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Longitudinal Change in Physical Activity and Disability in Adults

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Abstract

Objectives—To prospectively examine whether physical activity or change in physical activity increases or decreases the risk of disability later in life.

Methods—Tobit regression models were used to examine the effect of physical activity at baseline and change from baseline on disability 10 and 20 years later in 6913 adults.

Results—Increasing recreational physical activity was associated with reduced risk of disability whereas reducing recreational physical activity increased the risk of disability after 10 years.

Conclusions—The analyses reveal a protective effect of sustained physical activity on disability among adults.

Keywords

recreational activity; nonrecreational activity; physical functioning; health behavior

Physical activity has been shown to have a protective effect on the development of disease and disability, and regular physical activity is a staple of preventive health programs.¹ Among relatively healthy individuals, physical activity is associated with optimal function and low incidence of functional disability.² Even among those with disabilities, exercise programs improve health and can reduce existing levels of functional disability.³ Low levels of physical activity caused by difficulties in performing daily activities may cause a vicious circle leading to further decline in strength and worsening of functional ability. Alternatively, increased physical activity among older people is associated with increased functional ability⁴ as well as improved cognitive performance, mood, body image, self-esteem, and a general feeling of psychological well-being.⁵ Verbrugge and Jette⁶ suggested that a high level of physical activity some years earlier might be expected to improve the likelihood of having a lower level of disability, based on the familiar “use it or lose it” principal. Most studies that show a beneficial effect of exercise on disability have focused on leisure-time physical activity.⁷ However, nonrecreational physical activity has also shown a protective effect among vigorously active occupations against mortality from coronary heart disease compared with the effect observed among sedentary jobs. With respect to disability, some studies have suggested that jobs requiring frequent heavy lifting greater than 25 pounds, especially when combined with twisting or asymmetry, might predispose individuals to disability.^{8,9} The purpose of this investigation is to address the

relationship between changes in both nonrecreational and recreational physical activity and disability later in life using a large national database with 3 separate time points over a 20-year period in adults of all ages.

Methods and Materials

Sample

This investigation was approved by the Institutional Review Board at Purdue University. The database used in this investigation has been previously described.¹⁰ Briefly, data from the *National Health and Nutrition Examination Survey I* (NHANES I) and its *Epidemiologic Follow-up Study* (NHEFS) were used in this investigation.¹¹ The baseline NHANES I was conducted from 1971 to 1975. The sampling design was a multistage, stratified, probability sample of noninstitutionalized individuals who were 25-74 years of age. This study uses data from the baseline survey and 2 follow-ups. The second wave of data was collected from 1982 to 1984 (follow-up 1), and the third wave of data was collected in 1992 (follow-up 2), resulting in an approximate 20-year observation period.¹²

Analyses were completed on the NHEFS subsample, which received the “detailed component” including the Health Care Needs Questionnaire at Baseline (N = 6913). The sample used in this study is composed of 5955 white and 878 black respondents (12.8%) at baseline. Unweighted data were used throughout the analyses.^{13,14} The percentage of cases at baseline receiving the detailed component and traced through follow-ups was excellent (92.6% of survivors at follow-up 1 and 96.5% of survivors at follow-up 2). The number of subjects lost to mortality, tracing, and refusal to participate was 1644 by follow-up 1 and 2696 by follow-up 2.

Physical Activity

The measures for physical activity from the NHANES1 and NHEFS data sets that were used in this study are relatively broad, which is often the case with large national data sets that are not designed to investigate one specific health behavior. However, these measures and data sets have been used to elucidate important relationships between physical activity and a number of different diseases.¹⁵⁻¹⁸ Separate questions were asked about the participant's level of recreational and nonrecreational physical activity at baseline and follow-up. For each type of physical activity, the participant's self-perceived level was coded on a 3-point scale: Little, Moderate, and High. The nonrecreational question asked: “In your usual day, aside from recreation, are you physically very active, moderately active, or quite inactive? 1. Very active, 2. Moderately active, 3. Quite inactive.” This question was identical both at baseline and at follow-up 1.

The recreational physical activity question differed slightly between baseline and follow-up. At baseline, the question was “Do you get much exercise in things you do for recreation (sports, or hiking, or anything like that), or hardly any exercise, or in between?” At the follow-up interview the question was “In things you do for recreation, for example, sports, hiking, dancing, and so forth, do you get much exercise, moderate exercise, or little or no exercise?” For both questions the available responses were 1. Much exercise, 2. Moderate exercise, and 3. Little or no exercise.

Separate variables were defined for recreational and nonrecreational physical activity using 3 sets of categorical variables. The first set used only the baseline responses with 3 categories of activity level: Little, Moderate, and Much. The second set of variables was constructed in the same manner, but used the follow-up responses only. In order to evaluate changes in physical activity over time, a third set of variables was created using information from the baseline and the follow-up interviews to construct 9 categories of physical activity

change for recreational and nonrecreational physical activity change: (1) Little, (2) Moderate, or (3) Much at both interviews, or change from one category to another between interviews: (4) Little to moderate, (5) Little to much, (6) Moderate to little, (7) Moderate to much, (8) Much to little, and (9) Much to moderate.

Measurement of Disability

Disability was not measured during the baseline survey, but was measured at the follow-ups. Thus, the logic of these analyses is to use the prospective nature of the data to examine the lagged effect of physical activity on disability. For the follow-up surveys, items from the Stanford Health Assessment Questionnaire Disability Index were used. This survey has been commonly used to quantify functional disability in patients with rheumatic diseases, but normative values for the general population have been reported.¹⁹ *Disability* is operationally defined as level of difficulty in performing common functional tasks. The disability index addresses specific functional tasks based on the following question: “Please tell me if you have no difficulty, some difficulty, much difficulty or are unable to do these activities at all when you are by yourself and without the use of aids; for example, lift and carry a full bag of groceries?” The tasks span a wide range of functions in 8 domains. The original index included 26 items, but several items were either deleted or modified in later interviews.¹⁹ Nineteen items common to both follow-up 1 and follow-up 2 were used. Responses for each item were from 1 (no difficulty) to 4 (unable to do). Missing data were imputed as group means defined by age, gender, and race if the subject had missing data on 4 or fewer of the items on each index. If the respondents missed more than 4 items, they were treated as missing on the index.²⁰

Measurement of Covariates

Health measures were assessed in the baseline interview and were used as control variables. Morbidity was derived from a checklist type question designed to identify the illnesses of respondents. Respondents were asked the following question: “Has a doctor ever told you that you have ... hypertension or high blood pressure?” (36 conditions were presented). Unlike some surveys that ask if a person has a condition, the NHANES question solicited responses based on being told by a physician. Each condition was coded as a binary variable (0, 1). The conditions were then classified into those that were life threatening or serious and all remaining conditions.²¹ Serious conditions included: cancer, diabetes, heart failure (attack or trouble), hypertension, and stroke. Examples of chronic nonserious conditions included arthritis, asthma, bone fracture, cataracts, gout, psoriasis, and ulcer. The serious and chronic nonserious conditions were then summed separately for analyses: serious conditions range from zero to 5, and chronic nonserious conditions range from zero to 4. Supplementary analyses treated the diseases as separate binary variables.

The remaining independent variables span a range of factors related to disability or physical activity, either directly or indirectly. These include indicators of health-risk behaviors such as smoking and/or drinking based on self-reported consumption at the time of the interview and during one's lifetime. Measurement of the other independent variables was consistent with Ferraro et al.²²

Analysis

Consistent with other epidemiologic investigations of physical activity and disability,²³ the sample had a large percentage of cases with no disability (over 70%). The skewed distribution of the disability measures creates a *floor effect* (often referred to as “censoring”) and violates the assumptions of ordinary least squares (OLS) regression. OLS regression is designed for normally distributed interval or ratio dependent variables. In the case of highly skewed and censored data, OLS estimates are inconsistent (biased intercepts and slopes).

Logistic or probit regression models, whether binomial or ordered, are another option, but they do not make full use of the variability among individuals with different levels of disability. Tobit models assume a clustering at a limit and simultaneously account for the (1) probability of being censored and (2) variability among those at different levels of the outcome. For the present analysis, tobit models conveniently distinguish the cases with no disability from those with any disability and account for variability among the latter. Unlike OLS or logistic regression methods, tobit estimates are consistent and efficient for censored data. The tobit model uses the same structural form as the probit model, but preserves the information within the limit via maximum likelihood. Tobit regression coefficients can be interpreted just as one would interpret slopes in ordinary least square estimates. Using data from Table 2 as an example, disability is 1.802 less for men who reported moderate activity at baseline than for those who reported little activity at baseline (the reference group). The effect is even stronger for women: disability is 2.708 less for women who reported moderate activity at baseline than for those who reported little activity at baseline (the reference group).

Although case tracing and re-interview rates were high in the NHEFS, it is always possible that attrition in longitudinal analyses may influence sample estimates of relationships and lead to bias in the estimates. Thus, selection bias models, originally developed by Heckman,²⁴ were used to correct parameter estimates for differential selectivity due to death, refusal to participate, or inability to trace. The procedure was to first estimate a probit model to distinguish cases that participate from those who do not. The second step was to use the probit results to create a selection instrument (λ) based on the inverse Mills ratio and add the selection instrument to the selection model of interest.²⁵ This 2-step approach has been extended to incorporate 2 hazard-rate instruments for different forms of attrition²⁶ and is conveniently handled in LIMDEP.²⁷ The results presented below differentiate attrition due to mortality from that due to nonresponse by estimating separate probit equations, each with at least one instrumental variable (ie, one variable not included in the substantive equation). The probit model estimating mortality during the survey showed that deaths were more likely among black, older male respondents with more physician-evaluated morbidity and those with less income. The probit model estimating nonresponse during the survey waves showed that subjects more likely to drop out of the analysis were black, younger, missing on occupational status, urban, and those with less income.

Results

The participants' characteristics at baseline and follow-up 1 are listed in Table 1.

In both waves, the largest percentage of men reported getting a moderate amount of recreational exercise, with the fewest percentage reporting much recreational exercise. These numbers were reversed at baseline with respect to nonrecreational activity with the largest percentage reporting that they were very active and the lowest percentage, inactive. At follow-up 1, most men reported being moderately active in nonrecreational physical activities. In both waves the lowest percentage of men reported being quite inactive. The largest percentage of women respondents reported getting little or no recreational exercise at baseline, but were similar to men at follow-up 1 with the greatest percentage reporting moderate exercise. In both waves, the lowest percentage of women reported much recreational exercise. With respect to nonrecreational physical activity, responses were similar at follow-up 1 and follow-up 2, with most women reporting moderate levels of nonrecreational physical activity.

Table 2 displays the results of the tobit analysis predicting disability at follow-up 1 and follow-up 2 in association with recreational physical activity. The Tobit estimates presented are partial regression coefficients, adjusting for all of the other independent variables. For instance, age is associated with greater disability at the first follow-up for both men and women, even after controlling for recreational physical activity ($\beta=0.026$ for men, $\beta=0.086$ for women, $P < .01$). Both men and women who reported moderate or much activity at baseline had less disability approximately 10 years later at follow-up 1 compared to those who reported little recreational physical activity. Furthermore, those who reported little activity at baseline, but reported moderate or much activity at follow-up 1 also had less disability. Alternatively, participants who moved from much or moderate to little activity at follow-up 1 had an increase in disability. Moving from moderate at baseline to much at follow-up 1 or the reverse (much at baseline to moderate at follow-up 1) had no impact on disability at follow-up 1. The questions concerning recreational and nonrecreational physical activity from baseline and follow-up 1 were not used in follow-up 2. However, disability measures were available and are presented. These results do not show an association between activity level and disability assessed 20 years later.

Tobit analysis predicting disability at follow-up 1 in association with nonrecreational physical activity is shown in Table 3.

The association between nonrecreational physical activity and disability was similar to that for recreational physical activity for women, but these associations were much weaker for men. Although changes in disability were in the same direction for recreational and nonrecreational physical activity, men who reported moderate nonrecreational activity at baseline did not have significantly greater disability than did those reporting little nonrecreational physical activity. In addition, moving from little to moderate or much nonrecreational physical activity was not associated with a change in disability for men.

Figure 1 displays the disability score for subjects at follow-up 1 based on their reported physical activity level at baseline and follow-up 1. For both recreational and nonrecreational physical activity, the highest disability scores were for those reporting little physical activity at follow-up 1, followed by moderate and much.

Discussion

The present study systematically examined the relationship between physical activity and disability in a prospective longitudinal study. The finding that recreational physical activity was associated with less functional limitation is consistent with other studies. Data from the Longitudinal Study of Aging,^{28,29} the Honolulu Heart Study,³⁰ The Alameda County study,³¹ and other groups³²⁻³⁴ have found that physically active people had a lower prevalence of functional limitation than did sedentary people.

Not all studies have found a consistent relationship between physical activity and disability. The Framingham study found no association between an activity index and a cumulative disability index assessed 21 years later.³⁵ Similarly, in this study, no association between recreational physical activity and disability was found after 20 years. Christensen et al³⁶ showed a strong association between physical inactivity at age 70 and disability at age 75, but there was no effect of cumulated physical inactivity from age 50 to 60 to 70 on disability at age 75 when adjusting for functional ability at age 70. Similarly, data from the Established Populations for Epidemiologic Studies of the Elderly show that the association between physical activity and functional limitation diminished after 6 years (25). Huang et al²³ found an association between functioning and physical activity after a follow-up that averaged 5.5 years. Using a different approach, Nusselder et al,³⁷ using 2-year follow-ups, found that among 50-to-80-year-olds, higher levels of recreational physical activity extend

the number of disability-free years and reduce the number of years with disability. In this present investigation using a large number of subjects with a wide variation in ages, a strong relationship was found in both men and women between disability and recreational physical activity after 10 years, but not after 20 years.

The relationship between nonrecreational physical activity and disability is somewhat complicated because men involved in heavy manual labor such as firefighters, farmers, and construction workers are at greater risk of developing osteoarthritis.⁹ Among women, there is increased likelihood of developing arthritis in cleaners.⁹ Alternatively, higher levels of nonrecreational activity have been associated with reduced risk of cancer, acute myocardial infarction, diabetes, obesity, and all cause mortality.³⁸ In a study of physical activity in women, Weller and Corey³⁹ estimated that nonrecreational activity accounted for 82% of total activity and suggested that total activity is the primary determinant of mortality. Emphasizing the need for more data about the components and characteristics of physical activity, Raum et al⁴⁰ have reported that both too little and too much heavy physical activity increased risk of major cardiovascular events in adults. In this present study, the association between nonrecreational physical activity and disability was similar to that for recreational activity in women, but the associations were much weaker in men, who are more likely to be involved in heavy labor that could contribute to disability later in life.

An important aspect shown in this investigation is that a change in physical activity (increase or decrease) is associated with disability. Low levels of physical activity caused by difficulties in performing daily activities may cause a vicious circle leading to further decline in strength and worsening of functional ability. Alternatively, increased physical activity, especially among older people, is associated with increased functional ability. This investigation shows that when individuals report a decline from moderate or much to little recreational physical activity, there is a corresponding increase in disability. Conversely, when individuals report an increase from little to moderate or much recreational physical activity, there also is a corresponding decrease in disability. Interestingly, moderate recreational physical activity appeared as equally protective of disability as much physical activity. This may be viewed as support for the view that the quantity and quality of exercise needed to attain health-related benefits may differ from what is recommended for fitness benefits because lower levels of physical activity than are recommended for increasing fitness may still reduce the risk for certain chronic degenerative diseases⁴¹ that may impact functional ability. Similarly, individuals who reported moderate or much physical activity at baseline and/or follow-up 1 were less likely to smoke, drink heavily, or report serious illness or chronic nonserious illness. Again, for these health-related variables, moderate was as protective as much physical activity.

There were some limitations to this study. Assessments of disability at baseline were not available; there was a small change in wording from baseline to follow-up for recreational activity; and assessment of physical activity was not available at follow-up 2. Like many other epidemiologic studies, self-reported recreational and nonrecreational physical activities were measured using only 3 categories.¹⁵⁻¹⁸ The imprecise measurement of recreational and nonrecreational physical activity may help explain the lack of an association between previous physical activity and disability at follow-up 2. Finally, cohort effects/differences must be considered as a limitation.

In summary, the relationship between disability and physical activity that has been established in older subjects also holds for the general population. Furthermore, changing from little to moderate or higher levels of physical activity is associated with reduced disability. To reap health benefits in physical function, however, these analyses reveal that the physical activity must be sustained.

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Figure 1. Disability Score for Subjects at Follow-up 1 Based on Their Reported Physical Activity Level at Baseline and Follow-up 1

Table 1
Characteristics of Participants at Baseline and Follow-up 1 of the NHANES1

	Baseline		Follow-up 1			
			Recreational Physical Activity			
	Little	Moderate	Much	Little	Moderate	Much
Men	N=1079	N=1280	N=764	N=634	N=1081	N=473
Age (yr)	51.6 ± 13.3	48.9 ± 14.1	46.1 ± 14.8	61.6 ± 13.4	59.0 ± 13.1	54.5 ± 13.0
BMI (kg.M ⁻²)	26.1 ± 4.71	25.8 ± 4.0	25.3 ± 3.9	26.3 ± 4.6	25.9 ± 4.0	25.6 ± 3.9
Nondrinker (%)	22	18	16	20	17	16
Heavy drinker (%)	20	18	21	18	19	18
Past smoker (%)	43	40	36	39	41	39
Current smoker (%)	56	51	54	52	51	49
Serious illness	0.2 ± 0.4	0.1 ± 0.4	0.1 ± 0.3	0.1 ± 0.3	0.1 ± 0.3	0.0 ± 0.2
Chronic illness	0.3 ± 0.5	0.2 ± 0.4	0.2 ± 0.4	0.3 ± 0.5	0.2 ± 0.4	0.2 ± 0.4
Disability				24.2 ± 7.3	21.7 ± 2.3	21.5 ± 1.7
Women	N=1658	N=1478	N=498	N=1039	N=1318	N=372
Age (yr)	50.4 ± 13.6	46.7 ± 14.2	46.1 ± 14.6	60.4 ± 13.3	56.7 ± 13.3	56.1 ± 13.1
BMI (kg.M ⁻²)	26.7 ± 6.4	25.0 ± 5.2	24.2 ± 4.8	26.9 ± 6.3	24.9 ± 5.1	23.7 ± 4.3
Nondrinker (%)	38	28	24	34	27	25
Heavy drinker (%)	4	5	5	4	4	5
Past smoker (%)	11	13	14	11	13	14
Current smoker (%)	33	33	33	34	31	33
Serious illness	0.2 ± 0.5	0.1 ± 0.4	0.1 ± 0.3	0.2 ± 0.4	0.1 ± 0.3	0.1 ± 0.3
Chronic illness	0.4 ± 0.5	0.3 ± 0.5	0.3 ± 0.5	0.4 ± 0.6	0.3 ± 0.5	0.2 ± 0.4
Disability				25.8 ± 8.7	22.4 ± 3.5	21.8 ± 2.4
Nonrecreational Physical Activity						
Men	N=329	N=1390	N=1405	N=356	N=1125	N=703
Age (yr)	50.7 ± 14.2	50.5 ± 14.3	47.5 ± 13.8	60.7 ± 14.0	60.5 ± 13.4	57.5 ± 12.3
BMI (kg.M ⁻²)	25.8 ± 5.2	25.9 ± 4.1	25.7 ± 4.0	26.0 ± 4.7	26.0 ± 4.1	25.9 ± 3.9

	Baseline			Follow-up 1		
	Recreational Physical Activity					
	Little	Moderate	Much	Little	Moderate	Much
Nondrinker (%)	19	19	19	19	17	18
Heavy drinker (%)	21	19	19	19	18	19
Past smoker (%)	44	43	37	41	41	38
Current smoker (%)	56	50	56	52	51	49
Serious illness	0.2 ± 0.5	0.2 ± 0.4	0.1 ± 0.3	0.1 ± 0.4	0.1 ± 0.3	0.1 ± 0.3
Chronic illness	0.3 ± 0.5	0.3 ± 0.5	0.2 ± 0.4	0.3 ± 0.5	0.2 ± 0.4	0.2 ± 0.4
Disability				25.3 ± 8.8	22.0 ± 3.1	21.5 ± 1.9
Women	N=383	N=1827	N=1424	N=446	N=1590	N=694
Age (yr)	50.8 ± 14.1	48.9 ± 14.4	46.9 ± 13.6	60.8 ± 14.5	58.9 ± 13.2	56.9 ± 12.5
BMI (kg.M ⁻²)	27.7 ± 7.6	25.8 ± 5.6	24.9 ± 5.3	27.3 ± 6.8	25.4 ± 5.4	24.5 ± 4.9
Nondrinker (%)	38	30	32	32	28	31
Heavy drinker (%)	5	5	4	6	5	3
Past smoker (%)	15	13	11	14	13	11
Current smoker (%)	38	33	31	32	32	33
Serious illness	0.3 ± 0.5	0.2 ± 0.4	0.1 ± 0.3	0.3 ± 0.5	0.1 ± 0.3	0.1 ± 0.3
Chronic illness	0.5 ± 0.6	0.4 ± 0.5	0.3 ± 0.5	0.5 ± 0.6	0.3 ± 0.5	0.3 ± 0.5
Disability				28.8 ± 11.0	22.8 ± 4.2	22.2 ± 3.5

Table 2
Tobit Estimates of Disability at Follow-up 1 and Follow-up 2 of the NHANES1:
Comparing Recreational Physical Activity

	Disability follow-up 1		Disability follow-up 2	
	Male	Female	Male	Female
Moderate activity baseline ^a	-1.802 ***	-2.708 ***	-0.163	-0.862
Much activity baseline ^a	-1.695 ***	-2.897 ***	-0.709	-1.068
Little baseline, moderate follow-up 1	-1.840 ***	-2.710 ***	-0.009	-0.862
Little baseline, much follow-up 1	-2.174 ***	-3.020 ***	0.591	-0.545
Moderate baseline, little follow-up 1	2.686 ***	1.870 ***	0.663	0.859
Moderate baseline, much follow-up 1	-0.001	-0.411	-0.366	-0.317
Much baseline, moderate follow-up 1	-0.014	0.276	0.046	1.307
Much baseline, little follow-up 1	1.422 **	3.285 ***	0.893	1.491
Age	0.026 **	0.086 ***	-0.000	0.024
BMI	0.022	0.045 *	-0.020	-0.017
Nondrinker	0.046	-0.496	0.523	-0.204
Heavy drinker	0.426	0.542	-0.791	-1.150
Past smoker	0.045	0.390	-0.059	-0.099
Current smoker	0.096	0.383	0.309	-0.070
Serious illness	1.573 ***	1.960 ***	0.156	0.446 *
Chronic illness	1.250 ***	1.871 ***	-0.313	0.692 *
Black	-0.601	-1.181 **	-0.046	1.206
Live alone	-0.057	0.279	0.469	0.923
Widow	0.043	0.309	-0.449	1.367 *
Education	-0.173 *	-0.101	-0.408 **	-0.295 *
Income	0.087	0.273 *	0.079	0.351
Occupational status	0.005	-0.002	-0.004	-0.009
Restricted activity	0.172	1.150 **	1.085	1.336 *
Disability in 1982	--	--	0.492 ***	0.541 ***
Mortality lambda	3.185 *	8.431 ***	0.860	5.563
Nonresponse lambda	3.758 *	2.955	-0.768	0.610
Constant	19.045	14.471	13.361	7.043
N	2167	2704	1788	2394
Log-likelihood	-6158.3	-8427.1	-5839.7	-8185.5

* = P<.01,

** = P<.001,

*** = P<.0001

Note.

^aReference group is little activity

Table 3
Tobit Estimates of Disability at Follow-up 1 and Follow-up 2 of the NHANES1:
Comparing Nonrecreational Physical Activity

	Disability follow-up 1		Disability follow-up 2	
	Male	Female	Male	Female
Moderate activity baseline ^a	-1.179	-2.267 *	-0.727	-1.520
Much activity baseline ^a	-1.721 **	-2.646 **	-1.406	-1.917
Little baseline, moderate follow-up 1	-1.226	-2.669 ***	-1.238	-1.041
Little baseline, much follow-up 1	-1.290	-3.931 ***	2.006	-0.982
Moderate baseline, little follow-up 1	3.525 ***	4.826 ***	0.481	2.068 ***
Moderate baseline, much follow-up 1	-0.778 *	-0.416	-0.500	-0.349
Much baseline, moderate follow-up 1	0.229	0.189	0.239	-0.041
Much baseline, little follow-up 1	3.517 ***	5.552 ***	1.892 *	-0.073
Age	0.029 **	0.080 ***	0.004	0.026
BMI	0.026	0.052 **	-0.010	-0.020
Nondrinker	-0.000	-0.327	0.528	-0.150
Heavy drinker	0.392	0.340	-0.813 *	-1.254
Past smoker	-0.068	0.264	-0.111	-0.184
Current smoker	0.008	0.469	0.298	-0.085
Serious illness	1.403 ***	1.711 ***	0.183	0.374
Chronic illness	1.161 ***	1.810 ***	-0.376	0.689 *
Black	-0.680	-1.113 **	-0.080	1.233 *
Live alone	0.005	0.029	0.489	0.957
Widow	-0.269	0.577	-0.633	1.416 *
Education	-0.252 ***	-0.150	-0.453 ***	-0.325 *
Income	0.061	0.202	0.051	0.282
Occupational status	-0.002	-0.006	-0.007	-0.011
Restricted activity	0.473	2.112 *	0.658	0.634
Disability in 1982	—	—	0.476 ***	0.532 ***
Mortality lambda	2.630 *	6.441 **	0.611	4.927
Nonresponse lambda	3.692 *	3.193	-0.853	-0.054
Constant	19.737	15.800	14.737	9.546
N	2164	2705	1787	2395
Log-likelihood	-6112.6	-8359.6	-5833.6	-8184.7

* = P<.01,

** = P<.001,

*** = P<.0001

Note.

^aReference group is little activity