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Examining the Association Between Education Level and Physical Activity Changes During Early Old Age

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Abstract

Objective—This study examined the relationship between aging and regular physical activity. The moderating effects of education and the extent to which employment and health status influence physical activity were also examined.

Method—Multilevel logistic regression was conducted using longitudinal data from a national sample of 7,595 adults aged 54 to 72.

Results—An age-related decline in physical activity was observed, steeper among low-education individuals. Lack of physical activity was predicted by worsening health and reduced workforce participation, but these associations varied by education level. For low-education individuals, not working and job losses were associated with reduced physical activity, whereas for highly educated individuals the reverse was true. Health problems were associated more strongly with reduced physical activity in high-education individuals.

Discussion—Early old age is a critical period for promoting physical activity. Different intervention strategies for groups of different socioeconomic status may be needed.

Keywords

aging; education; physical activity

Current trends in population aging are unprecedented in human history and have raised concerns about the prospects of an increase in the prevalence of morbidity in the population and a rise in health care costs (Gruenberg, 1977). These concerns have helped bring to light the protective roles of individual behaviors (McGinnis & Foege, 1993; Mokdad, Marks, Stroup, & Gerberding, 2004). Indeed, many believe that promoting healthy behavior offers the most promising means for offsetting, or “compressing,” the growing illness burden that could arise from our aging population (Fries, 2003).

Physical activity is one behavior that has well-documented health benefits and is considered one of the most effective measures for preventing chronic illnesses such as coronary heart disease and diabetes (U.S. Department of Health & Human Services [USDHHS], 1996). For this reason, the Centers for Disease Control and Prevention (CDC) recommend that adults engage in moderate-intensity activities for at least 30 minutes on 5 or more days per week or vigorous-intensity activities for at least 20 minutes on 3 or more days per week (USDHHS, 1996). Current data from the Behavioral Risk Factor Surveillance Study (BRFSS), however, indicate that approximately 50% of all adults do not currently meet these recommendations (CDC, 2006). Furthermore, the prevalence of regular physical activity appears to decline precipitously in later life, dropping from 44.8% among those aged 55 to 64 to 39.0% among those aged 65 and older (CDC, 2006).

Cross-sectional, aggregate-level data such as these are useful for monitoring the magnitude of inactivity in the population and for setting broad intervention priorities (Brownson, Boehmer, & Luke, 2004). However, these data reveal little about changes in physical activity behavior that are likely to occur within individuals as they age or how individuals differ from one another with respect to age-related changes in physical activity. Utilizing data collected from the same individuals over extended periods during the aging process can help to address these gaps. For example, following the same individuals over time enables testing of the effects of aging on physical activity within individuals in a way that is not completely confounded by interpersonal differences across age groups (Shaw, Krause, Liang, & Bennett, 2007). It is possible that within-person aging-related declines in physical activity occur even more readily than is suggested by cross-sectional data. This might be the case, for instance, if the healthiest and most active members of older age groups are more likely than those with poorer health to respond to cross-sectional surveys (i.e., the healthy participation effect), thereby obscuring declines in activity that might occur over time within the same individuals (Mendes de Leon, 2007).

Examining interpersonal differences in age-related changes in physical activity is also essential, especially in light of current evidence of an increasing degree of heterogeneity in health during old age (Liang et al., 2003; Liang et al., 2005; Nelson & Dannefer, 1992). Consistent with a notion of the social stratification of health, this study aims to begin accounting for variation in physical activity behavior during early old age by focusing on a major component of socioeconomic status (SES): education level. Indeed, many consider education to be a primary driving force behind the social stratification of health, shaping several more proximate determinants of health, such as employment opportunities and financial well-being as well as personal control beliefs and healthy lifestyles (Mirowsky & Ross, 2003).

Nevertheless, much is not known about the linkages between education and physical activity during the aging process. Findings from several population-based cross-sectional studies show evidence of education-based disparities in physical activity during middle and late life (Chad et al., 2005; Grzywacz & Marks, 2001; Kaplan, Newsom, McFarland, & Lu, 2001; King et al., 2000; Kubzansky, Berkman, Glass, & Seeman, 1998). At the same time, some forms of physical activity, such as strenuous work-related activity, are known to be inversely related to education level (He & Baker, 2005). And we know little about the degree to which education level is associated with within-person changes in physical activity during old age.

The extent to which changes in key health and lifestyle factors influence physical activity during early old age is also not well understood. Departures from the workforce, as well as increases in the incidence of chronic conditions and functional limitations during early old age, may each contribute to the trend of declining physical activity observed for the population as a whole; however, these transitions may affect physical activity differently depending on an individual's education level. For example, leaving the work force may have a particularly strong negative impact on the physical activity of those with lower levels of education. Recent evidence supports this notion by revealing substantial variability in the effects of retirement on physical activity. For instance, investigators have recently found that retirement is likely to cause declines only in certain types of work-related physical activity and not in leisure-time physical activity (Slingerland et al., 2007). Given that adults with low levels of education are more likely to have worked in positions that require physical labor (He & Baker, 2005), this pattern of decline would suggest that the less well educated would suffer the greatest losses in overall physical activity following departures from the workforce. Furthermore, other research has suggested that for retirees who do not return to work, rates of physical activity actually increase following retirement, at least during early old age (Mein, Shipley, Hillsdon, Ellison, & Marmot, 2005). Given that highly educated adults are more likely than less educated adults to have the financial resources to retire without returning to work, this suggests that retirement may in fact enable high SES adults to devote more time to engaging in physical activities.

Highly educated individuals may also be better equipped to maintain regular physical activity after the onset of morbidity and disability. For example, higher levels of education provide individuals with a myriad of advantages that are likely to promote physical activity even in the face of age-related changes in abilities, including increased knowledge about its benefits, a stronger sense of personal control and self-efficacy for physical activity, healthier influences from social network members, and greater access to resources that facilitate physical activity (McAuley et al., 2006; Mirowsky & Ross, 2003; Wray, Herzog, Willis, & Wallace, 1998). On the other hand, it is also possible that increasing age and impairment may actually serve to "level the playing field" with respect to physical activity stratification. According to the age-as-leveler hypothesis, socioeconomic differentials in physical activity would be expected to grow significantly smaller in old age, as the physical changes associated with aging create barriers to physical activity across the entire socioeconomic gradient (House et al., 1994; Wray, Alwin, & McCammon, 2005).

The purpose of this study is to address each of these issues, utilizing data from a nationally representative sample of older adults followed over a 6-year period, from 1996 to 2002. The following specific hypotheses were tested: (a) on average, the probability of engaging in regular physical activity declines within individuals with increasing age, (b) education level is positively associated both with the probability of engaging in regular physical activity overall and with less steep age-related declines in physical activity, and (c) age-related increases in health problems and declines in participation in the work force are associated with lower rates of subsequent physical activity, and these associations are particularly strong among individuals with relatively low education levels.

Method

Data Source and Collection

Data for this study came from the Health and Retirement Study (HRS), a nationally representative panel survey of community-dwelling older Americans born between 1931 and 1941 (RAND Center for the Study of Aging, 2004). The original HRS sample was selected from a sampling frame of households, generated using a multistage, clustered area probability frame. The HRS is sponsored by the National Institute of Aging and is conducted by the University of Michigan. Further details about this study are available online (http://hrsonline.isr.umich.edu/) and in print (Juster & Suzman, 1995).

Data were first collected from the HRS sample (N = 12,521) in 1992, and data collection continues on a biannual basis. To make use of consistent measures of physical activity, four waves of data collected between 1996 and 2002 were used. Furthermore, only those respondents with valid responses to the physical activity measure for at least two waves were included in this study.

After employing these criteria, the sample included 7,595 respondents, observed 27,050 times (an average of 3.56 observations per respondent). This sample was 44.0% male, was 81.0% White, and had an average age at baseline of 59.7 years (range = 54 to 72). The average level of education in this sample was 12.1 years of schooling.

Measures

Physical activity—The HRS survey contained the following single question about physical activity in each of the four waves: "On average over the last 12 months have you participated in vigorous physical activity or exercise three times a week or more? By vigorous physical activity, we mean things like sports, heavy housework, or a job that involves physical labor." Responses were coded in a binary format (1 = yes, 0 = no). Over the course of the study period, the prevalence of participation in regular physical activity was 48.0%.

Education level—Education level was measured as a continuous variable and represents years of completed schooling.

Time-varying predictors—The current study included a set of work and health status measures that were assessed at each wave. The work status measure represents whether an individual was working for pay (1) or not (0). Health status measures included a count of eight chronic conditions (i.e., high blood pressure, diabetes, cancer, lung disease, heart disease, stroke, psychiatric problems, and arthritis), a count of functional limitations (i.e., the number of activities of daily living—bathing, eating, dressing, walking across a room, and getting into or out of bed—with which an individual reported at least some difficulty), and a measure of depressive symptoms based on the Center for Epidemiologic Studies Depression Scale (Radloff, 1977), ranging from 0 to 8. In addition, a time-varying measure of marital status (1 = married, 0 = other) was included as a control variable in our models.

Additional demographic control variables—All analyses controlled for the effects of gender (1 = male, 0 = female) and race (1 = White, 0 = non-White). It should be noted that the vast majority (82%) of the non-White group in this sample consisted of Black or African American individuals. In fact, non-Whites who were not Black made up less than 5% of the total sample. Under these conditions, it is not feasible to break the non-White category into a finer gradation. In this case, therefore, race is broadly conceptualized in terms of majority versus minority racial status.

Data Analysis

The analyses for this study focused on estimating the association between a respondent's age at different observation points and the probability of engaging in regular physical activity. These analyses were carried out with multilevel logistic regression. Multilevel analyses are appropriate in this context because the occasions of measurement of physical activity and age are nested within individuals (Hox, 2002). Multilevel modeling of these data allows for the estimation of the changes in the log odds of participation in regular physical activity that are associated with increasing age within individuals.

The statistical procedures for this study were conducted in three stages. In the first stage, the log odds of participation in regular physical activity were modeled as a function of age (centered on the sample mean and divided by the standard deviation) over the course of the four waves of data collection for each individual. This model produces two fixed effects and two random effects. The fixed effects represent the average log odds of physical activity at the mean age for the sample and the average intraindividual changes in the log odds of physical activity with increasing age for the sample taken as a whole. The random effects represent the degree to which respondents' physical activity at the intercept, and change rates, deviated from the mean. These random effects are used to determine whether the data included interindividual variance with regard to intraindividual changes in physical activity.

To control for the potential effects of heterogeneity with respect to age at baseline, a time-invariant variable representing birth year was included in this, and subsequent, models. Also, a variable distinguishing between respondents with complete data at all four waves (n = 6,228) and those who dropped out (n = 1,367) was included in the models to control for potential differences in the trajectories of these two groups. Gender, race, and marital status were also included as control variables.

Next, education level was included in the model, specified as both a main effect and an interaction with age. The main effect for education level represents the association between educational attainment and the log odds of physical activity at the mean age of the sample, after controlling for the effects of gender, race, and the other control variables. The multiplicative term between age and education level represents the influence of educational attainment on age-related changes in physical activity.

Finally, several other time-varying covariates—measures of work and health status—were entered into the model. As an extension of the work of Yang and George (2005), for each time-varying construct, two variables were included in the model. The first set of time-varying predictors represents each respondent's score on a predictor during the prior wave. Associations between these so-called "lagged" time-varying predictors and physical activity represent the relationship between work or health status at a given point in time and physical activity approximately 2 years later. The second set of time-varying variables represents the change in a given predictor between the current and prior wave. For dichotomous predictors, such as work status, change variables indicating gains (i.e., a job gain) and losses (i.e., job loss) were entered as dummy variables to be compared with stable work status. For continuous predictors, such as chronic conditions, a single change score was entered for each respondent at each wave. Associations between these change variables and physical activity represent the relationship between transitions in work or health status during the preceding 2 years and physical activity at a given point in time. In addition, a series of multiplicative terms was estimated for each of these time-varying covariates and education level. These multiplicative terms represent the degree to which the association between the time-varying predictors and participation in regular physical activity varied across education level.

Results

The relationship between age and physical activity was examined first. Table 1 shows the percentage of the sample who met the recommended level of vigorous physical activity at each of the four waves. As is evident from this table, physical activity rates declined in this sample over time (from 50.9% in Wave 1 to 44.9% in Wave 4) as the mean age increased (from 59.4 in Wave 1 to 65.3 in Wave 4). The extent to which this overall pattern of decline represents within-person declines in physical activity with advancing age, however, is uncertain. This is because, as this table shows, between each wave both increases and decreases in physical activity were observed. Specifically, between each wave approximately 12.7% to 14.6% of the sample increased their frequency of physical activity from less than three times per week to three or more times per week, whereas approximately 15.5% to 16.7% of the sample experienced declines. It should also be noted that the size of the available sample, and presumably the composition, changed over time. Therefore, it is unclear to what extent the pattern of decline in physical activity reflects the fact that a slightly different available sample was analyzed at each wave.

Multilevel logistic regression analysis can help to control for these uncertainties by estimating the sample's average rate of within-person, age-related change in physical activity. A parameter estimate representing the average change in the log odds of physical activity associated with increasing age between 1996 and 2002 appears in the column labeled Model 1 of Table 2. This estimate shows that, after controlling for the effects of birth cohort, attrition, gender, and race, the log odds of participation in regular physical activity decreased with advancing age ($b = -0.163$, $p \leq .001$). The odds ratio (OR) associated with this estimate (OR = 0.849, 95% confidence interval [CI] = 0.820, 0.880) suggests that between ages 54 and 72, individuals' odds of participation in regular physical activity decreased by about 15% every 3.85 years (i.e., 1 standard deviation), or about 3.9% per year.

The potential effects of education, work status, and health status on physical activity were assessed next. Before turning to the relevant results from the logistic regression analyses presented in Table 2, we examined how each of our predictors varied according to physical activity status at baseline. The results of these bivariate analyses are presented in Table 3. At baseline, respondents defined as not engaging in regular vigorous activity were slightly older (59.43 vs. 59.32 years) and less well educated (11.90 vs. 12.39 years) than respondents performing regular exercise at baseline ($p = .07$ for both associations). Regular physical activity at baseline was associated more strongly with other predictors. For instance, participation in regular physical activity was more common among males than females (56.2% vs. 46.5%, $p \leq .001$), Whites than non-Whites (52.7% vs. 44.0%, $p \leq .001$), workers than nonworkers (57.0% vs. 42.9%, $p \leq .001$), and married than nonmarried respondents (53.0% vs. 45.7%, $p \leq .001$). Furthermore, respondents engaging in regular physical activity had fewer chronic conditions (1.16 vs. 1.59, $p \leq .05$), functional limitations (0.09 vs. 0.33, $p \leq .05$), and depressive symptoms (0.93 vs. 1.62, $p \leq .05$) than did less active respondents. Finally, this table also shows that respondents who remained in the study for all four waves of data collection had higher rates of physical activity at baseline than did those who dropped out (51.7% vs. 47.6%, $p = .004$).

In the next stages of analyses, these associations were examined in a multivariate and time-varying context, as shown in Models 2 and 3 of Table 2. Model 2 shows the extent to which education level was associated with both the odds of engaging in regular physical activity and age-related changes in the odds of physical activity participation. These estimates suggest that the odds of engaging in physical activity at any time during this study were higher for individuals with high levels of education compared to individuals with less education (OR = 1.176, 95% CI = 1.137, 1.216). Furthermore, the results of this model show that education level moderated the association between age and physical activity. Specifically, the positive coefficient of the multiplicative term education × age ($b = 0.056$, $p \leq .001$) suggests that the inverse association between age and physical activity became weaker as education level increased. The predicted relationship among physical activity, age, and education level is presented in Figure 1. As this figure shows, the age-related decline in physical activity was not as steep among the highly educated compared to the less educated. As a result, education disparities in physical activity widened with increasing age.

Finally, the third model shown in Table 2 examines the degree to which other time-varying predictors were associated with physical activity as well as the degree to which these associations varied according to education level. The findings presented here show that all of the lagged time-varying predictors were significantly associated with physical activity. For example, chronic conditions (OR = 0.826, 95% CI = 0.802, 0.852), functional limitations (OR = 0.646, 95% CI = 0.605, 0.691), and depressive symptoms (OR = 0.893, 95% CI = 0.871, 0.916) were each associated with decreased odds of physical activity. Working for pay was associated with increased odds of subsequent physical activity (OR = 1.184, 95% CI = 1.091, 1.285).

In addition, interwave changes, or transitions, in many of the time-varying predictors were associated with subsequent physical activity status. For example, increases in chronic conditions (OR = 0.878, 95% CI = 0.829, 0.930), functional limitations (OR = 0.765, 95% CI = 0.722, 0.811), and depressive symptoms (OR = 0.925, 95% CI = 0.909, 0.941) were all associated with decreased odds of engaging in regular physical activity. Job losses were also negatively associated with physical activity (OR = 0.894, 95% CI = 0.813, 0.982), whereas job gains were positively associated with physical activity (OR = 1.229, 95% CI = 1.069, 1.412).

The multiplicative terms in Table 2 provide information about the degree to which health and work status factors may affect physical activity at different levels of education. For instance, the interaction between education and lagged work status ($b = -0.322$, $p \leq .001$) indicates that the association between employment status and physical activity varied by level of education. In fact, as shown in Figure 2, this coefficient indicates that at lower than average levels of education, employment was positively associated with physical activity, whereas at higher than average levels of education, employment became negatively associated with physical activity. In addition, the negative interactions between education and chronic conditions ($b = -0.046$, $p \leq .01$) and functional limitations ($b = -0.110$, $p \leq .001$) indicate that the negative association between health problems and physical activity was particularly strong among individuals with high levels of education. As shown in Figure 2, when also considering education differences in the intercept of physical activity, these negative interactions mean that highly educated individuals are likely to engage in physical activity at higher rates than less educated individuals until health or functional limitations arise.

The effects of transitions in work status and functional limitations on physical activity also appear to have varied by education, with significant interactions found between education and job gains ($b = -0.221$, $p \leq .01$), education and job losses ($b = 0.262$, $p \leq .001$), and education and functional limitation transitions ($b = -0.071$, $p \leq .05$). These relationships are shown in Figure 3 and indicate that education-based advantages in physical activity were apparent primarily following transitions out of the work force and following improvements in functioning.

Discussion

These findings help advance our understanding of physical activity during early old age in several ways. First, these findings substantiate previous reports of a substantial decline in physical activity during early old age (DiPietro, 2001). Previous reports of this pattern of age-related decline had mainly relied on comparing rates of physical activity between individuals of different birth cohorts using cross-sectional data. After examining repeated measures of physical activity within individuals, this study confirmed the presence of an overall trend of declining physical activity with increasing age. This age-related decline in physical activity persisted even after controlling for the effects of gender, race, education, birth cohort, and attrition. This further supports the conclusion that age differences in rates of physical activity are not simply the results of demographic or historical differences between respondents of different cohorts in our sample.

Beyond this, the current findings provide evidence of some noteworthy socioeconomic differences in the patterns of physical activity observed during early old age. The finding that education-based disparities in physical activity widened over time during early old age is consistent with the theory of cumulative advantage (Ross & Wu, 1996), suggesting that the benefits of education in promoting a physically active lifestyle accumulate and grow over time. Moreover, these education-based differences in rates of physical activity decline contribute to our growing understanding of the relationship between socioeconomic position and physical activity (McNeill, Kreuter, & Subramanian, 2006) and may help explain observations of socioeconomic disparities in functional disability incidence among older adults (Melzer, Izmirlian, Leveille, & Guralnik, 2001). However, an understanding of the factors responsible for the growing educational disparities in physical activity is also critical for developing effective physical activity promotion interventions for older adults.

This study provides some preliminary insight into why rates of decline in physical activity may differ by education level. In particular, the interactions between the health and work status variables and education level suggest that the contributions of these time-varying factors differ according to education level. For example, the current findings suggest that working for pay was positively associated with physical activity for low education individuals but inversely associated with physical activity for highly educated individuals. Previous research has shown a positive relationship between leisure-time physical activity and education level and an inverse relationship between work-related physical activity and education level among older adults (He & Baker, 2005; Ransdell & Wells, 1998). The current findings significantly advance our understanding of the relationships among education, work status, and physical activity by examining them over time and may help explain why individuals with relatively low levels of education experienced steeper declines in physical activity during early old age. In particular, the current findings seem to suggest that low education individuals' reliance on employment as a major source of physical activity results in precipitous declines in physical activity as they move through early old age and transition out of the workforce. In contrast, for individuals with higher levels of education, work is not as strongly associated with physical activity and may in fact detract from it. Thus, when highly educated individuals leave the workforce, it is unlikely that they are losing their main source of activity and may actually be freeing up time to engage in leisure-time physical activity. Such a finding has important intervention implications for aging adults with low levels of education. In particular, these findings suggest that developing and promoting opportunities for physical activity among aging individuals with low levels of education who have recently transitioned out of the formal workforce, or who are planning such a transition in the near future, should be a major public health priority.

In addition, the current findings suggest that increases in health problems appear to be particularly salient impediments to physical activity for highly educated individuals. These findings appear to be consistent with the age-as-leveler hypothesis (House et al., 1994; Wray et al., 2005). Although our findings regarding education differences in age-related changes in physical activity showed a widening gap in physical activity with increasing age, our findings also suggest that this education gap may diminish following the onset of morbidity and disability. In other words, health status appears to matter more than education level in determining physical activity participation. This should signal the need to target individuals at all levels of SES with interventions promoting physical activity after the onset of age-related morbidity.

In reviewing the findings from this study, readers should keep in mind some of the study's key limitations. For example, the dependent variable, physical activity, is measured with a single survey item, with just two response options (*yes* or *no*). This is problematic for several reasons. First, as demonstrated by Mendes de Leon (2007), this artificial dichotomizing of a variable that naturally occurs on a continuum can bias results. For instance, according to this measurement strategy, it is possible for individuals to change their physical activity frequency by 2 or more days per week without showing change in our measure (e.g., changing from 5 to 3 days per week). At the same time, other individuals who change from 2 to 3 or from 3 to 2 episodes of physical activity per week would show a change in our measure.

Second, like any single-item measure of an outcome, our measure of physical activity is subject to random measurement error and, thus, low reliability. Although this type of error typically attenuates associations, thus resulting in a conservative estimate of the effects of age on physical activity, future research in this area should strive to employ a more reliable measure of this construct to more accurately represent the relationship between age and physical activity.

Third, concerns about the content validity of this measure of physical activity should be noted. For example, walking is a major form of physical activity in later life yet was not included in our measure. On the other hand, other activities that are not always included in measures of physical activity, such as heavy housework and job-related activities, were included in the measures of physical activity in the HRS survey. Therefore, we advise caution when comparing rates of vigorous physical activity from the current study to rates from other studies that use different measures of physical activity, such as the BRFSS. In fact, according to the BRFSS, rates of vigorous activity for individuals aged 55 to 64 and 65 and older are only 21.1% and

14.1%, respectively. The rates of vigorous physical activity that we found are more similar to the rates of "moderate or vigorous" physical activity found in the BRFSS (i.e., 44.8% for ages 55 to 64 and 39.0% for ages 65 and older; CDC, 2006).

Finally, a more accurate representation of age-related changes in physical activity during early old age could be gained with additional waves of data collection. Also, whenever possible, the inclusion of several additional predictors of physical activity, such as living arrangements and income (Chad et al., 2005), could provide a more precise understanding of the extent to which age, education, and work and health status are associated with physical activity.

Despite these data limitations, the current study provides an important set of findings regarding aging and physical activity. It is clear from this study that as physical activity rates decline during later life, the education-based disparities in physical activity apparent in cross-sectional data do not simply persist but actually increase. Therefore, early old age is a critical period for promoting physical activity. However, in light of current evidence that some of the contributors to physical activity that decline during this stage of life vary on the basis of educational attainment, it is also apparent that different strategies may be needed to promote physical activity for older adults with different levels of education.

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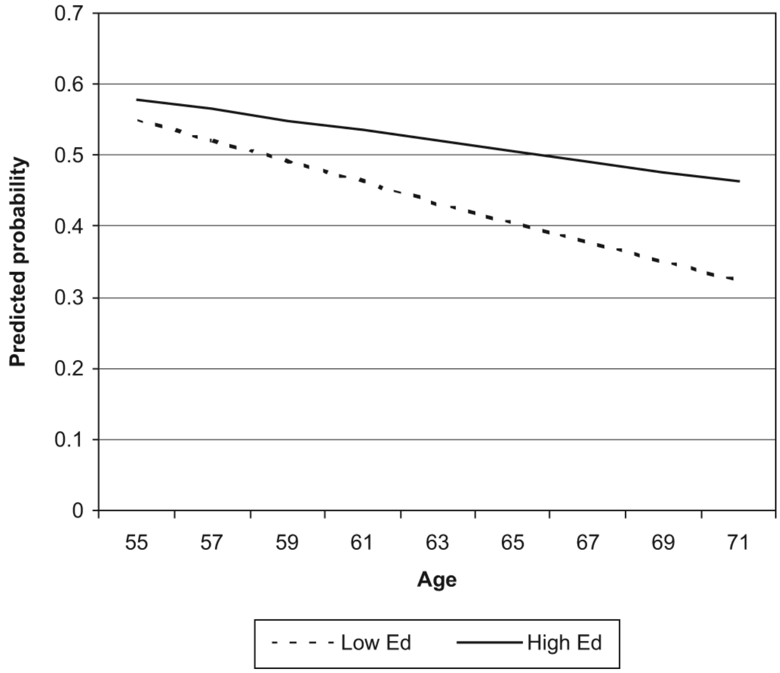

Figure 1.
Age-Related Changes in the Predicted Probability of Regular Physical Activity by Education Level

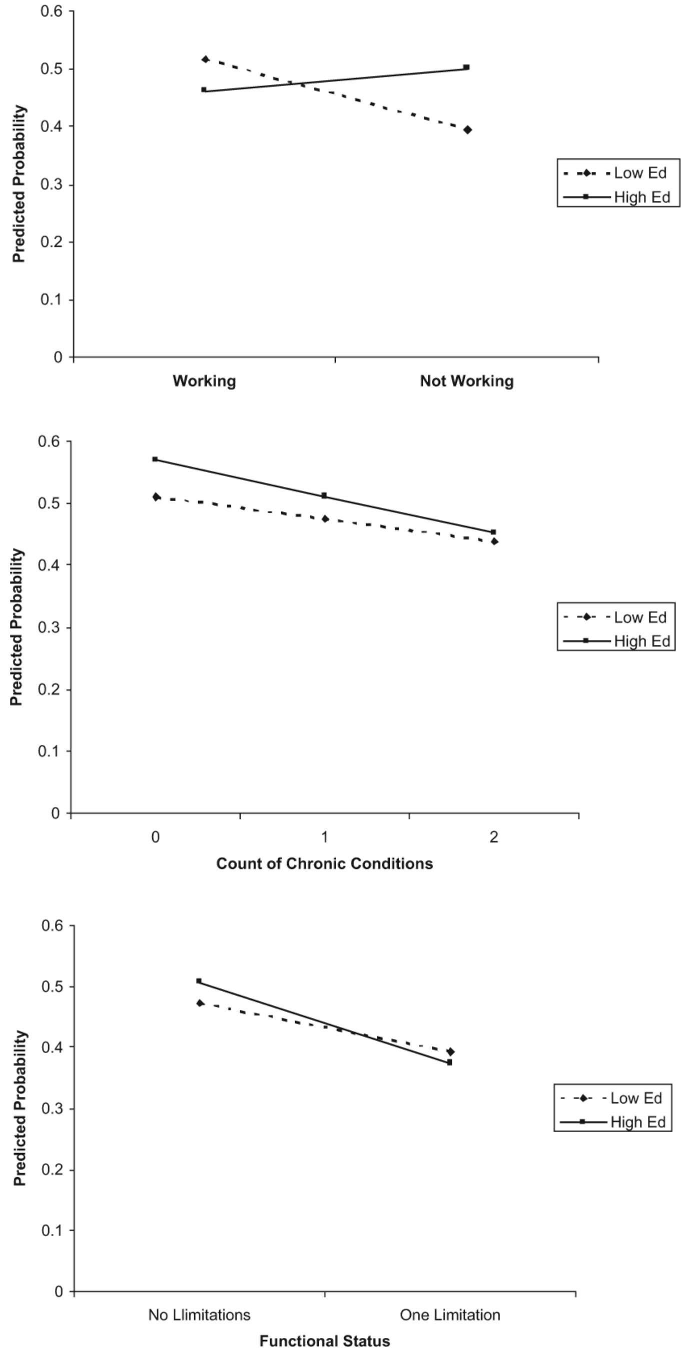

Figure 2.
Education Differences in the Predicted Probability of Regular Physical Activity by Work, Health, and Functional Status, 1996 to 2002

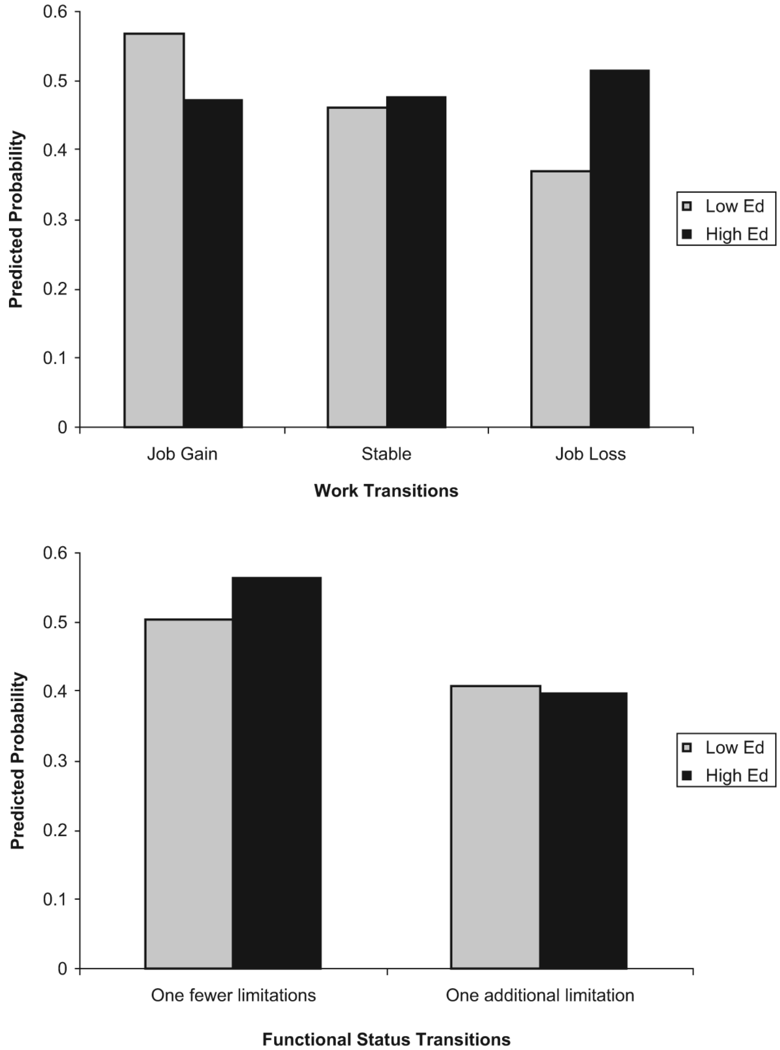

Figure 3.
Education Differences in the Associations Between Interwave Transitions in Work and Functional Status and the Predicted Probability of Regular Physical Activity

Table 1

Rates of Vigorous Physical Activity and Activity Change and Mean Age by Wave

	Observation Year			
	1996	**1998**	**2000**	**2002**
Vigorous physical activity (≥ 3 times per week)				
% of available sample meeting recommendation	50.9	47.4	47.3	44.9
% of available sample increasing from previous wave[a]	—	13.0	14.6	12.7
% of available sample decreasing from previous wave[b]	—	16.7	15.5	16.0
Mean age of available sample	59.4	61.2	63.2	65.3
Available sample size	7,940	8,020	7,600	7,236

[a] Increasing from < 3 times per week to ≥ 3 times per week.

[b] Decreasing from ≥ 3 times per week to < 3 times per week.

Table 2

Parameter Estimates, Robust Standard Errors, and Odds Ratios for Multilevel Logistic Regression Models Predicting Regular Physical Activity

	Model 1				Model 2				Model 3			
Independent Variable	***b***	***SE***	**OR**	**95% CI**	***b***	***SE***	**OR**	**95% CI**	***b***	***SE***	**OR**	**95% CI**
Intercept	−0.046	0.019*	0.955	0.920, 0.990	−0.056	0.019**	0.946	0.912, 0.981	−0.127	0.022***	0.881	0.844, 0.919
Time-varying predictor												
Age	−0.163	0.018***	0.849	0.820, 0.880	−0.169	0.018***	0.844	0.814, 0.875	−0.015	0.031	0.985	0.927, 1.046
Work status (lagged)									0.169	0.042***	1.184	1.091, 1.285
Job gain									0.206	0.071**	1.229	1.069, 1.412
Job loss									−0.112	0.048*	0.894	0.813, 0.982
Chronic conditions (lagged)									−0.191	0.015***	0.826	0.802, 0.852
Chronic condition transition									−0.130	0.029***	0.878	0.829, 0.930
Functional limitations (lagged)									−0.436	0.034***	0.646	0.605, 0.691
Functional limitation transition									−0.267	0.030***	0.765	0.722, 0.811
Depressive symptoms (lagged)									−0.113	0.012***	0.893	0.871, 0.916
Depressive symptom transition									−0.078	0.009***	0.925	0.909, 0.941
Time-invariant predictor												
Education					0.162	0.017***	1.176	1.137, 1.216	0.047	0.021*	1.048	1.006, 1.091
Interactions												
Education × age					0.056	0.014***	1.058	1.029, 1.088	0.025	0.019	1.025	0.987, 1.065
Education × work status									−0.322	0.043***	0.725	0.666, 0.788
Education × job gain									−0.221	0.071**	0.802	0.697, 0.922
Education × job loss									0.262	0.052***	1.299	1.173, 1.439
Education × chronic conditions									−0.046	0.015**	0.955	0.927, 0.985
Education × chronic conditions transition									−0.034	0.030	0.967	0.912, 1.025
Education × functions limitations									−0.110	0.027***	0.895	0.850, 0.944
Education × functions limitations transition									−0.071	0.028*	0.932	0.881, 0.985
Education × depressive symptoms									−0.004	0.011	0.996	0.974, 1.018
Education × depressive symptoms transition									−0.005	0.009	0.995	0.978, 1.012

Note: OR = odds ratio; CI = confidence interval. Model controls for the main effects of birth cohort, attrition, gender, race, and marital status.

* $p \leq .05$.

** $p \leq .01$.

*** $p \leq .001$.

Table 3

Bivariate Associations Between Physical Activity and Predictor Variables at Baseline

Predictor	Vigorous Physical Activity ≥ 3 Times per Week		
	Yes	No	*p*
Gender (%)			.000[a]
Male	56.2	43.8	
Female	46.5	53.5	
Race (%)			.000[a]
White	52.7	47.3	
Non-White	44.0	56.0	
Work status (%)			.000[a]
Working for pay	57.0	43.0	
Not working for pay	42.9	57.1	
Marital status (%)			.000[a]
Married	53.0	47.0	
Not married	45.7	54.3	
Attrition (< 4 waves of data) (%)			.004[a]
Yes	47.6	52.4	
No	51.7	48.3	
Mean age	59.32	59.43	.07[b]
Mean education (years)	12.39	11.90	.07[b]
Mean # of chronic conditions	1.16	1.59	.03[b]
Mean functional limitations	0.09	0.33	.02[b]
Mean CESD score	0.93	1.62	.04[b]

Note: CESD = Center for Epidemiologic Studies Depression Scale.

[a] *p* value for chi-square test comparing prevalence of physical activity by predictor.

[b] *p* value for independent-samples *t* test comparing means between “yes” and “no” physical activity groups.