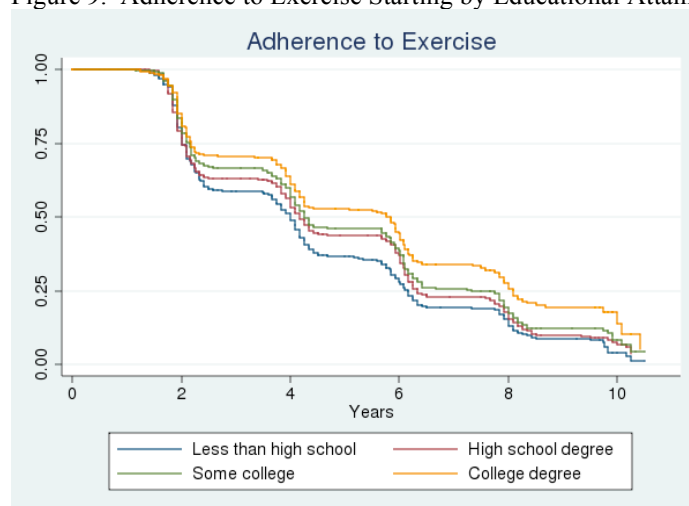


* Differences in adherence by education statistically significant p<.01

**REFERENCES**

ACCF/AHA Expert Consensus Document. 2009. "ACCF/AHA 2009 Expert Consensus Document on Pulmonary Hypertension: A Report of the American College of Cardiology Foundation Task Force on Expert Consensus Documents and the American Heart Association." *Circulation* 119(16): 2250.

Adler, N.E., T. Boyce, M.A. Chesney, S. Cohen, S. Folkman, R.L. Kahn, S.L. Syme. 1994. "Socioeconomic status and health- The challenge of the gradient." *American Psychologist* 49(1): 15-24.

Allison, P.D. 1982. Event History Analysis: Regression for Longitudinal Event Data. Series: Quantitative Applications in the Social Sciences.  Beverly Hills: Sage Publications.

Andrulis, D. P. 1998. "Access to care is the centerpiece in the elimination of socioeconomic disparities in health." *Annals of Internal Medicine* 129(5): 412-416.

Bindman, A. 1995. "Preventable Hospitalizations and Access to Health Care." *Journal of the American Medical Association* 274(4): 301-311.

Chung, S., M.E. Domino, S.C. Stearns, and B.M.Popkin. 2009. "Retirement and Physical Activity: Analyses by Occupation and Wealth." *American Journal of Preventive Medicine* 36(5):422-428.

Cleves, M.A., W.M. Gould, R. G. Gutierrez, and Y.U. Marchenko. 2008. "An Introduction to Survival Analysis Using Stata: Second Edition." College Station, TX: A Stata Press Publication.

Costa, D. L. 1993. "Height, weight, wartime stress, and older age mortality- Evidence from the Union Army Records." *Explorations in Economic History* 30(4): 424-449.

Cutler, D., A. Deaton, and A. Lleras-Muney. 2006. "The determinants of mortality." *Journal of Economic Perspectives* 20(3): 97-120.

Cutler, D. and A. Lleras-Muney. 2007. "Understanding Differences in Health Behavior by Education." *NBER Working Paper*.

Davey Smith, G. D., M. J. Shipley, and G. Rose. 1990. "Magnitude and Causes of Socioeconomic Differentials in Mortality- Further Evidence from the Whitehall Study." Journal of Epidemiology and Community Health 44(4): 265-270.

Dawood, N., V.Vaccarino, K.J.Reid, J.A. Spertus, N.Hamid, S. Parashar. 2008. "Predictors of Smoking Cessation After a Myocardial Infarction." Archives of Internal Medicine 168(18):1961-1967.

Elo, I. T. 2009. "Social Class Differentials in Health and Mortality: Patterns and Explanations in Comparative Perspective." *Annual Review of Sociology* 35:553-572.

Elo, I. T. and S. H. Preston. 1992. "Effects of early life conditions on adult mortality- A Review." *Population Index* 58(2): 186-212.

Escobdo, L.G. and J.P. Peddicord. 1996. "Smoking Prevalence in US Birth Cohorts: The Influence of Gender and Education." *American Journal of Public Health* 86(2): 231-236.

Evanson, K.R., W.D. Rosamond, J. Cai, A.V. Diez-Roux, and R. L. Brancati. 2002. "Influence of Retirement on Leisure-time Physical Activity." American Journal of Epidemiology 155 (8):692-699.

Fiscella, K., P. Franks, M.R. Gold, C.M. Clancy. 2000. "Inequality in Quality: Addressing Socioeconomic, Racial, and Ethnic Disparities in Health Care." *Journal of the American Medical Association* 283: 2579-2584.

Fuchs, C.S., M.J. Stampfer, G.A. Colditz, E.L. Giovannucci, J.E. Manson, I. Kawachi, D.J. Hunter, S.E. Hankinson, C.H. Hennekens, B. Rosner, F.E. Speizer, and W.C. Willett. 1995. "Alcohol Consumption and Mortality Among Women." *New England Journal of Medicine* 332(19):1245-1250.

Hayward, M. D. and B. K. Gorman. 2004. "The long arm of childhood: The influence of early-life social conditions on men's mortality." *Demography* 41(1): 87-107.

Hayward, M.D., T.P. Miles, E.M. Crimmins, and Y. Yang. 2000. "The significance of socioeconomic status in explaining the racial gap in chronic health conditions." *American Sociological Review* 65(6): 910-930.

Herd, P., B.Goesling, and J.S. House. 2007. "Socioeconomic position and health: The differential effects of education versus income on the onset versus progression of health problems." *Journal of Health and Social Behavior* 48(3): 223-238.

Lantz, P.M., J.W. Lynch, J.S.House, J.M. Lepkowski, R.P.Mero, M.A. Musick, and D.R. Williams. 2001. "Socioeconomic disparities in health change in a longitudinal study of US adults: the role of health-risk behaviors." *Social Science & Medicine* 53(1): 29-40.

Lantz, P.M., J.S. House, J.M. Lepkowski, Willians, D.R., Mero, R.P., Chen, J. 1998. Socioeconomic Factors, Health Behaviors, and Mortality: Results from a Nationally Representative Prospective Study of US Adults. *JAMA* 279(21):1703-1708.

Goldman, D. P. and J. P. Smith. 2002. "Can patient self-management help explain the SES health gradient?" *Proceedings of the National Academy of Sciences of the United States of America* 99(16): 10929-10934.

Haas, S. A. 2007. "The long-term effects of poor childhood health: An assessment and application of retrospective reports." *Demography* 44(1): 113-135.

Hirdes, J. P. and W. F. Forbes. 1992. "The importance of social relationships, socioeconomic status, and health practices with respect to mortality among healthy Ontario males." *Journal of Clinical Epidemiology* 45(2): 175-182.

Kaplan, E.L. and P. Meier. 1958. "Nonparametric estimation from incomplete observations." *Journal of the American Statistical Association*. 53: 457-481.

Keenan, P.S. 2009. "Smoking and Weight Change After New Health Diagnoses in Older Adults." *Archives of Internal Medicine* 169(3):237-242.

King, D.E., A.G. Mainous, M.Carnemolla, and C.J. Everett. 2009. "Adherence to Healthy Lifestyle Habits in US Adults, 1988-2006. *The American Journal of Medicine* 122(6):528-534.

King, D.E., A.G Mainous, and M.E. Geesey. 2007. "Turning Back the Clock: Adopting a Healthy Lifestyle in Middle Age." *The American Journal of Medicine* 120(7):598-603.

Lundborg, P., P. Nystedt, and B. Lindgren. 2007. "Getting Ready for the Marriage Market? The Association Between Divorce Risks and Investments in Attractive Body Mass Among Married Europeans. *Journal of Biosocial Science 39*:531-544.

Lynch, J.W., G.A. Kaplan, R.D. Cohen, J.Tuomilehto, and J.T. Salonen. 1996. "Do cardiovascular risk factors explain the relation between socioeconomic status, risk of all-cause mortality, cardiovascular mortality, and acute myocardial infarction?" *American Journal of Epidemiology* 144(10): 934-942.

Marmot, M., C.D. Ryff, L.L. Bumpass, M. Shipley, and N.F. Marks. 1997. "Social inequalities in health: Next questions and converging evidence." *Social Science & Medicine* 44(6): 901-910.

Mirowsky, J. and C.E. Ross. 1998. "Education, Personal Control, Lifestyle, and Health: A Human Capital Hypothesis." *Research on Aging* 20:415-449.

Picone, G. and F. Sloan. 2003. "Smoking Cessation and Lifestyle Changes." *Forum for Health Economics and Policy* 6(6):115-142.

Preston, S. H. and I. T. Elo. 1995. "Are Educational Differentials in Adult Mortality Increasing in the United States." *Journal of Aging and Health* 7(4): 476-496.

Preston S.H., and P.Taubman. 1994. "Socioeconomic Differences in Adult Mortality and Health Status." Pp:279-318 in The Demography of Aging. Eds, L.G. Martin and S.H. Preston. Washington, DC, National Academy Press.

Preston, S.H. and H. Wang. 2006. "Sex Mortality Differences in the United States: The Role of Cohort Smoking Patterns." *Demography* 43(4):631-646.

Ross, C.E. and C.L. Wu. 1996. "Education, Age, and the Cumulative Advantage in Health." *Journal of Health and Social Behavior*." 37:104-120.

Smith, J. P. 1999. "Healthy bodies and thick wallets: The dual relation between health and economic status." *Journal of Economic Perspectives* 13(2): 145-166.

Thun, M.J., R. Peto, A.D. Lopez, J.H. Monaco, S. J. Henley, C.W. Heath, and R. Doll. 1997. "Alcohol Consumption and Mortality among Middle-Aged and Elderly U.S. Adults." *New England Journal of Medicine* 337(24):1705-1714.

Wray, L.A., A.R. Herzog, W.J. Willis, and R.B.Wallace.1998. "The Impact of Education and Heart Attack on Smoking Cessation Among Middle-Aged Adults." *Journal of Health and Social Behavior* 39(4):271-294.