Why Do Depressed People Die Younger?
An Inquiry into the Relationship Between Depressive Symptoms and Mortality

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Abstract:

In this study, I use nationally representative longitudinal data from the American's Changing Lives Survey and discrete time hazard models to estimate the association between depressive symptoms and mortality risk at follow-up, accounting for physical health conditions, health behaviors, personal and coping resources, social support, and life stress. Findings show that physical health conditions and health behaviors fully explain the association between depression and mortality, while stress process variables account for only a small portion of the relationship. Further analyses modeling change over time suggest that physical health and health behaviors mediate the relationship between depression and death, but pre-existing health conditions do not render the depression-death relationship spurious. Implications and limitations of the study are discussed.

Introduction

Poor mental health, specifically depression and depressed mood, have long been hypothesized to increase the risk of premature mortality. Many studies have shown that individuals with major depressive disorder or high levels of depressive symptoms tend to die younger than their counterparts who are not depressed persons (see Schulz et al. 2000; Wulsin et al. 1999 for review). But a question that remains is *why* do depressed persons die younger?

There are two broad potential explanations for the relationship between depression and death. First, it may be entirely due to omitted or third variables that increase the risk of both depression and death. For example, life stress, chronic strains, social support, and personal resources influence both depression (e.g. Turner and Lloyd 1999) and mortality (e.g. Lantz, House, Mero, and Williams 2005). Thus, past stressful experiences and a lack of personal and social resources may put individuals at a high risk of being depressed and dying younger. Furthermore, pre-existing chronic health conditions limit daily activities and lead people to be both more depressed and increase their risk for early death (Macleod et al. 2001; Rasul et al. 2004; Schulz et al. 2000; Wulsin, Vaillant, and Wells 1999).

Another explanation is that the depression-death relationship is causal; depression causes persons to become withdrawn, lose hope on life, leading physical health to deteriorate and increasing the risk of early death (Blazer, Hybels, and Pieper 2001).

In this paper I test a series of competing hypotheses to better understand the nature of the association between depression and death. I ask the following questions: 1. Is depression related to mortality after accounting for omitted factors such as sociodemographic traits, life stress, chronic strains, and pre-existing health conditions? 2. Are *changes* in depression related to mortality? And if it is, what mechanisms explain the association between depression and death? To do this, I use longitudinal data from four waves of data from the Americans Changing Lives

Survey (ACLS), a randomly selected, longitudinal nationally representative survey and event history models to analyze the association between depression and death from 1986 through 2007.

Background

The association between depression and mortality has been a common point of contention among medial, psychiatric and social science researchers in recent years. In two reviews of the literature, Wulsin and colleagues (1999) and Schulz and colleagues (2000) reviewed over 100 studies conducted from 1960 through 2000 and found decidedly mixed evidence for the association between depressive symptoms and mortality.

Mixed support for the association between depression and mortality has been attributed to sample selection, lack of control variables, and failure to specify cause of death[1] (Ferraro and Nurridin 2006). Past research on depression and mortality has typically utilized clinical samples of the elderly, or small community samples of older persons (see Schulz et al. 2000; Wulsin et al. 1999 for review). In such samples, suicide rates and deaths from accidents tend to be significantly higher than in the general population (Roberts, Kaplan, and Camacho 1990), and elderly populations in nursing homes or specific communities likely differ in a variety of unmeasured ways from the general population. Thus, it is perhaps unsurprising that some samples reveal a positive association between depression and mortality while others do not.

Inconsistent findings have also created questions about the functional form of the depression-death relationship. Does depression cause death? Or, is the relationship spurious and entirely due to common causes of depression and mortality? A key part of this question is the role of physical health and functioning for the depression-death relationship. Clinicians and

[1] In this study, I address the former two issues. Although examining how the association between depression and cause-specific mortality is an important venture (see Ferraro and Nurridin 2006), it is beyond the scope of the current study.

medical researchers typically consider physical health conditions and health behaviors as pre-existing conditions that may contaminate the observed relationship between depression and death (Schulz et al. 2000; Wulsin et al. 1999). These researchers argue that conditions such as chronic illnesses, Body Mass Index (BMI), general physical health, and functional limitations need to be controlled in order to ascertain the "true" effect of depression on death (Macleod et al. 2001; Rasul et al. 2004; Schulz et al. 2000; Wulsin, Vaillant, and Wells 1999). For example, chronic illnesses and disability have been found to increase the risk of depression (Schnittker 2005), and these health conditions may drive both depression and mortality. Additionally, research shows that physical health and health behaviors have a greater causal effect on mental health than the reverse (Aneshensel, Frerichs, and Huba 1984; Farmer et al. 1988). The general logic to this argument is that if depression is associated with mortality only insofar as confounding health conditions lead people to be both more likely to die and more depressed, then depression likely plays little independent role in causing premature death.

However, other scholars view physical health conditions and activity not as spurious factors, but as mechanisms by which depression increases the risk for mortality (Blazer, Hybels, and Pieper 2001). Moreover, Blazer and colleagues (2001) argue that the process by which depression affects mortality may occur in feedback loops, where depression leads to poor functioning and health, poor functioning and health worsen depression, and health deteriorates. Although this paper does not model feedback loops, the overall logic to this argument is in stark contrast to that of clinicians: physical health characteristics are not third variables that need to be controlled away, but important mechanisms and pathways forming the relationship between depression and mortality.

Research about the role of physical health for the depression-death relationship in nationally representative surveys has been mixed. For instance, Ferraro and Nuriddin (2006) use data from the National Health and Nutrition Examination Survey I (NHANES) and find that the effect of psychological distress on mortality is attenuated after including comorbid physical health conditions, but remains positive and significant. In another study, Everson-Rose and colleagues (2004) use wave 1 of ACLS data and find a positive association between depressive symptoms and mortality at follow-up. But contrary to the Ferraro and Nuriddin study, they find that the relationship is completely explained by functional health and chronic conditions. In sum, it's clear that physical health influences the depression-death relationship, but it is not clear whether it acts as a spurious third variable whose effects need to be accounted for, or a pathway or mechanism by which depression impacts mortality.

Part of the difficulty of elucidating the depression-death relationship is due to the fact that most studies measure depression, health, and other controls at a single point in time, with a mortality follow-up appended several years later. In the case of physical health, this makes it difficult to discern whether it is a confounder or a mechanism by which depression increases the risk of mortality. The two potential roles of physical health and health behaviors are shown in **Figure 1.**

Physical health conditions and health behaviors have received the most attention as potential confounders of the depression-death realationship, in addition to standard sociodemographic characteristics of age, race/ethnicity, sex, and socioeconomic status. But other factors have received surprisingly little attention in the literature. Perhaps most surprising is the relative absence of the stress process (Pearlin 1989; Pearlin et al. 1981) . Generally, the stress paradigm shows that social inequalities in mental and physical health are created by inequalities

in exposure to stress and chronic strains, access to personal resource that help individuals cope with stress, and social support (Pearlin 1989; Pearlin et al. 1981). Over the past several decades, research on the stress process has repeatedly shown that those who are exposed to chronic and acute stressors, have little social support, and have little access to coping resources suffer from a variety of negative mental and physical health outcomes. For example, stress exposure--as well as a lack of social support and personal resources—increases the risk of depression (Turner and Lloyd 1999), and research has repeatedly shown that stress and stressful life events have a strong association with health and mortality (Lantz, House, Mero, and Williams 2005). In sum, the elements of the stress process—stress exposure, personal resources, and social support—play an important role in determining both depression and mortality, and in turn have the potential to render the depression-death relationship spurious. Like physical health conditions, these underlying social causes of physical and mental health may lead people to be both more likely to die and be depressed. The potential role of stress exposure, personal resources, and social support for the relationship between depression and death are shown in **Figure 1.**

[Figure 1 About Here]

The Current Study

In this study, I use longitudinal data from the American's Changing Lives Survey and discrete time event history models to elucidate the pathways by which depression influences mortality. In particular, I ask whether or not the relationship is explained by potential spurious and confounding factors—such as pre-existing physical health conditions and stress—or, if there is evidence that health conditions mediate (rather than confound) the relationship. Based on the above research, I develop the following hypotheses:

H1: Higher levels of depressive symptoms at baseline should be associated with earlier death, before accounting for potential confounding factors.

H2: Omitted/Third Variable Hypothesis: Assuming the effect of depression on mortality is not independent of confounding conditions including these conditions should fully explain the relationship between depressive symptoms and mortality.

H2a: The inclusion of physical health conditions and health behaviors should explain the association between depressive symptoms and mortality.

H2b: The inclusion processes of social support, personal and coping resources, and stressors should also explain the association between depressive symptoms and mortality.

H3: Mediating Hypothesis: The effect of depression on mortality should remain positive and significant after accounting for prior health conditions and other confounders at (t-1), but will be reduced to nonsignificance when physical health at (t) or (t+1) is controlled.

Data and Methods

Data

To conduct this study I use data from the American's Changing Lives Survey (ACLS), collected by James House and Colleagues. The ACLS is a nationally representative sample of Americans in 1986. The ACLS uses a multistage stratified area probability sample and oversamples African Americans and persons age 60 and over. Wave 1 consists of 3,617 respondents. Respondents were followed up in 1989 (wave 2), 1994 (wave 3) and 2002 (wave 4). Missing data was handled using listwise deletion. After missing data was accounted for all

variables in the analysis, the final N=3,608. All results are weighted and corrected for sample design.

Measures

Mortality

Mortality status was ascertained by ACLS staff members via the social security death index or proxy report, and was verified with obituaries. Mortality data has been collected since directly after the first wave of data collection (1986) until 2007. 1,411 of the original 3,617 respondents died by 2007 (39%). After accounting for sample design (and especially the elderly oversample) average mortality is 26%. See Table 1 for descriptive statistics for all variables included in the study.

Depressive Symptoms

Depressive symptoms was measured using the Center for Epidemiological Studies Depression Scale (Radloff 1977). The CES-D scale in the ACLS is composed of 11 items that ask respondents to what extent they felt depressed, that everything was an effort, sleep was resless, was happy (reverse coded-RC), felt lonely, people were unfriendly, enjoyed life (RC), didn't feel like eating, felt sat, people disliked me, and couldn't get going in the past week. Responses ranged from 1(hardly ever) to 3(most of the time). Responses were summed and the final scale was normalized with a mean of 0 and standard deviation of 1.

It is important to note that the CES-D scale is not an adequate tool for diagnosing clinical depression. However, persons who score in the top decile of the score have a very high likelihood of having diagnosable major depressive disorder or minor depression (Myers and Weissman 1980). Additionally, most past studies of depression and death have utilized the CES-

D scale (Schulz et al. 2000; Wulsin, Vaillant, and Wells 1999). Thus, using a similar instrument to detect depressive symptoms provides greater comparability across samples.

Health Conditions and Behaviors

Health conditions are measured with variables indicating the number of chronic conditions experienced in the past year, functional health index, health limitations, serious illness or injuries reported in the past three years, disability status, and Body Mass Index (BMI). Chronic conditions include reports of arthritis, lung disease, hypertension, heart attack, diabetes, cancer, or stroke in the past year. On average, respondents in the sample report having experienced 0-1 chronic conditions in the past year (average = .781).

The functional health index is a measure created by ACLS staff and indicates the extent to which the respondent's physical health conditions limit their daily functioning. The index is constructed from a series of questions that ask respondents the extent to which they are forced to sit in a chair or bed all day, have difficulty or need assistance bathing, have difficulty climbing stairs, have difficulty walking blocks, and have difficulty with heavy work around the house. The Functional Health Index is a Gutman scale coded from highest or most severe functional impairment (coded as 1) to the lowest (coded as 4). Respondents who are most severely functionally impaired are those that are required to spend most of the day in a bed or chair (1). Respondents who are least functionally impaired (4) reported no functional impairments. On average, respondents in the sample have a score of 3.73 on the functional health index, suggesting relatively good functional health in the sample. In addition, I also include a measure of self-reported health limitations, whereby respondents were asked to what extent they felt their physical health limited their daily activities. Responses range from a great deal (1) to not at all

(5). On average, respondents in the sample report very few limitations due to their health (average = 4.406).

In addition to the above health measures, I also include dummy variables indicating respondent self-repoted disability status, whether or not they experienced a life threatening or serious injury/illness in the past three years, and dummy variables indicating BMI category (underweight, normal weight [reference], overweight).

Health behaviors are operationalized with smoking status, the number of alcoholic beverages consumed in an average month, and a physical activity index. Smoking status is a dummy variable indicating whether or not a respondent currently smokes (1=smoker). 30% of respondents in the sample smoke at wave 1. Number of drinks in a month is constructed from questions asking respondents how many drinks they have on average during the day or week. Responses range from 0-600 with the average respondent having 16 drinks in a month. Physical activity is an index constructed by ACLS staff from mean responses to three physical activity items: how often the respondent reports working in the garden or yard (1=always; 4=never), take walks, or engage in sports or athletics. The physical activity index is standardized with a mean of 0 and a standard deviation of 1 and recoded so higher scores indicate higher levels of physical activity.

Socioeconomic Background Characteristics

Background characteristics include sex (female=1; male=0), race/ethnicity, respondent's level of education, employment status, and household income. Race/ethnicity is included as a series of dummy variables indicating whether respondents self-identify as Non-Hispanic white (reference group), Non-Hispanic black, Native American/Alaskan Indian, Asian, or Hispanic. Income bracket is a ten category variable where family income is coded into deciles. The average

income bracket in the sample is 5.3, which corresponds to a family income of $22,000-$26,000/year (in 1986 dollars). Missing data on income was imputed by ACLS staff. Education is a six category variables bracketed by years where 1=0-8 years of education; 2=9-11 years; 3=12 years (HS degree); 4=13-15 years; 5=16 years (college degree); 6=17 years or more. On average, respondents in the sample have at least a high school degree (average=3.39).

Social Support/Integration

Social support is operationalized using marital status and two scales indicating informal and formal social integration. Marital status is a series of dummy variables indicating that the respondent is married (reference), divorced or separated, widowed, or never married. Most respondents in the sample are currently married (69%). Informal social support is a scale constructed by ACLS staff from the mean response from questions in which respondents were asked how often they talked on the telephone and spent time with friends and family. Responses ranged from more than once a week (1) to never (6). The informal social integration scale was standardized with a mean of 0 and SD of 1, and recoded so higher scores indicate higher levels of informal social integration. ACLS staff also constructed the formal social integration scale, in which respondents were asked how often they attended meetings or programs of any clubs organizations or groups to which they belonged and attend religious services. The formal social integration scale was standardized with a mean of 0 and SD of 1, and recoded so higher scores indicate higher levels of informal social integration.

Personal/Coping Resources

I include measures of personal and coping resources that are commonly used in stress process research (e.g. Pearlin 1989). Measures include self-esteem, mastery, and two of the Big

Five Personality traits—neuroticism and extraversion (John 1990; 1991). The ACLS includes a three item version of the Rosenberg Self-Esteem scale (Rosenberg 1965; 1979), a stable measure of individual feelings of self worth. Mastery is a two-item version of the Pearlin Mastery Scale (Pearlin et al. 1981) which indicates the extent to which individuals feel they have control over their lives. Neuroticism and extraversion are stable personality traits that indicate the extent to which individuals are nervous, constantly worry and feel emotionally unstable (neuroticism), and are outgoing, gregarious, and talkative (extraversion). All of the above scales or indexes were standardized with a mean of 0 and SD of 1.

Life Stress

Life stress is operationalized using two measures of stress — chronic financial stress and the number of stressful life events reported by the respondent in the past three years. Chronic financial stress is a scale constructed from the average response to questions where respondents were asked how satisfied they are with their family's financial situation, how difficult it is to make ends meet, and if enough money is leftover after paying bills each month. The scale is standardized with a mean of 0 and SD of 1. The number of stressful life events in the past three years is a sum of of the following nine stressful events: divorce, death of a spouse, death of a child, victim of a physical attack or assault, death of a parent, death of a friend, involuntary job loss, being robbed or burglarized, and any other event that the respondent reported caused them to be upset. On average, respondents in the sample have experienced between 0-1 stressful life events in the past year (average = .876).

Time Varying Covariates

Most of the independent variables listed above were collected at all four waves (1986, 1989, 1994, 2001). Thus, in later analyses I allow all variables to vary over time, in order to get a

better estimate of how *changes* in depressive symptoms are associated with mortality[2]. Time varying covariates were constructed using wave 1 data at baseline. Wave 1 values were replaced with wave 2, 3, or 4 data at the appropriate time interval. There are two important limitations for the way in which I constructed my time variables: first, if respondents dropped out of the sample after wave 1, they retained their wave 1 value on the variables for all person years in the analyses. The same can be said for later waves. Thus, if respondents dropped out of the sample they retained the value of the measure acquired from the previous wave. Second, the time varying covariates logically assume that values for the independent variables remained constant in between waves of data collection. The limitations of the assumptions made in constructing these time varying covariates will further be discussed in the conclusion.

Analysis Strategy

I use discrete time event history models to analyze the association between depressive symptoms and mortality from 1986-2007. Mortality status was ascertained through 2007, when respondents either died or were censored. Although nearly all of past research on depression and death uses Cox Hazard Regression Models, over 50% of my event (or death times) are ties. This is unsurprising given that age is measured in years rather than months, and there are over 1400 deaths over a 20 year time period in my analytic sample. Since continuous time models are not suited to deal with such a large number of ties, I instead use discrete time event history models (Singer and Willett 2003). Data was converted into a person-period data set using the "psrnprd" command in STATA 10.0. After accounting for left-truncation, the final sample size is 64,236 person years.

[2] All variables were allowed to vary over time with the exception of race/ethnicity, gender, education, neuroticism, extraversion, and life stress variables (the latter four variables were not measured at all waves of the ACLS).

My analysis strategy is as follows. First, I estimate the bivariate association between depressive symptoms in 1986 and mortality through 2007, and graphically depict the hazard and survivor curves for respondents who have high versus low levels of depressive symptoms. Then, I estimate a series of discrete time event history models adding potential confounding variables in blocks (Table 2). Model 1 adds sociodemographic controls to the model and is the baseline model for analysis. Model 2 adds comorbid health conditions to the baseline model; Model 3 adds health behaviors to the baseline model; and Model 4 adds stress process variables to the baseline model. The final model (Model 5) includes all covariates. I then repeat model estimation (Table 3), using time varying covariates and taking advantage of all four waves of the ACLS. Finally, I include lagged measures of physical health and health behaviors, to better discern whether they should be considered spurious factors or mediators of the relationship between depression and death (Table 4).

[Table 1 About Here]

Results

[Figure 2 about here]

The first goal of this study was to assess whether or not there was evidence for an association between depressive symptoms in mortality in a nationally representative sample. I begin with results from the bivariate model, where age and depressive symptoms are the only predictors in the model. Figure 2 displays both the predicted hazards and odds ratios from the baseline model. Depressive symptoms are significantly associated with mortality in the bivariate model, providing support for hypothesis one. Results from the baseline model show that a one standard deviation increase in depressive symptoms is associated with a 15% increase in the odds of mortality (OR = 1.15). Figure 1 also shows the hazard curve for respondents who suffer from

high levels of depressive symptoms (90th percentile) compared to respondents with the lowest symptoms (10th percentile). Depressed respondents have a significantly higher hazard of dying at all ages than respondents who have fewer or no depressive symptoms (note: supplementary analyses revealed that the association between depressive symptoms and mortality did not vary by age).

[Table 2 about here]

The second goal of this study was to assess whether or not the association for depressive symptoms persisted after accounting for social position, comorbid health conditions, health behaviors, and common social causes of health and mortality (stress process variables). Table 2 shows the estimated association between depressive symptoms and mortality after accounting for confounders.

Model 1 shows that the association between depressive symptoms and mortality remains significant after accounting for sex, race/ethnicity, income, education, and employment status. The inclusion of these variables slightly attenuates the relationship, but it remains statistically significant. A one standard deviation increase in depressive symptoms is associated with an 11% increase in the odds of dying (OR=1.107).

Model 2 shows that comorbid health conditions completely explain the relationship between depressive symptoms and mortality. After accounting for chronic conditions, prior illness or injury, functional health, health limitations, prior depression, disability, and BMI, the coefficient for depressive symptoms is rendered statistically non-significant. Supplementary analyses (not shown) revealed that including *either* chronic conditions or functional health in the model completely explained the relationship between depressive symptoms and mortality. These results are congruent with past findings that suggest the relationship between depressive

symptoms and mortality is fully explained after accounting for comorbid physical health conditions (Everson-Rose, House, and Mero 2004).

Model 3 replaces comorbid health conditions with health behaviors, and shows that including smoking, drinking, and physical activity into the model fully explains the association between depressive symptoms and mortality. Supplementary analyses showed that physical activity alone renders the relationship statistically non-significant. These findings suggest that the association between depressive symptoms and mortality do not operate independently of health or health behaviors.

Model 4 includes stress process variables—social support, personal/coping resources, and life stressors—in the model. The inclusion of these variables attenuates but does not fully explain the association between depressive symptoms and mortality. After accounting for stress process variables, a one standard unit increase in depressive symptoms is associated with a 9% increase in the odds of dying (OR = 1.086; p=.053). However, in a sample of over 64,000 person years, a significant association at the .05 level is decidedly weak evidence against the null hypothesis (Raftery 1995:141). Thus, the inclusion of the stress process variables attenuates the relationship between depressive symptoms and mortality and renders it virtually (and substantively) nonsignificant.

Finally, Model 5 includes all confounders. As expected due to findings from the prior models, the relationship between depressive symptoms and mortality is not significant. The inclusion of all of the variables in the model explains 20% of the variance in mortality. Other than age, the best predictors of mortality when all other variables are held constant are chronic conditions (OR=1.159, p<.001), smoking (OR=1.68; p<.001), physical activity (OR:.866; p<.001) and income (OR=.934; p<.01), and sex—women have 54% lower odds of dying than

men. Overall, findings from the models with wave 1 measures show that physical health and health behaviors fully explain the relationship between depressive symptoms and mortality.

The next goal of the study is to assess if *changes* in depressive symptoms are associated with mortality at follow-up. While the prior models utilized only wave 1 data (with the exception of mortality), the models below utilize data from all four waves of the ACLS (1986, 1989, 1994, and 2001). All variables in the model are allowed to vary over time, with the exception of race/ethnicity, sex, education, life stressors, neuroticism and extraversion (ACLS does not have congruent measures of life stressors across all waves, and neuroticism and extraversion are only measured at wave 1). Below, I replicate the above analyses using time varying covariates.

[Figure 3 About Here]

Figure 3 shows that a one standard unit change in depressive symptoms yields a 33% increase in the odds of dying in the model where only depressive symptoms and age is included. The hazard curve graphically demonstrates that becoming more depressed significantly increases the hazard of death. Furthermore, the hazards of death associated with changes in depressive symptoms are substantively larger than those shown in Figure 2. This suggests that the hazard of death associated with *becoming* more depressed may be larger than the hazard of death associated with interindividual differences in depressive symptoms at baseline.

Table 3 shows the relationship between depressive symptoms and mortality in models accounting for confounders. Model 1 shows that the relationship between depressive symptoms and mortality remains significant after accounting for race, sex, income, education, and employment status. Including social position variables attenuates the relationship slightly, and a one standard unit increase in depressive symptoms is associated with a 26% increase in the odds of dying.

After accounting for comorbid health conditions, Model 2 shows that the relationship between depressive symptoms and mortality is nonsignificant. The risk of dying associated with becoming more depressed is completely explained by diminishing physical health. Increases in chronic conditions, diminishing functional health and health limitations, and becoming disabled are all significantly associated with mortality risk and render the relationship between depressive symptoms and mortality nonsignificant.

Accounting for health behaviors attenuates but does not fully explain the relationship between time-varying depressive symptoms and mortality. When health behaviors are held constant, a one standard unit increase in depressive symptoms raises the risk of dying by 18% (OR=1.178). Becoming or remaining a smoker, becoming physically active, or drinking more do not explain the depressive symptoms coefficient. Although health behaviors fully explained the association between depressive symptoms and mortality at baseline, becoming more depressed increases the risk of mortality net of changes in health behaviors.

The stress process variables (Model 4) slightly attenuate but do not explain the relationship between depressive symptoms and mortality. After accounting for all confounders (Model 5), physical health, health behaviors, and sex have the largest effect on mortality. The predictor variables in the final model explain 21% of the variance in mortality in the sample.

The final goal of this study was to elucidate the role of physical health and health behaviors in the relationship between depression and death. Therefore, Table 5 includes lagged (t-1) predictors to assess whether or not pre-existing health conditions fully explain the relationship between depression and death. To create lagged measures, all deaths before 1989 (wave 2) were dropped for this portion of the analysis, resulting in 45,828 person years. Model 1 shows the relationship between depression and death after accounting for lagged physical health

conditions and health behaviors (and all other controls from the previous model, not shown). Model 2 adds physical health and health behaviors at time (t). Model 1 shows that net of prior (lagged) health characteristics and health behaviors, depression is a significant predictor of mortality. A one standard unit increase in depressive symptoms is associated with a 17% increase in the odds of dying. Model 2 adds current health status, and the effect of depression is reduced to nonsignificance. Overall, findings from Table 5 show support for hypothesis 3 and suggests that the effect of depression on mortality operates through deteriorating physical health conditions, but is not explained by spurious pre-existing health conditions.

Discussion/Conclusion

The goal of this study was to build on past research and provide a more complete picture of the association between depressive symptoms and mortality. This study improved on past research by: (1) Examining the association between depressive symptoms and mortality in a nationally representative sample; (2) Accounting for potential confounders, especially comorbid health conditions, health behaviors, and stress process variables; (3) Assessing how *change* in depressive symptoms is related to mortality; and (4) using longitudinal data to better understand the mechanisms by which depression is related to mortality.

The findings of this study confirms previous work by Everson-Rose and colleagues (2004),and shows that the relationship between depressive symptoms and mortality does *not* operate independently of comorbid physical health conditions. In addition, the findings of this study suggest that pre-existing physical health conditions and health behaviors do not explain the relationship between depression and mortality, suggesting that health and health behaviors are mediators of the relationship, not spurious factors. Furthermore, this study examined the role of stress process variables in shaping the depression-death relationship, and finds that failing to

account for prior stress exposure, personal resources, and social support may artificially inflate the association between depression and mortality.

Despite improvements on past research, this study is not without its limitations. For instance, the assumptions made in the construction of the time varying covariates were less than ideal. I made two assumptions in the construction of the time varying covariates. First, I assumed that covariates were stable across waves of data collection. For example, due to data limitations I had to assume that the measure of depressive symptoms in 1986 remained constant until 1989, until the next measure of depressive symptoms was ascertained. Second, if the respondent had wave 1 data, but was missing on wave 2 data, I assumed that the wave 1 value was constant across waves. For example, if a respondent had a valid value on depressive symptoms in wave 1 but not in wave 2, 3, or 4, the wave 1 value was assigned for all time points. This assumption, however, may be less problematic because these respondents will not contribute (time varying) variation to a given variable and therefore are not likely biasing the estimates from the time varying covariates. However, in future iterations of this paper I plan to improve on these decisions by using linear interpolation (to relax the first assumption) and multiple imputation (to relax the second assumption).

Another limitation of this study stems from the age of respondents in the ACLS sample. Although I improve on past research by using a nationally representative sample, my findings are limited to respondents who survived to be surveyed (respondents ranged from age 25-96 at baseline). Thus, I may actually be underestimating the association between depression and mortality, because those who were most depressed (and theoretically most likely to die) were likely left-censored. Pending data availability, future research should utilize a cohort design that follows respondents from early life (such as the Wisconsin Longitudinal Study).

Finally, perhaps the most glaring limitation of this study is the inability to determine precise time ordering of depressive symptoms and comorbid physical health conditions. Though my findings suggest that physical health and health behaviors are mediators and not spurious factors, my lagged measures are not perfect, especially given the long gap between survey waves (3-6 years). However, no study we are aware of has used longitudinal data with depression measured at multiple waves to examine the depression-death link, although more detailed data would be ideal were it available.

Despite its limitations, this builds on past research and provides new evidence about the relationship between depression and death. Future research should continue to disentangle the complex relationship between depression and death using longitudinal data to provide insight into the intricate connection between these aspects of physical and mental health.

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Table 1: Weighted Descriptive Statistics (wave 1)

	Mean	SD	Range
Depressive Symptoms	-.001	1.000	-1.18 - 4.5
Mortality Status (1=died)	.261		
Sociodemographic Controls			
Sex (Female =1)	.529		
Race/Ethnicity (ref = NH white)			
NH Black	.107		
NH Native American	.014		
NH Asian	.019		
Hispanic	.067		
Income Bracket	5.326	2.584	1 - 10
Education Bracket	3.339	1.413	1 - 6
Unemployed (1=yes)	.046		
Comorbid Health Conditions			
# of Chronic Conditions	.781	1.051	0 - 6
Serious Illness/Injury in Past 3 years	.195		
Health Limitations	4.406	1.097	1 - 5
Functional Health Index	3.731	.703	1 - 4
Disabled (1=yes)	.029		
BMI Category (Normal Weight=Ref)			
Underweight	.051		
Overweight	.153		
Depressed in Past year? (1=yes)	.148		
Personal/Coping Resources			
Self Esteem	.000	1.001	-4.33 - 1.2
Pearlin Mastery Scale	.002	1.001	-3.14 - 1.3
Neuroticism	-.001	1.000	-1.24 - 2.2
Extraversion	.000	.999	-1.72 - 1.3
Social Support			
Martial Status (Married = ref)			
Widow	.087		
Divorced/Separated	.117		
Never Married	.102		
Formal Social Integration	.002	.999	-1.55 - 2
Informal Social Integration	.001	.999	-3.07 - 1.4
Life Stress			
Financial Stress	-.001	.998	-1.5 - 2.8
# of Life Events in Past 3 years	.876	.881	0 - 6
Health Behaviors			
Smoker (1=yes)	.304		
# of alcholic drinks/months	16.324	36.873	0 - 600
Physical Activity Index	.002	1.000	-2.47 - 1.5

N= 3,608 Source: American's Changing Lives Survey

Figure 1: Hypothesized Relationships Between Depression and Mortality

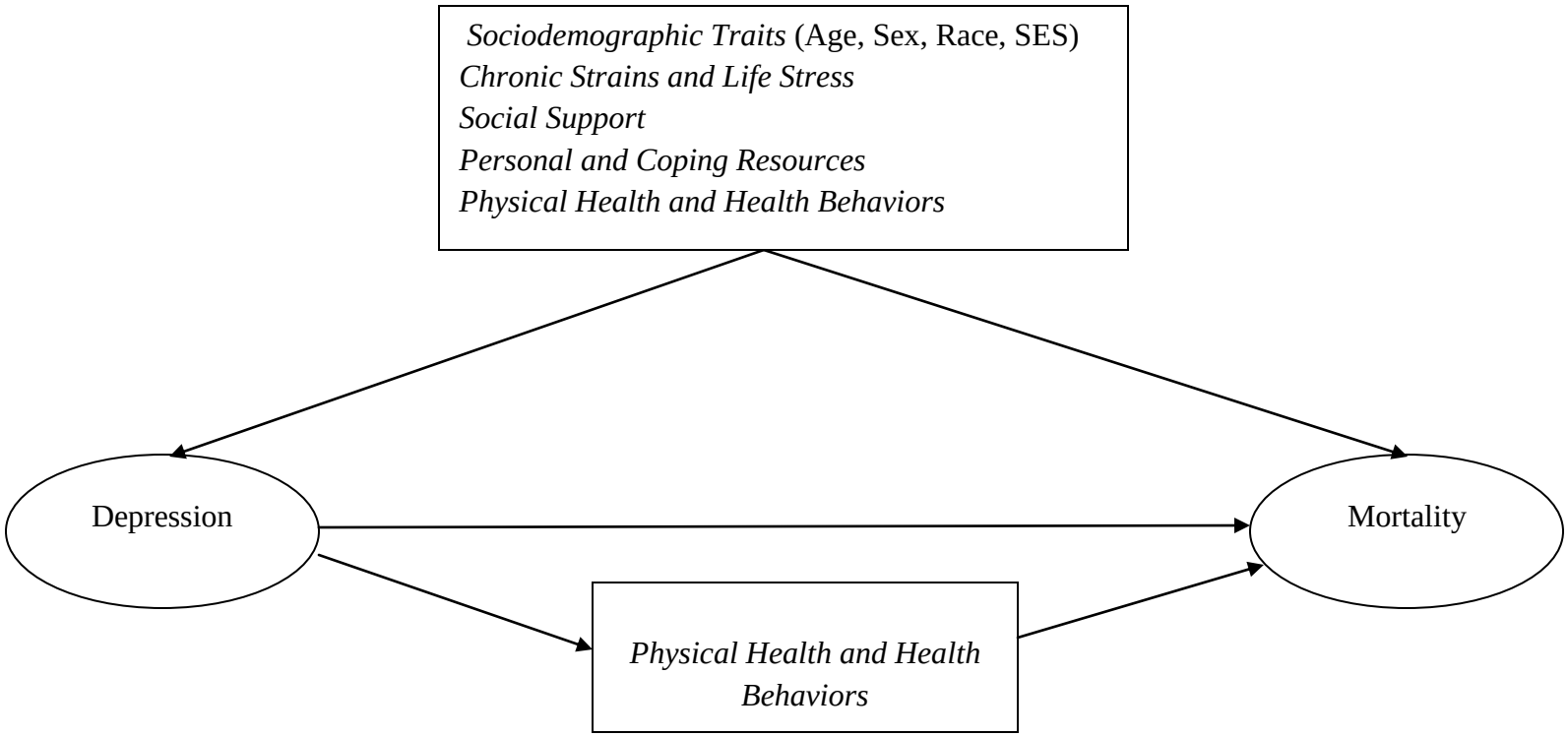
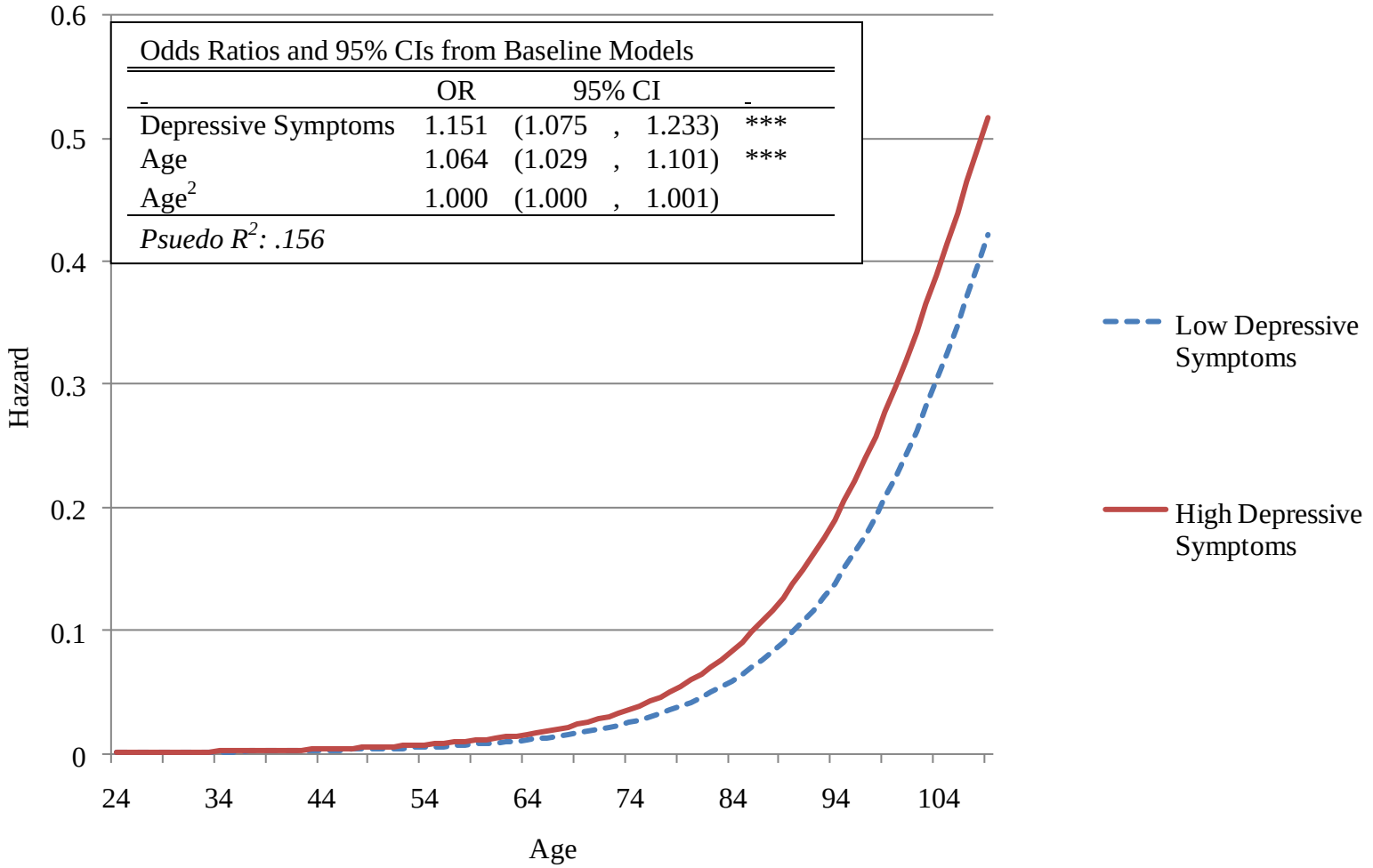


Figure 2: Predicted Hazard of Death for Respondents with Low (10th percentile) and High (90th percentile) Depressive Symptoms with Odds Ratios and 95% Confidence Intervals from baseline models estimating the association between depressive symptoms and mortality



Notes: ***p<=.001; **p<=.01; *p<=.05; N=64,236

Table 2: Odds Ratios from Discrete Time Models Predicting Mortality in the ACLS (wave 1 predictors)

	Model 1		*Model 2*		*Model 3*		*Model 4*		*Model 5*	
Depressive Symptoms	1.107	**	.983		1.056		1.086	*	.984	
Sociodemographic Controls										
Sex (Female =1)	.467	***	.470	***	.442	***	.466	***	.461	***
Race/Ethnicity (ref = NH white)										
NH Black	1.234	*	1.253	*	1.163		1.300	**	1.226	*
NH Native American	1.671		1.467		1.681		1.625		1.398	
NH Asian	.475		.497		.460		.482		.519	
Hispanic	.888		.968		.840		.930		.973	
Income Bracket	.896	***	.926	***	.904	***	.902	***	.934	**
Education Bracket	.959		.972		.984		.965		.986	
Unemployed (1=yes)	1.406		1.688	*	1.470		1.380		1.723	*
Comorbid Health Conditions										
# of Chronic Conditions			1.147	***					1.159	***
Serious Illness/Injury in Past 3 years			1.207	*					1.262	*
Health Limitations			.969						.947	
Functional Health Index			.876	*					.940	
Disabled (1=yes)			2.270	***						
BMI Category (Normal Weight=Ref)										
Underweight			1.547	**					1.400	*
Overweight			.965						1.001	
Depressed in Past year? (1=yes)			.937						.970	
Health Behaviors										
Smoker (1=yes)					1.647	***			1.682	***
# of alcoholic drinks/months					1.001				1.001	
Physical Activity Index					.800	***			.866	***

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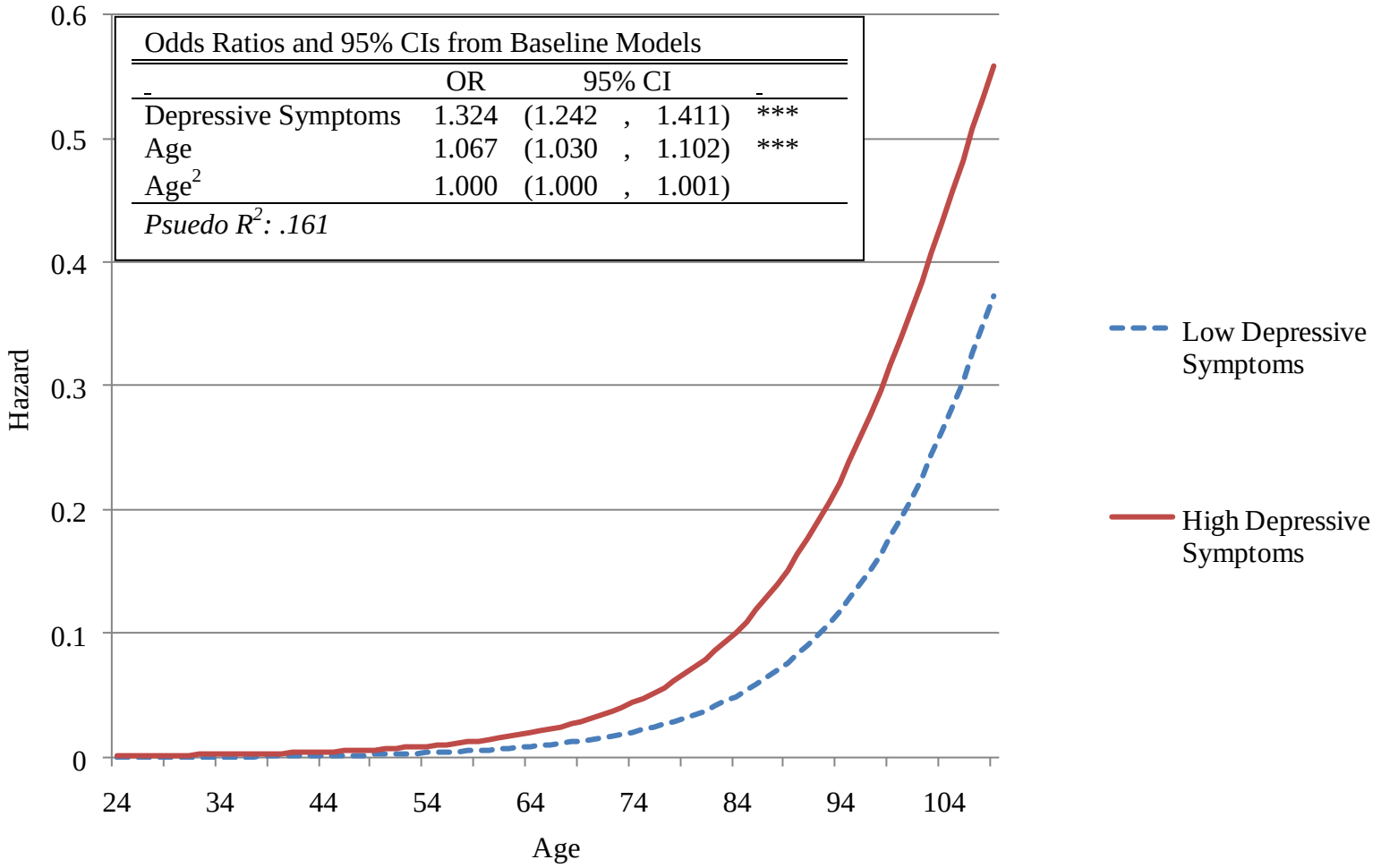
Table 2 (*continued from last page)*

Personal/Coping Resources						
Self Esteem				.958		.976
Pearlin Mastery Scale				1.041		1.031
Neuroticism				.984		.935
Extraversion				.991		.951
Social Support						
Martial Status (Married = ref)						
Widow				1.112		1.069
Divorced/Separated				1.017		1.014
Never Married				1.062		1.050
Formal Social Integration				.876	***	.951
Informal Social Integration				1.003		1.018
Life Stress						
Financial Stress				.998		.963
# of Life Events in Past 3 years				1.059		1.008
Pseudo Log Likelihood	-3806	-3747	-3764	-3797		-3710
Pseudo R^2	.174	.187	.183	.176		.195

Notes: ***p<=.001; **p<=.01; *p<=.05; N=64,236
Age and Age-squared included in all models (coefficients not shown)

Figure 3: Predicted Hazard of Death for Respondents with Low (10th percentile) and High (90th percentile) Time Varying Depressive Symptoms with Odds Ratios and 95% Confidence Intervals from baseline models estimating the association between depressive symptoms (time varying) and mortality



Notes: ***p<=.001; **p<=.01; *p<=.05; N=64,236

Table 3 Odds Ratios from Discrete Time Models Predicting Mortality in the ACLS (Time Varying Covariates)

	Model 1		*Model 2*		*Model 3*		*Model 4*		*Model 5*	
Depressive Symptoms	1.260	***	1.044		1.178	***	1.209	***	1.019	
Sociodemographic Controls										
Sex (Female =1)	.464	***	.466	***	.424	***	.466	***	.455	***
Race/Ethnicity (ref = NH white)										
NH Black	1.186	*	1.258	**	1.142		1.248	*	1.288	**
NH Native American	1.528		1.315		1.403		1.548		1.326	
NH Asian	.497		.488		.416		.484		.446	
Hispanic	.887		1.060		.871		.932		1.103	
Income Bracket	.903	***	.937	**	.918	***	.908	***	.938	**
Education Bracket (w1 only)	.982		.981		1.000		.992		.993	
Unemployed (1=yes)	1.527		1.883	*	1.571		1.423		1.788	*
Comorbid Health Conditions										
# of Chronic Conditions			1.089	**					1.108	**
Serious Illness/Injury in Past 3 years			1.321	***					1.381	***
Health Limitations			.908	**					.918	*
Functional Health Index			.794	***					.833	***
Disabled (1=yes)			1.760	**					1.730	**
BMI Category (Normal Weight=Ref)										
Underweight			2.027	***					1.901	***
Overweight			.834						.855	
Depressed in Past year? (1=yes)			.900						.961	
Health Behaviors										
Smoker (1=yes)					1.615	***			1.622	***
# of alcholic drinks/months					.999				1.000	
Physical Activity Index					.763	***			.876	**

(Continued on next page)

Table 3 (*continued from last page)*

Personal/Coping Resources							
Self Esteem				.894	**	.918	*
Pearlin Mastery Scale				.988		.994	
Neuroticism (w1 only)				.929		.909	*
Extraversion (w1 only)				1.010		.975	
Social Support							
Martial Status (Married = ref)							
Widow				1.038		.972	
Divorced/Separated				.854		.787	
Never Married				1.069		1.070	
Formal Social Integration				.854	***	.935	
Informal Social Integration				1.023		1.037	
Life Stress							
Financial Stress (w1 only)				.997		.938	
# of Life Events in Past 3 years (w1 only)				1.051		1.004	
Pseudo Log Likelihood	-3785	-3669	-3741	-3770		-3638	
Pseudo R^2	.178	.204	.188	.182		.210	

Notes: ***p<=.001; **p<=.01; *p<=.05; N=64,236
Age and Age-squared included in all models (coefficients not shown)

Table 4: Odds Ratios from Discrete Time Models Predicting Mortality with lagged time varying covariates

	Model 1		*Model 2*	
Depressive Symptoms (t)	1.174	**	1.053	
Depressive Symptoms (lagged, t-1)	.909		.938	
Comorbid Health Conditions (t)				
# of Chronic Conditions			1.057	
Serious Illness/Injury in Past 3 years			1.371	**
Health Limitations			.866	**
Functional Health Index			.824	***
Disabled (1=yes)			1.415	
BMI Category (Normal Weight=Ref)				
Underweight			2.634	***
Overweight			.741	*
Comorbid Health Conditions (lagged, t-1)				
# of Chronic Conditions	1.221	***	1.135	*
Serious Illness/Injury in Past 3 years	1.053		.946	
Health Limitations	.985		1.101	
Functional Health Index	.876	*	.966	
Disabled (1=yes)	1.230		.994	
BMI Category (Normal Weight=Ref)				
Underweight	1.345		.720	
Overweight	1.002		1.218	
Health Behaviors (t)				
Smoker (1=yes)			1.408	
# of alcholic drinks/months			.999	
Physical Activity Index			.961	
Health Behaviors (lagged, t-1)				
Smoker (1=yes)	1.897	***	1.404	*
# of alcholic drinks/months	1.001		1.001	
Physical Activity Index	.878	***	.913	
Pseudo Log Likelihood	-2529		-2440	
Pseudo R^2	.199		.216	

N= 45,828Source: American's Changing Lives Survey. Sociodemographic controls, life stress, social support, and personal/coping resources included in all models (not shown)