March 22, 2011

Education Differences in Adherence to Smoking Cessation and Physical Activity Among Middle-Aged Americans

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Abstract

There are well-documented differences in morbidity and mortality by socioeconomic status (SES) in the United States. Among the mechanisms proposed to explain the SES gradient in health are health behaviors. The better-educated are more likely to practice healthy health behaviors when measured at a point in time. However, there is not clear evidence regarding whether better-educated people are more likely to initiate healthy lifestyle changes and whether they better adhere to these healthy changes, once made. I use nationally representative survey data on a cohort of middle-aged Americans to examine patterns of healthy behavior changes by education over a 16-year period. There are different patterns by educational attainment for the two health behaviors examined- smoking and physical activity. I find that while the more-educated are the least likely to smoke in middle age and the most likely to quit, adherence to smoking cessation does not differ by education. There are strong differences by educational attainment in physical activity, starting physical activity overall, and adherence. Future research should try to better understand the barriers to exercise among those with low education.

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Acknowledgements: The author gratefully acknowledges the financial support of the National Institute of Health-National Institute on Aging (T32 AG000177 and P30 AG12836), the National Institute of Child Health and Human Development (T32 HD 007242 and R24 HD-044964), and a dissertation completion grant from the University of Pennsylvania.

INTRODUCTION

Chronic diseases are the primary cause of mortality in low-mortality societies (Horiuchi 1999). Because death rates are low at young ages, further improvements in life expectancy in the U.S. and other developed societies must come from reductions in death rates at older ages. Health behaviors are an important factor in improving chronic disease prevalence, management, and overall health in older age. The American Heart Association urges people to quit smoking, limit alcohol consumption, and start or increase physical activity in order to prevent and manage chronic illnesses (ACCF/AHA Expert Consensus Document 2009).

Researchers in public health and medicine seek to understand the best points of intervention and methods to encourage patients to adopt healthier lifestyles (AHA 2006). Although some research has documented the correlates of healthy lifestyle changes (Wray et al. 1998; Evanson et al. 2002), there is little research at the population level about how common healthy behavior changes are and for how long people sustain lifestyle changes once initiated. Understanding social patterns in health behavior changes and trajectories can help locate opportunities for interventions to encourage healthy changes, decrease morbidity and mortality, and reduce SES disparities in health.

In this analysis, I examine patterns in health behavior changes by educational attainment for a cohort of middle-aged Americans over a 16-year period. I document the prevalence of healthy behavior changes overall and adherence to healthy changes, once made.[1] The two healthy changes that I examine are smoking cessation and starting physical activity, which are both important for preventing and managing chronic illness (Rogers et al. 2000).

[1] I refer to adherence and maintenance interchangeably.

Socioeconomic Status and Health

It is well-established that that there is a large degree of stratification in health and well-being by socioeconomic status (SES) in the United States (Adler et al. 1994). Individuals higher in the social hierarchy have better health outcomes for almost every condition for which we have data (Illsley & Baker 1991). Policymakers aim to reduce social disparities in health, but accomplishing this goal necessitates understanding the relative contributions of the various factors that underlie these differences. Although many factors have been studied, the processes responsible for the gradient are still not well understood (Cutler, Deaton, & Lleras-Muney 2006; Smith 2004).

Some of the mechanisms proposed to explain SES differences in health occur early in life. Children from low SES families experience higher rates of childhood morbidity, under-nutrition, and poor conditions in utero, which may influence health later in life (Barker 1997; Elo & Preston 1992; Hayward & Gorman 2004; Margolis 2010). Later life factors are also thought to matter. Health care is another often cited factor, as people of lower SES also have less access to health care in the U.S. (Bindman, 1995; Andrulis, 1998) and to lower quality of care (Fiscella et al., 2000). Lifestyle factors are another explanation. Smoking, excessive drinking, obesity, and lack of exercise are all more prevalent among the least-educated in the U.S. (Cutler & Lleras-Muney 2007; Lantz et al. 2001; Ross & Wu 1995). Another explanation is that better-educated patients more successfully manage chronic disease with complex treatment regimes such as diabetes and HIV (Goldman and Smith 2002). In addition to the many ways in which socioeconomic status influences heath, causality also flows in the other direction, with poor health affecting educational attainment, working hours, and income (Smith 1999). My analysis will focus on health behaviors.

Socioeconomic Status and Health Behaviors

In this analysis I focus on two health behaviors, smoking and physical activity, which are both important for promoting health and longevity (Rogers et al. 2000). There are many explanations for differences in health behaviors by socioeconomic status and no single factor can explain patterns. Pampel and colleagues (2010) group the broad explanations for the correlation between socioeconomic status and health behaviors into nine broad categories.

One explanation is that people of low socioeconomic status have less knowledge about the harm to their health done by smoking and physical inactivity and therefore may have less incentive to practice healthy behaviors (Siahpush et al. 2006). Although this may have been important when information about the health risks of smoking first became known in the 1960s, this seems less important today as there is widespread understanding that smoking and physical inactivity pose health risks (Lyons 2005; Saad 2006) and there are few differences by SES in people's reported desire to quit smoking (Barbea et al. 2004; Link 2008).

Another explanation is that education leads to greater efficacy and ability to understand health information, which could translate to decisions to overcome nicotine addiction and the discomfort of exercise (Mirowsky & Ross 2003; 2007). The fact that the more-educated are more likely to use new programs to help quit smoking, (Honjo et al. 2006), and are more responsive to antismoking campaigns (Neiderdeppe et al. 2008) lend support to this explanation. Locus of control and agency have also been found to be important for physical activity, explaining about half the relationship between physical activity and education (Droomers et al. 1998).

Third, the highly-educated also have higher incomes which may allow them to better reach their health goals. While quitting smoking and being physically active do not necessarily cost money, and cigarette smoking even costs money, resources allow people to buy services

which aid healthy lifestyles. For example, counseling and medications to ease withdrawal aid smoking cessation and fitness clubs can facilitate regular exercise. Cutler and Lleras-Muney (2010) estimate that economic resources can explain about 20 percent of the differences in health behaviors by education, while others estimate that up to 40 percent of the higher activity levels of the more-educated (Droomers et al. 1998).

People of high SES also may find it easier to adopt and maintain healthy behaviors because of the characteristics of the communities in which they live. High-income neighborhoods have fewer places to buy cigarettes, fewer cigarette advertisements, and while they have similar access to parks and gyms as low-income neighborhoods, may have nicer and safer spaces to exercise out of doors (Barbaeau et al. 2004; Powell et al. 2006). They also may be influenced by the people in their networks through peer influence and social support (Smith & Christakis 2008). Given that much social interaction occurs within SES group, people of high SES are likely to be influenced by healthy norms held by those in their social network. One social relationship which is thought to be particularly important is for health behaviors is the marital relationship (Umberson 1992).

Another potential explanation for the correlation between SES and health behaviors is that people use health behaviors to delineate their status within a society (Bourdieu 1984; Cockerham 2005; Veblen 1899). While smoking was first popularized by those with high status, it later became popular among the low SES (Pampel 2005). After it became known that smoking was harmful for health, the more-educated quit faster (USDHHS 1990) and smoking has become more stigmatized among the highly-educated (Stuber et al. 2008). People also signal social status by participating in certain kinds of physical activity and keeping a thin figure has become a sign of prestige (McLaren 2007; Sobal & Stunkard 1989).

Deprivation and stress are the focus of another explanation for SES differences in health behaviors. It is theorized that having a disadvantaged social position causes stress and decreases coping skills. Stress may arise from relative social position, disadvantaged neighborhood or other chronic stressors more often experienced by those of low SES such as poverty, unemployment and family stress (Lantz et al. 2005; Marmot 2004). Smoking and physical inactivity are two things that may bring pleasure and regulate mood (Lantz et al. 2005; Wilkinson 1996; Latye & Whelan 2009). Lutfey and Freese (2005) argue that because people of low SES use these unhealthy behaviors as coping functions, they see them as more costly to give up and therefore have a harder time adopting healthy behaviors. However, research has not clearly defined the causal pathways through which stress causes unhealthy behaviors. Indeed there is some evidence that smoking may increase stress because of addiction (Parrott 1999) and that physical activity can decrease stress, anxiety, and depression (Salmon 2001).

Another explanation is that people of low socioeconomic status are more likely to practice unhealthy behaviors because they have less reason to invest in their future health. This idea has its roots in economic theory and assumes that people make decisions in the present looking forward to the future (Becker & Murphy 1988). Cutler and Lleras-Muney (2008) argue that the lower lifetime earnings and wealth of low SES give them more reason to focus on the present. Likewise, different beliefs in the benefits of healthy behaviors also might contribute to SES differences in health behaviors.

Lastly, there may be unobserved factors about people which influence both SES and health behaviors, such as self-control and innate intelligence (Fuchs 1982; Gottfredson 2004). However, these arguments are limited by the difficulty of providing direct tests of the theory and

the fact that much research has found evidence of effects of education on health behaviors (Mirowsky & Ross 2003).

The Contribution of Health Behaviors to the SES Gradient in Health

Health behaviors are often cited as a primary cause of the SES gradient in health because negative health behaviors such as smoking, heavy alcohol consumption, physical inactivity, and obesity are most common among those with low levels of education (Cutler & Lleras-Muney 2007; Lantz et al. 2001; Ross & Wu 1995) and they are associated with the onset of chronic diseases and mortality (Healthy People 2000; Rogers et al. 2000). Estimates of the contribution of health behaviors to SES differences in mortality vary depending on the method, population, and length of time during which health behaviors are assessed.

Studies measuring health behaviors at one point in time in adulthood and subsequent mortality have found that health risk behaviors account for a relatively small proportion of SES differences in mortality (Davey Smith et al. 1990; Hirdes & Forbes 1992; Lynch et al. 1996; Lantz et al. 1998; 2001; Laaksonen et al. 2008; Schrijvers et al. 1999; Strand et al. 2004; Woodward et al. 2003). For example, Lantz et al. (2001) examined the extent to which four behavioral factors (smoking, alcohol drinking, sedentary lifestyle, and relative body weight) accounted for differences in mortality by socioeconomic status among a nationally representative sample of adult Americans (Americans' Changing Lives Study). They examined mortality over a 7.5-year period and found that the odds ratio for the mortality of the lowest education group relative to the highest fell by only 14% when controlling for these behavioral factors, concluding that the higher prevalence of risky behaviors is not the primary cause of SES differences in mortality. A similar study conducted by Marmot and colleagues (2006) uses British civil servant

data for a 25-year period and find that smoking and other risk factors for heart disease account for just over a quarter (27%) of the social gradient in coronary heart disease.

Another approach used to assess the contribution of health behaviors such as smoking to SES differences in mortality is indirect estimation. For example, Jha and colleagues (2006) use indirect estimation methods to attribute mortality to either smoking related causes or other, among adult men in England and Wales, Poland, the U.S. and Canada. They find that smoking accounts for 38 to 45 percent of the excess mortality among the lowest SES men in each country.

There has been more recent emphasis on measuring health behaviors dynamically, since health behaviors might explain more of the SES gradient in health if we measure them over the life course rather than at one point in time (Harris 2010). A recent study by Stringhini and colleagues (2010) examined the role of health behaviors in the association between socioeconomic position and mortality among a sample of British civil servants. They compare whether the contribution of health behaviors differs when assessed at only one point compared when assessed longitudinally, four times throughout the follow-up period. Socioeconomic position was derived from civil service employment grade at baseline and the health behaviors examined were smoking, alcohol consumption, diet, and physical activity. They find that health behaviors at baseline explained 42 percent of all cause mortality, 29 percent of cardiovascular disease mortality, and 61 percent of non-cancer and non-cardiovascular disease mortality. However, when using repeated measures of health behaviors, health behaviors explained a much greater percentage of differences by mortality by socioeconomic position, 72, 45, and 94 percent respectively.

Health Behavior Changes

Although SES differences in health behaviors are well-studied, there has not been much research on the variability of health behaviors and whether health behavior changes and trajectories vary by socioeconomic status. The few studies that have been conducted on health behavior changes have found that in addition to having healthier behaviors in young adulthood, the well-educated are also more likely to stop smoking and start exercising later in life than the poorly-educated (Chung, Domino, Stearns, & Popkin 2009; Dawood et al. 2008; Shaw & Spokane 2008; USDHHS 1990). For example, between 1974 and 1985, after the evidence accumulated that smoking causes lung cancer and heart disease, the prevalence of smoking among the college-educated declined five times faster than among those with less than a high school education (Pierce et al. 1989).

Other research has examined the predictors of health behavior changes. Prior research has found that changes in partnership status, especially divorce, are negatively associated with healthy behavior changes because of stress and lack of social support (Umberson, 1992). Labor force participation is also thought to affect healthy lifestyle changes. For example, people are more likely to exercise after they retire (Evanson et al. 2002) although they may retire because they want to spend more time being active, or may retire because they experience health problems. Thus, the direction of causality is difficult to determine. Another predictor of health behavior changes is a change in health status. Recent evidence shows that smoking cessation (Clark & Etile 2002; Falba 2005; Keenan 2009; Wray et al. 1998), drinking cessation (Pringle et al. 2006), and weight loss among the obese (Keenan 2009) are more likely after respondents receive a new diagnosis. In my other work, I examine whether there are differences by education in healthy behavior changes upon diagnosis with chronic illnesses.

Adherence to Healthy Behavior Changes

Although many studies have examined SES differences in health behaviors at a point in time, and some have examined health behavior changes, we know little about the patterns of adherence to lifestyle changes once initiated, and whether they differ by education. I hypothesize that education will be positively associated with adherence, based on findings from two literatures. First, the research on socioeconomic status and health behaviors discussed above suggests that the better-educated will be better able to maintain a healthy lifestyle. Second, I look to the literature on socioeconomic status and medical adherence. The well-educated also manage chronic conditions with complex treatment regimes such as HIV/AIDS and diabetes better (Goldman & Smith 2002) and better adhere to screenings such as mammograms and flu shots (Carrasquillo, Lantigua & Shea 2001)

If there are education differences in adherence to smoking cessation and physical activity, I explore three correlates of adherence to healthy lifestyle changes that could mediate the relationship between educational attainment and adherence to healthy lifestyles: health status, social support, and household wealth. The highly-educated also might better adhere to healthy lifestyles because they are in better health for longer. The more-educated have lower rates of disability, obesity, and later onset of chronic conditions than those of low SES (Jaco 1958; Haan & Kaplan 1986; Hayward et al. 2000). Disability, obesity, and illness may hinder the ability to continue exercise. Similarly, illness can bring on stress, which can affect smoking behavior and other negative health risk behaviors (Williams 1990).

The second is social support. Social relationships are hypothesized to positively affect health for a wide range of outcomes (Cohen & Syme 1985). Population level panel studies have

found that social ties are associated with lower mortality risk (Berkman & Breslow 1983; House, Robbins, & Metzner 1982). The more-educated are partnered for more of their lives on average, because of lower mortality and assortative mating by education (Schwartz & Mare 2005). In addition to being partnered for longer, the highly-educated are more likely to have spouses that are less likely to smoke and more likely to be physically active, behaviors which can affect those of partners (Eraker et al. 1985; Appleton & Pharoah 1998).

Wealth is another factor that may explain why the educated have better adherence to healthy behaviors. Resources may allow people to buy services such as gym membership, personal training, or counseling or medications to stay off smoking. People with high incomes also might have better adherence because they live in nicer, safer neighborhoods where it is easier to be physically active right there in the neighborhood (Powell et al. 2006).

The Present Study

In this analysis, I use survey data on a nationally representative cohort of middle-aged Americans to document patterns in healthy behavior changes and trajectories for smoking and physical activity. Specifically, I address the following questions:

1- How frequent are healthy behavior changes among middle-aged Americans?
2- Is educational attainment associated with the probability of making a healthy behavior change in middle age?
3- Is educational attainment associated with adherence to healthy behavior changes in middle age?
4- If education is associated with adherence to smoking cessation and physical activity, how can we explain those differences?

This analysis extends research on socioeconomic status and health in several ways. Prior research has not examined adherence to healthy lifestyles and whether these patterns differ by education. I document these descriptive patterns and examine the predictors of adherence to smoking cessation and physical activity. Second, a clear understanding of who makes healthy lifestyle changes can improve health interventions by targeting information and support. Moreover, if education is positively correlated with healthy lifestyle changes and adherence, then this may explain why measuring health behaviors over time explains much more of SES differences in health than when measured at only one point in time.

DATA

This study is based on the Health and Retirement Study (HRS), a longitudinal study of aging that is nationally representative of the U.S. population above age 50 (Juster & Suzman 1995). The main advantage of using the HRS is that it allows the analysis of health behavior changes over a long period of time. This is important because we observe respondents' trajectories starting from when they are in their 50s, when most are still relatively healthy, into their 60s and early 70s, a period during which many change their health behaviors, experience health changes, and retire. The second advantage is the ability to 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 behavior change (Evanson et al.; Umberson 1992).

In this analysis, I focus on the 1931–1941 birth cohort. These participants were interviewed at baseline in 1992 when they were ages 50-61 and subsequently interviewed every

other year over a 16-year period.[2] The analytic sample is structured to follow respondents' health behavior trajectories for as long as the biennial data allow. It includes respondents who were interviewed at baseline in 1992 and participated in two through eight interviews, until consecutive interviews cease, either because of death, attrition, or a missing or proxy interview.[3] 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 fewer than two consecutive non-proxy interviews, and 399 because of missing data on the key demographic and health data. Thus, the analytic sample consists of 8,141 respondents, 88 percent of the age-eligible respondents who participated in the baseline study. A comparison of the characteristics of the analytic sample to the cohort at large can be found in appendix Table A1.

The analytic data contain 52,963 panel observations for the 8,141 respondents. Sixty percent of the analytic sample is interviewed in all eight waves, eight 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. More than three quarters are alive throughout their time in the study, 11 percent are confirmed dead with the National Death Index (NDI), six percent have an imperfect NDI match, and three percent have no NDI match.

Health Behaviors

In each interview, participants answered questions about their health behaviors, including smoking, and physical activity. Smoking cessation is defined by whether the respondent reported

[2] I focus on the HRS cohort because they were the first cohort entering the study in their 50s and are followed for the longest period of time. I exclude the AHEAD cohort because they were older when entering the study. In future work I will examine the cohorts that entered the study in their 50s in later years and compare across groups. This includes the "War Babies" and "Early Boomer" birth cohorts added to the study in 1998 and 2004 respectively.

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

smoking in one interview, but reported not smoking in the subsequent interview.[4] Starting physical activity 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 this period, 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 interviews, 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." Results are robust when excluding 2004 and 2006 data for which question wording differs.

To examine adherence to healthy lifestyle changes in middle age, I examine two subsamples of the respondents, those who make a healthy change for smoking or physical activity and whom we follow at least one wave after this change. The sample for adherence to smoking cessation consists of 1,227 respondents who quit smoking and the sample for adherence to physical activity consists of 5,115 respondents who began to exercise during the follow-up period. Adherence is measured from the interview of the first healthy change to the interview when they report the unhealthy health behavior, or until they are censored either because of death, attrition from the study or a missing interview, or the end of the follow-up period. In this analysis, I examine only the first observed healthy change for those who make multiple changes for each health behavior. Of those who stop smoking, we observe 85 percent quit only once, 13 percent twice, and two percent three times. Of those who start physical

[4] Questions about smoking refer to cigarette smoking, but exclude pipes or cigars. Longitudinal data on the intensity of cigarette smoking are not available.

activity, we observe 72 percent starting only once, 25 percent twice, and three percent three times.

This analysis of adherence captures broad health behavior trajectories. We do not observe short term changes in behavior since health behaviors are recorded at interviews about two years apart. Also, the period for which health behaviors are reported varies by the behavior. Questions about smoking behavior are directed at the present time, while questions about physical activity are about average activity over the last 12 months. The measurement at infrequent but regular intervals is similar to how others have studied the maintenance of other infrequent yet repeated events such as HPV screening and mammography (Gierisch et al. 2010).

Socioeconomic Status

Educational attainment is the key measure of socioeconomic status and is coded as: less than high school, high school degree or GED, some college, or college degree. I focus on educational attainment as the main measure of socioeconomic status, rather than income or wealth, for three reasons. First, 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 and self-efficacy, which allow patients to better understand the importance of lifestyle factors and have the sense of control to change health behaviors (Mirowsky & Ross 1999). Second, higher education leads to more health-promoting resources such as gym memberships, nutrition counseling, and healthy foods (Ross & Wu, 1995). Last, income and wealth can be volatile in middle age, partially because they are affected by changes in health status (Smith 1999) and retirement.

Explanatory Variables

Four sets of variables are potential confounders in the relationship educational attainment and healthy lifestyle changes and adherence to those changes. The first are demographic characteristics- age and sex. The second is health status, which I measure with three variables which are time-varying. First, I control for the number of chronic conditions that the respondent reports, 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 conditions are coded from questions that ask if a doctor ever told the respondent that they had the conditions listed above. Additionally, obese and disabled respondents may not be able to start exercising as easily as those who are lighter and more mobile. Therefore in the physical activity analysis, I also control for whether the respondent was obese (BMI≥30). This was coded from questions which asked weight at every interview and height at the first interview. Body mass index was calculated according to standard practice, weight (kg) divided by height (m) squared. The measure of mobility limitations comes from questions which asked respondents whether they had any difficulty with any of the following tasks: walking several blocks, walking one block, walking across the room, climbing several flights of stairs, and climbing one flight of stairs. These questions were asked in every interview after the baseline interview. My measure of mobility limitations is whether the respondent had difficulty with *any* of the aforementioned tasks. This was a better predictor of physical activity than the number of tasks with which respondents reported difficulty.

The third factor is social support. I measure both partnership status and partner's health behavior at each interview. I use a four category variable coded as: un-partnered (never married, widowed, separated, or divorced), partnered with partner practicing the healthy behavior,

partnered with the partner practicing the unhealthy behavior, and partnered but no data on partner's health behavior. The last independent variable is household wealth. I examine amount of total household wealth, the sum of all wealth components minus all debts.[5] I incorporate wealth into my models in a log scale.

ANALYTICAL APPROACH

Health Behavior Changes

I use logistic regression models to examine whether there are differences by educational attainment in the odds of making a healthy change at any point in middle age. Equations (1) and (2) below present the odds of making a healthy lifestyle change for individual i at time t. The first model estimates each healthy change as a function of educational attainment and the demographic characteristics of age and sex, among a sample of respondents practicing the unhealthy behavior in the previous interview. The second equation adds health status. For smoking cessation, the only health variable included is the number of existing chronic conditions, and for physical activity mobility limitations and obesity are also included, as they are especially important for activity. To account for the non-independence of observations for each individual, I estimate all of these models using robust standard errors, (Huber-White method). These regression models are weighted to be representative of the 1931-1941 birth cohort at baseline in 1992.

(1) $$\tilde{y}_{it} = \beta_0 + \beta_1 E_i + \beta_2 A_{it} + \beta_3 S_i + e_{it}$$

(2a Smoking) $$\tilde{y}_{it} = \beta_0 + \beta_1 E_i + \beta_2 A_{it} + \beta_3 S_i + \beta_4 C_{it} + e_{it}$$

(2b Physical Activity) $$\tilde{y}_{it} = \beta_0 + \beta_1 E_i + \beta_2 A_{it} + \beta_3 S_i + \beta_4 C_{it} + \beta_4 M_{it} + \beta_4 O_{it} + e_{it}$$

[5] RAND imputations for missing wealth data. (RAND HRS Data Documentation, 2010 Version J). If respondents report a negative amount of wealth, I code this as just above zero and take the log.

Adherence to Healthy Changes

I examine whether there are differences by educational attainment in adherence to healthy behavior changes after they are initiated. First, I chart the survival curves to adherence to each healthy behavior changes with Kaplan-Meier survival curves. Then, I estimate adherence to healthy behavior changes using a discrete-time event history framework, estimating binary logistic regression models on pooled person-interview observations (Allison 1982). This method is ideal because it is not biased by censoring and time-varying variables. It is also more appropriate than continuous survival analysis because the data on health behaviors are only available at each biennial interview, not at the exact time that the change occurs, making it inappropriate to treat the data as continuous.

I estimate the conditional probability of reverting to an unhealthy lifestyle for individual i at time t (P_{it}), given that the individual has started practicing the healthy behavior at interview t-1. Respondents cease contributing person-interviews when they revert back to an unhealthy behavior or are censored, either because of the end of the study, death, attrition, or missing values (Allison 1982). First, I estimate equation (3) to see whether there are differences in adherence to each health behavior by educational attainment (E_i), when controlling for the number of months between interviews (L_{it}), and time since the healthy change was made (T_{it}).

(3) $$\ln (P_{it}/1\text{-}P_{it}) = \alpha_t + \beta_1 E_i + \beta_2 L_{it} + \beta_3 T_{it} + e_{it}$$

(4) $$\ln (P_{it}/1\text{-}P_{it}) = \alpha_t + \beta_1 E_i + \beta_2 A_{it} + \beta_3 S_i + \beta_4 C_{i,t} + \beta_5 M_{it} + \beta_6 O_{it} + \beta_7 P_{it} + \beta_8 W_{it} + \beta_9 L_{it} + \beta_{10} T_{it} + e_{it}$$

If adherence to healthy changes does indeed vary by educational attainment, then I estimate equation (4) with a series of nested models to explore the correlates of adherence. The first multivariate model includes education and demographic characteristics, age (A_{it}) and sex

(S_i). The second model adds four aspects of health status, existing chronic conditions(C_{it}), obesity (O_{it}), and mobility limitations (M_{it}) to test whether poorer adherence to physical activity among those with low education is due to poorer health and higher levels of mobility limitations. The next factor I examine in the third model is partnership and partners' health behaviors (P_{it}). I examine whether the respondents are partnered or not and if partnered, what the health behaviors of the spouse are at that time, which captures social support. Last, I examine household wealth (W_{it}).

RESULTS

Sample Characteristics

Table 1 presents characteristics for the total analytic sample, weighted to be representative of the cohort at baseline in 1992. Respondents were between ages 50 and 61 at first interview (mean age 55.6, sd 3.3) and 64 to 75 at the last interview in 2006. The analytic sample is 55 percent female at first interview and the sex ratio decreases throughout the study. 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, two fifths (39%) has a high school degree, and one fifth (22%) has less than a high school education.

The respondents in the analytic sample are relatively healthy at first interview. Half (55%) have no existing chronic conditions, 31 percent have only one, and 14 percent have two or more. More than eighty percent of respondents report being in excellent, very good, or good health at baseline. During the study period, half of respondents report one or more new chronic conditions. Hypertension is the most common new condition, 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.

During the 16-year study period, respondents also experience a moderate amount of changes in partnership status and labor force participation. At baseline, about three quarters (76%) are married or cohabiting with a partner. Throughout the study period, 84 percent experience no changes in partnership, but 13 percent lose a partner due to widowhood, separation, or divorce, and 6 percent gained a partner. Changes in labor force participation are also common during this period. At first interview, the majority of respondents are working full time (55%), 14 percent are working part time, and 30 percent are not working. Most respondents decreased their labor force participation (60%), however 38 percent experienced no changes in the degree of participation, and 27 percent increase their working hours.

Most respondents (79%) are alive throughout the study period, however 19 percent are reported dead. Most reported deaths are confirmed in the National Death Index (NDI), comprising 11.5% of the cohort, while 5.9 percent have imperfect matches and 3.1 percent are not matched. While the majority of respondents in the sample (61%) are followed for all eight interviews, eight percent are followed for 6 or 7 interviews, 14 percent are followed for 4 or 5, and 18 percent are followed for 2 or 3 interviews.

Health Behaviors

At first interview, one quarter (26%) of respondents report smoking and one fifth report being physically active. However, the prevalence of both of these health behaviors differs significantly by educational attainment. Table 2 reports the prevalence of these two health behaviors at baseline for all respondents and stratified by educational attainment. There is more than a two

fold difference in smoking between the least and most-educated. More than one third of respondents with less than a high school education smoke (36%), compared with one quarter of those with a high school degree or some college smoke, and 15 percent of those with college degrees smoke. In the past, this cohort had very high rates of smoking, but other research has documented high rates of smoking cessation in the past, especially among the highly-educated (Pierce et al. 1989). The college-educated are also more likely than those with less education to be physically active. Almost a quarter of respondents with a college degree are physically active at first interview (23%), which is significantly more than 20 percent of those with less than a high school degree.

The prevalence of these health behaviors also changes with age, as shown in Table 2. Smoking declines monotonically with age for all education groups. This is likely due to both the higher mortality among smokers and smoking cessation. Physical activity increases over ages 50-59 and peaks at ages 60-64 which coincides with retirement ages, and then decreases.

Health Behavior Changes

Healthy behavior changes are common in middle and older age among the members of this cohort. Table 3 presents a summary of health behavior trajectories for the study period for the cohort and by educational attainment. Seventy percent of the cohort are non-smokers at baseline and remain non-smokers. The remaining 30 percent smoke at some point during the study, and half of these smokers (15% of the cohort) quit smoking during the study period. Smoking is least common among the most-educated, and a higher proportions of educated smokers stop smoking than smokers with less education.

Few respondents are physically active throughout the entire study period (5%). However, the majority of respondents start physical activity at some point (64%) and less than a third remain inactive. There are strong differences by educational attainment in physical activity changes. Not only are the most-educated the most likely to be consistently active, but they are also more likely to start physical activity during the study period. Nine percent of the college-educated remain physically active compared to two percent of those with less than a high school education. Almost two thirds of those who completed college (64%) start physical activity, while only 57 percent of those with less than a high school education do.

Education Differences in Healthy Behavior Changes Overall

Next, I address whether the more educated are more likely to make healthy behavior changes at any point in middle age. Table 4 presents these results for smoking cessation and starting physical activity. Education is positively associated with smoking cessation in both models, when controlling for demographic characteristics and health status. Respondents with some college and college degrees have about 40 percent higher odds of smoking cessation than those with the least education. There is also a strong education gradient in starting physical activity, shown in Model 1 which controls for demographic characteristics. Relative to those with the least education, those with more education have 19-29 percent higher odds of starting exercise. The second model additionally controls for three aspects of health status. When including chronic conditions, mobility limitations, and obesity, education differences in starting physical activity disappear. This suggests two possible interpretations. One is that the fact that the least-educated are in the poorest health limits their ability to be active and the other is that another factor underlies both poor health and a dislike of physical activity.

Adherence to Smoking Cessation

Figure 1 presents the survival curve for adherence to smoking cessation for the 1,227 respondents who are observed quitting smoking and followed. It plots the proportion of respondents still not smoking at each subsequent interview. There is a large drop off in the period following cessation, as 30 percent of those who stopped smoking report smoking again at the next interview. Of the 70 percent who remain non-smokers after two years, most remain non-smokers. Over the rest of the study period of eight years, just over half of those who quit smoking remain non-smokers. There are no significant differences in adherence to smoking cessation by educational attainment.

I examine other correlates of adherence to smoking cessation with discrete-time event history analysis, as shown in Table 5. The table presents the bivariate association for each variable with adherence to smoking cessation, with controls for the number of months between interviews and the length of time since smoking cessation. An odds ratio higher than one represents higher odds of reverting to smoking. There are no significant differences in adherence to smoking cessation by educational attainment. In fact, of all the independent variables, only partnership and smoking status of partner was associated with adherence to smoking cessation. Relative to those with non-smoking partners, the un-partnered and those with partners who smoke have significantly higher risk of starting smoking again. This accords with theories about the importance of social support and social influence on smoking behavior.

Adherence to Physical Activity

Figure 2 presents the survival curve for adherence to physical activity after initiation for 5,115 respondents. For all education groups, the direction of the survival curve is downward. The

largest drop occurs between starting physical activity and the next interview two years later. However, after two years, more than 70 percent of those with college degrees are still active compared with 62 percent of those with less than a high school degree. The better adherence to physical activity for the most-educated remains throughout the length of the period of observation. For example, after four years half of those with the least-education have stopped physical activity, compared to six years for those with a college education.

To examine other correlates of adherence to physical activity, I turn to Table 6 which presents results from discrete-time event history analysis. The first column reports the bivariate associations of each variable with adherence to physical activity, with only controls for the number of months between interviews and the number of years since starting activity. As seen in the above survival curves, there are distinct differences by education in activity adherence. Relative to the college-educated, respondents with some college have 16 percent higher odds of reverting to inactivity, those with a high school degree have 27 percent higher odds, and those without a high school degree have 77 percent higher odds.

Each of the other characteristics in Table 6 is also significantly associated with adherence to physical activity. The first column presents the bivariate associations between each characteristic and adherence to exercise. Rates of reverting to inactivity are higher among older respondents and among women. Those in poorer health, as measured by chronic conditions, mobility limitations, and obesity, all have lower adherence to activity. Respondents with active partners have significantly better adherence than those who have inactive partners and those who are un-partnered. The wealthier also have better adherence.

The next four columns present results from nested multivariate models organized to see whether education differences in adherence to physical activity can be explained by demographic

characteristics, the better health status of the better-educated, differences in social support, and household wealth. Results from Model 1 show that when accounting for demographic characteristics, education differences in adherence do not change. Results from Model 2 show that the fact that the highly-educated are in better health explains much of the differences in adherence. Differences between the college-educated and those with some college disappear, and differences between the best and least-educated shrink from an odds ratio of 1.75 to that of 1.46. The last model examines partnership status and the activity level of partners. Those with higher levels of education have lower mortality and are partnered with people who are more likely to be in good health and remain physically active. Taking this into account, no differences in adherence remain for those with a high school degree, some college, or college degree. Lastly, accounting for wealth in Model 4, the differences between the most and least educated further shrink. However, large differences in the maintenance of physical activity remain between only those with the least education and all other groups, which cannot be explained by the examined factors.

DISCUSSION

Although many studies have examined differences in health behaviors by socioeconomic status, few have studied health behavior changes and trajectories over time. In this analysis, I examined the continuity and change of health behaviors for a nationally representative sample of middle-aged Americans over a 16-year period. Healthy lifestyle changes for smoking and physical activity are common among members of this cohort. Half of those who smoke in middle age quit smoking (15% of the cohort) and two thirds of those not physically active at baseline started activity during the study (62% of the cohort). If anything, this analysis underestimates the degree

of change because with biennial data it is impossible to analyze very short term health behavior changes. Rather, I examine broad health behavior trajectories. I tested whether there were differences by educational attainment in the probability of making a healthy change overall during this period, and whether education was associated with adherence to smoking cessation and physical activity, after a healthy change was observed.

Similar to other research (Pierce et al. 1989; USDHHS 1990), I find that education is negatively correlated with smoking in middle age and positively correlated with stopping at some point. However, my analysis builds on prior research by showing that there are no significant differences by educational attainment in adherence to smoking cessation, once initiated. For all education groups, there is a large uptake of smoking in the first two-year period, where about 30 percent of those who stopped smoking start again by the next interview. However, after the first two-year period after cessation, there is very high adherence to smoking cessation. This makes sense in light of the biology of addiction to nicotine. The period of withdrawal, where cessation is most difficult is right after cessation. Quitters who make it past this period, generally have high rates of maintaining non-smoking status. The fact that smoking cessation was so common for all education groups and that adherence over the medium term is relatively good implies that even among adult smokers, smoking behavior can be changed. Policies that aim to reduce SES differences in smoking should also focus on decreasing the higher rates of smoking earlier in the life course, before smokers reach middle age.

Similar to prior research, I find that the more-educated are more likely to be active in middle to older age and more likely to start being active overall (Chung et al. 2009; Cutler & Lleras-Muney 2007; Lantz et al. 2001; Shaw & Spokane 2008). However, the more-educated also had significantly better adherence to physical activity once initiated. I explored three

explanations for the better adherence to physical activity of the highly-educated. The first is that education is positively associated with health status. The fact that the low-SES have more chronic conditions, are more likely to be obese, and have higher rates of disability may impede the less-educated to be physically active. This was indeed an important factor and explained the differences in physical activity between those with college degrees and some college. Moreover, it explained the most of any of the measured factors.

Social support and the health behaviors of partners were also important in explaining differences by educational attainment in adherence to physical activity. The more-educated are more likely to be partnered in middle age and conditional on being partnered, are more likely to be partnered with people who practice healthier behaviors. Social support accounted for the differences in activity between those with college degrees, some college, and high school degrees.

Resources are another explanation for the higher activity levels of the more-educated. Droomers and colleagues (1998) estimate that differences in resources accounts for 40 percent of the higher activity levels of the well-educated. Similarly, this analysis finds that accounting for resources explains much of the difference between those with the most and least education. However, we don't know what it is about resources that translates into better adherence to activity. It could be the fact that people with more resources live in neighborhoods with safer spaces for exercise. They could also use their resources to purchase things that make it easier to stay physically active, like personal trainers, gym memberships, yoga classes, or houses in warm weather locations.

Even after accounting for health status, social support, and wealth, there still remained differences in adherence to activity between the most and least educated. There are other reasons

that are hypothesized that we cannot measure in this analysis, such as knowledge about the importance of physical activity, investment in future health, and self-control. Future research should try to differentiate between various proposed mechanisms, as suggested by Pampel and colleagues (2010). Ameliorating the strong differences in physical activity by educational attainment necessitates understanding the specific barriers to physical activity among those with low levels of education. Evidence from medical studies shows that physical activity counseling can increase the frequency and intensity of physical activity among symptomatic older adults living with chronic disease or disablement (King et al., 1997; Conn et al., 2002; van der Bij et al., 2002). Future research should try to assess the relative effectiveness of various types of interventions.

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TABLES AND FIGURES

Table 1. Sample Characteristics, 1931-1941 Birth Cohort Weighted to be Representative of the Cohort in 1992, Health and Retirement Study (N=8,141)

	% or Mean (sd)		%
Demographic Characteristics [a]		**Partnership Status**	
Age	55.5 (3.2)	Partnership Status at Baseline	
Female	55.3	Partnered (married/cohabiting)	76.4
Educational Attainment [a]		Not Partnered	23.6
Less than high school	21.7	Partnership Changes	
High school degree	39.0	No change	84.0
Some college	20.2	Gained partner	14.3
College degree	19.1	Lost partner	13.1
Health Status		**Labor Force Participation**	
Number existing chronic conditions [a]		Labor Force Participation at Baseline	
None	55.2	Not working	30.0
One	31.2	Works part time	14.3
Two	10.3	Works full time	55.7
Three or more	3.3	Labor Force Participation Change [c]	
Self-rated health [a]		No change	37.8
Good, Very Good, Excellent	81.2	Worked Less	59.2
Fair or Poor	18.8	Worked More	27.6
Obese (BMI $\geq$ 30) [a]	22.7	**Vital Status**	
Any Mobility Limitation [b]	34.2	Alive	79.4
Health Changes [c]		Death Confirmed (NDI)	11.5
Number New Chronic Conditions		Death Imperfect Match	5.9
None	49.7	No NDI Match	3.1
One	32.0	**Number of Completed Consecutive Interviews**	
Two	12.8	8	60.7
Three or more	4.4	7	3.8
Type of New Chronic Conditions		6	4.0
Hypertension	24.0	5	6.4
Heart Disease	15.3	4	7.3
Diabetes	11.8	3	8.2
Cancer	10.4	2	9.6
Lung Disease	7.2		
Stroke	5.1		

Notes

[a] Measured at baseline, 1992.

[b] Measured at 2nd interview (1994) because not asked at baseline.

[c] Reported 1994-2006. Respondents may have experienced more than one change during the study, therefore changes in partnership and labor force participation do not sum to 100 percent.

Table 2. Health Behaviors at First Interview (1992) by Age and Educational Attainment, HRS

	Analytic Sample	Less than High School	High School Degree	Some College	College Degree
	N=8,141	**N=2,044**	**N=3,114**	**N=1,578**	**N=1,405**
% Smokes (All Ages) [a]	26.5	36.5	26.8	25.8	15.1
% Smokes by Age					
Ages 50-54	28.3	40.1	26.6	29.0	19.4
Ages 55-59	24.0	34.1	24.9	22.9	13.1
Ages 60-64	19.4	27.9	19.5	18.4	11.1
Ages 65-69	16.8	23.6	17.8	16.5	8.3
Ages 70-75 [c]	15.5	21.9	16.2	14.5	8.4
% Physically Active (All Ages) [b]	20.3	19.9	18.5	21.4	23.1
% Physically Active by Age					
50-54	24.1	22.2	22.8	26.3	25.6
55-59	35.0	31.0	33.3	39.2	38.0
60-64	40.1	32.2	39.8	43.1	45.9
65-69	38.9	29.4	37.1	41.9	48.5
70-75 [c]	26.9	17.6	23.7	31.4	37.5

Notes
[a] Smoking refers to cigarette smoking.
[b] Physical activity is measured as doing "vigorous physical activity or exercise."
[c] The oldest respondents were 75 years of age at last interview and are grouped with the 70-74 year olds in this table.

Table 3. Health Behavior Trajectories by Educational Attainment, HRS

	Analytic Sample	Less than High School	High School Degree	Some College	College Degree
	N=8,141	**N=2,044**	**N=3,114**	**N=1,578**	**N=1,405**
Smoking Behavior					
Non-Smoker at Baseline and Remains Non-Smoker	70.1	60.9	70.1	71.3	82.6
Smoker and Never Quits	14.7	21.9	15.6	11.8	7.5
Smoker and Quits	14.6	17.2	14.3	16.9	10.0
Total	100	100	100	100	100
Physical Activity Behavior					
Physically Active at Baseline and Remains Active	4.9	2.4	3.6	6.2	8.9
Physically Inactive and Does Not Become Active	31.8	40.9	31.5	27.6	26.9
Physically Inactive and Becomes Active	63.3	56.7	64.9	66.3	64.2
Total	100	100	100	100	100

Table 4. Odds of a Healthy Behavior Change Overall, HRS (1992-2006)

	Smoking Cessation		Starting Physical Activity	
	Model 1	**Model 2**	**Model 1**	**Model 2**
Educational Attainment (Less than High School)				
High School Degree	1.09	1.10	1.19 **	1.07
Some College	1.39 **	1.41 **	1.29 **	1.09
College Degree	1.37 **	1.40 **	1.22 **	0.94
Demographic Characteristics				
Age	1.03 **	1.02 **	0.97 **	0.93 **
Female (Male)	0.96	0.96	0.77 **	0.77 **
Health Status				
Number of Chronic Conditions	-	1.06 †	-	0.83 **
Any Mobility Limitation	-	-	-	0.55 **
Obese	-	-	-	0.79 **

**p<.01 * p<.05 † p<.10

The examined new chronic conditions for smoking cessation are heart disease, diabetes, hypertension, cancer, lung disease, and stroke. Only the first three are examined for starting exercise.

Table 5. Correlates of the Adherence to Smoking Cessation: Odds Ratios for Not Adhering to Smoking Cessation after Initiation, HRS, (N=1,227)

	Bivariate [a]
Educational Attainment (College degree)	
Some College	1.19
High School Degree	0.94
Less than High School	1.19
Demographic Characteristics	
Age	0.98
Female (Male)	1.02
Health Status	
Number of Chronic Conditions	0.93
Any New Chronic Condition	0.90
Partnership and Partner Smoking (Non-smoking partner)	
Partner Smokes	1.71 **
Not Partnered	1.38 *
Missing Partner Smoking Data	1.53 †
Household Wealth (log scale)	0.97

** p<.01 * p<.05 † p<.10

Notes

[a] Each bivariate model is a separate regression and each controls for the number of months between interviews, and dummies for the number of interviews since smoking cessation.

Table 6. Correlates of the Adherence to Physical Activity: Odds Ratios for Stopping Physical Activity after Initiation, Health and Retirement Study, (N=5,115)

	Bivariate [a]	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Educational Attainment (College degree)					
Some College	1.16 *	1.18 *	1.10	1.05	1.03
High School Degree	1.27 **	1.25 **	1.12 +	1.08	1.02
Less than High School	1.77 **	1.75 **	1.46 **	1.36 **	1.18 *
Demographic Characteristics					
Age	1.07 **	1.07 **	1.06 **	1.06 **	1.05 **
Female (Male)	1.44 **	1.41 **	1.33 **	1.35 **	1.32 **
Health Status					
Number of Chronic Conditions	1.32 **	-	1.16 **	1.15 **	1.13 **
Obese	1.52 **	-	1.27 **	1.25 **	1.21 **
Any mobility limitations	2.45 **	-	1.98 **	1.94 **	1.83 **
Partnership and Partner Activity (Physically active partner)					
Partner Physically Inactive	2.20 **	-	-	2.06 **	2.08 **
Not Partnered	2.08 **	-	-	1.72 **	1.60 **
Missing Partner Data	0.96	-	-	0.98	1.01
Household Wealth (log scale)	0.87 **	-	-	-	0.92 **

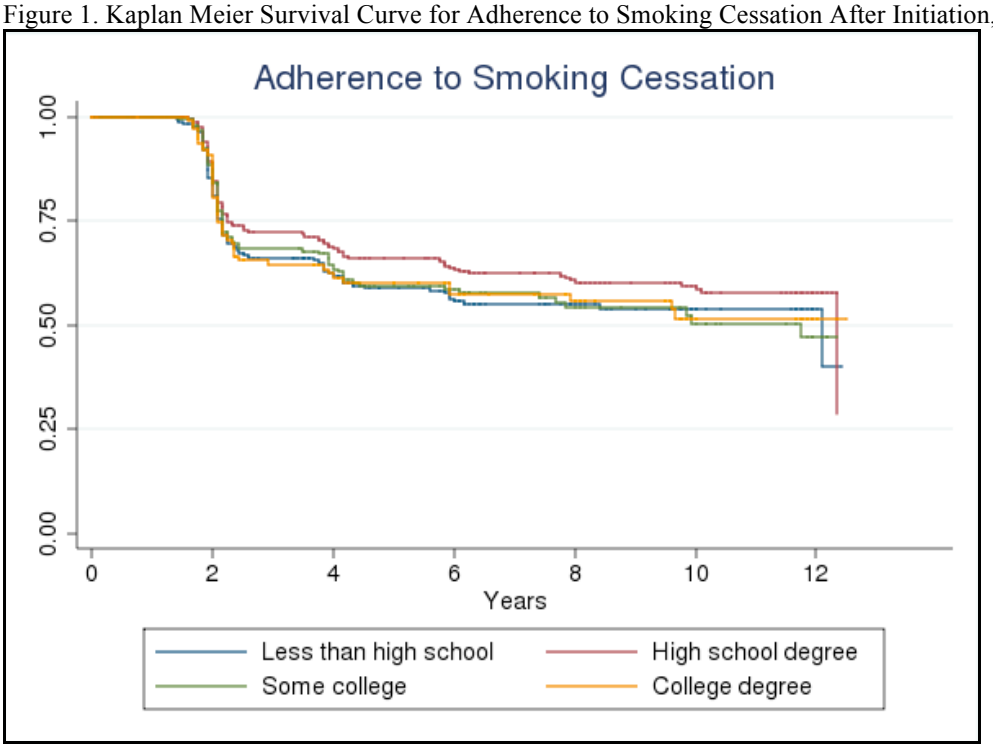
Notes:

** p<.01 * p<.05 † p<.10

All models except bivariate control for age at interview and the number of months between interviews.

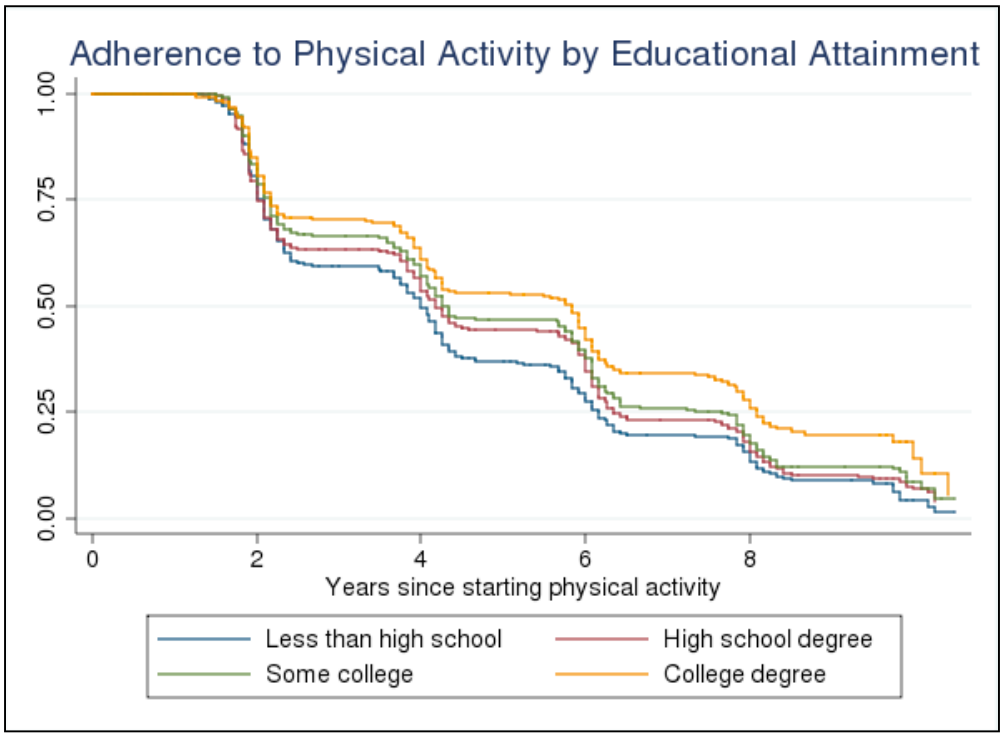
[a] Each bivariate model is a separate regression and each controls for the number of months between interviews, and dummies for years.

Figure 1. Kaplan Meier Survival Curve for Adherence to Smoking Cessation After Initiation, HRS (N=1,227)



* The log-rank test of equality across strata finds that there are no significant differences between the adherence patterns by educational attainment.

Figure 2. Kaplan Meier Survival Curve for Adherence to Physical Activity After Initiation, HRS (N=5,115)



* The log-rank test of equality across strata finds that there are significant differences between the adherence patterns by educational attainment ($p<.001$)