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Self-reported Sleep Problems Prospectively Increase Risk of Disability: Findings from the Survey of Midlife Development in the United States (MIDUS)

Elliot M. Friedman, PhD¹

¹Department of Human Development and Family Studies, Purdue University, West Lafayette, IN

Abstract

Objectives—To determine whether subjective poor sleep prospectively increases functional limitations and incident disability in a national sample of adults living in the United States.

Design—Prospective cohort

Setting—Longitudinal Survey of Midlife Development in the United States (MIDUS)

Participants—Young, middle aged, and older men and women (age 24–75) surveyed in 1995–1996 (MIDUS 1) and followed up in 2004–2006 (MIDUS 2). Complete data were available for 3,620 respondents.

Measurements—Data were from telephone interviews and self-administered questionnaires. Participant reported chronic sleep problems within the prior month; functional limitations were assessed using the Functional Status Questionnaire. Demographic (age, sex, race), socioeconomic (educational attainment), health (chronic conditions, depression), and health behavior (obesity, smoking) covariates were assessed to reduce potential confounding.

Results—Approximately 11% of the sample reported chronic sleep problems at both MIDUS waves. Average numbers of basic and intermediate ADL limitations increased significantly between MIDUS 1 (basic: .06; intermediate: .95) and MIDUS 2 (basic: .15; intermediate: 1.6; $P < .001$). Adjusted regression models estimating change in ADL scores showed that chronic sleep problems at MIDUS 1 predicted significantly greater increases in both basic (incident rate ratio (IRR) = 1.55, $P < .001$) and intermediate (IRR = 1.28, $P < .001$) ADL limitations. In those with no functional limitations at baseline, logistic regression models showed that chronic sleep problems significantly increased the odds of incident basic (OR = 2.33, CI: 1.68, 3.24, $P < .001$) and intermediate (OR = 1.70, CI: 1.21, 2.42, $P < .01$) ADL disability.

Corresponding Author: Elliot M. Friedman, PhD, Department of Human Development and Family Studies, 1202 West State Street, West Lafayette, IN 47907, Ph: 765-496-6378, FAX: 765-496-1144, efriedman@purdue.edu.

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Conclusion—Reports of chronic sleep problems predicted greater risk of both onset of and increases in functional limitations 9–10 years later. Poor sleep may be a robust and independent risk factor for disability in adults of all ages.

Keywords

subjective sleep; ADLs; MIDUS; disability

INTRODUCTION

Disability rates in older adults have declined in recent years,^{1,2} due principally to medical and technological advances and to broad improvements in socioeconomic indicators, including poverty and educational attainment.³ Nonetheless, inability to perform daily activities remains common. Estimates from the National Health Interview Surveys and the National Long-Term Care Survey show that 15%–20% of adults over age 65 have at least one functional limitation.^{1,2} Further improvements in disability rates will largely rest on changes in lifestyle factors. Obesity⁴ and physical inactivity,⁵ for example, are robustly linked to increased risk of disability,^{1,6} and rates of both are high in aging adults; these factors threaten to slow or stall the downward trends in disability rates. Another lifestyle factor – sleep – has received relatively little attention as a predictor of disability, despite well-documented links between sleep problems and a range of adverse health outcomes, including mortality.^{7–10} This study examines the prospective associations between self-reported sleep problems and activities of daily living (ADL) in a national sample of middle-aged and older adults living in the United States.

Two lines of research converge on sleep as a compelling focus for understanding disability risk. First, sleep quality tends to decline with age. Objective assessments show significant age-related declines in sleep duration, sleep efficiency, rapid eye movement (REM), and stage 3/4 sleep coupled with significant increases in sleep latency and stage 1–2 sleep.¹¹ Subjective complaints of poor sleep also tend to increase with age.^{12,13} Second, both quantitative (e.g. number of hours slept per night) and qualitative (e.g. complaints of poor sleep) aspects of sleep are linked to morbidity and mortality in older adults.^{7,8,14} Subjective reports of impaired sleep, for example, significantly increased the risk of subsequent heart attack, stroke, and cardiac mortality in older men and women with primary acute myocardial infarction from the Stockholm Heart Epidemiology Program.¹⁴ A regional longitudinal study in Sweden found that sleep complaints at baseline predicted greater risk of coronary artery disease¹⁵ and diabetes¹⁶ in men 12 years later. Few studies have examined the prospective links between sleep complaints and disability. A recent study of 908 older Catholic clergy in the United States found that poor subjective sleep significantly increased risk of disability at follow-up 9.6 years later.¹⁷

The current study extends this earlier work by examining the prospective associations of sleep complaints and disability in a representative national sample of men and women in the US: the Survey of Mid-Life Development in the United States (MIDUS)¹⁸. We hypothesized that subjective report of sleep problems would increase the risk of both increases in functional limitations and incident disability in those with no functional impairments at

baseline. The MIDUS sample is community dwelling, making the results applicable to the general adult population of the US. The broad age range of the MIDUS sample, spanning 5 decades from mid-20s to mid-70s, also makes it possible to determine whether the links between poor sleep and functional impairment are limited to older adults or extend to mid-life and younger adults as well. Finally, while the main analyses in this study involve self-reported functional limitations, these are bolstered by supplemental analyses using objective assessments of functional status available for sub-samples of MIDUS participants.

METHODS

Participants

Data are from the first two waves of MIDUS, a longitudinal study of the physical and mental health of middle-aged and older adults.¹⁸ The first wave of data collection (MIDUS 1; N = 7,108) included a national probability sample of non-institutionalized English-speaking adults living in the contiguous United States recruited by random digit dialing (RDD; n = 3,487), a sample of monozygotic and dizygotic twin pairs from a national twin registry (n = 1,914), oversamples from five metropolitan areas (n = 757), and siblings of individuals from the RDD sample (n = 950). Respondents completed telephone interviews and self-administered questionnaires (SAQ). A follow-up study was completed 9–10 years later (MIDUS 2). Mortality-adjusted retention from the original study was 75%. Complete data for the present analyses were available for 3,620 participants. Compared to the full longitudinal sample, the analytical sample had fewer female respondents, was better educated, and had fewer functional limitations at baseline; they were comparable on all other key variables. Collection of data for both waves of MIDUS and analyses for the current study were approved by the Institutional Review Boards at the University of Wisconsin-Madison and Purdue University, respectively.

Measures

Sleep complaints were assessed using a single questionnaire item: “In the past 12 months, have you experienced or been treated for chronic sleeping problems?” A dichotomous variable was used in all models. Information on basic and intermediate activities of daily living came from the Functional Status Questionnaire.¹⁹ Respondents were asked how much health limited their ability to do a number of activities. Basic ADL limitations were determined from two items: “bathing or dressing yourself” and “walking one block.” Intermediate ADL limitations were determined from seven items: “lifting or carrying groceries,” “climbing several flights of stairs,” “bending, kneeling, or stooping,” “walking more than a mile,” “walking several blocks,” “vigorous activities (e.g., running, lifting heavy objects),” and “moderate activities (e.g., bowling, vacuuming).” Response ranged from 1=Not at all to 4=A lot. To determine the number of activities for which respondents reported at least some degree of limitation, responses of “Some” or “A lot” of limitation were scored ‘1’ and other responses ‘0.’ Responses were then summed into separate scores for basic and intermediate ADLs with possible scores of 0–2 for basic and 0–7 for intermediate scales. Total scores at both MIDUS 1 and MIDUS 2 were calculated and used to examine changes in numbers of functional limitations over time. Dichotomous variables

for presence or absence of any limitations were also created for logistic regression models estimating incident functional limitations between MIDUS 1 and MIDUS 2.

A set of demographic, socioeconomic, health, and health behavior covariates was included in all models to reduce the likelihood of confounding. These included age, sex, race, and educational attainment (dummy coded variables for high school degree or GED, some college, and college degree or more).

To assess health, a variable for 12 chronic medical conditions was used in all analyses. Information on 9 of these conditions came from participant responses to self-administered questionnaire items; participants were asked whether they had experienced or received treatment for any of the following conditions in the prior 12 months: chronic obstructive pulmonary disease (COPD), arthritis or other joint conditions, AIDS, hypertension, diabetes, tuberculosis, neurological disorders, stroke, ulcer. Presence of heart problems and cancer were determined from single items in the telephone interview. Participants were asked whether they had had heart trouble suspected or confirmed by a doctor and whether they had ever had cancer. Possible scores ranged from 0–12.

Variables for obesity and smoking were included to control for health behaviors. Body mass index (BMI) was calculated from participant measurement of height and weight and dummy coded variables for normal weight (BMI<24.99), overweight (BMI between 25.00 and 29.99) and obese (BMI≥30.00) were created. Smoking status was assessed using dummy-coded variables indicating non-smoker, ex-smoker, and current smoker.

Finally, as depressed individuals are more likely to report both poor sleep²⁰ and greater functional impairment,²¹ likely depression was determined using the short form of the Composite International Diagnostic Interview (CIDI).²² Respondents were scored as positive for depressed affect if they indicated 1) that they felt sad, blue, or depressed and that “The feeling of being sad, blue, or depressed lasted ‘All day long’ or ‘Most of the day’ and 2) that they felt this way “Everyday” or “Almost every day.” They were scored as positive for anhedonia if they reported a loss of interest in most things lasting “All day long” or “Most of the day” and that this feeling was “Everyday” or “Almost every day.” A dichotomous variable indicating likely clinical depression (i.e. positive scores for both depressed affect and anhedonia) was included in all models.

Statistical analyses

Longitudinal increases in ADL limitations were estimated in separate Poisson regression models. Poisson modeling was appropriate because the outcome measures (numbers of limitations) were counts rather than continuous variables. Incident rate ratios (IRR) comparing the rate of functional limitations in respondents with sleep problems to those without were determined; these are interpreted in a similar fashion as odds ratios. All models adjusted for age, sex, race, educational attainment, and functional limitations at MIDUS 1. To control for the possible influences of coincident illness, obesity, and depressive symptoms on functional abilities, MIDUS 2 measures of number of chronic medical conditions, smoking status, BMI, and depression were included in all models. Poisson models used data from the full longitudinal sample.

Binary logistic regression models were used to estimate the odds of incident basic and intermediate ADL disability between MIDUS 1 and MIDUS 2, adjusted for covariates. In these models, the analytical samples were limited to respondents with no functional limitations at MIDUS 1 ($n = 3,244$ for basic ADLs, and $n=1,329$ for intermediate ADLs). Models were estimated using Stata 13.0 (Statacorp., College Station, TX).

Given age-related changes in both sleep complaints and disability risk, and to determine whether the associations between sleep and ADL limitations varied with age, we conducted additional analyses that included interaction terms for sleep problems and age as predictors of longitudinal changes in ADL and incident ADL impairments.

Clustered robust standard errors were applied to account for familial relatedness among the twins and siblings in the sample. A threshold for statistical significance was set at $\alpha = 0.05$ in all models.

RESULTS

Descriptive statistics for the full analytical sample are shown in Table 1. Sociodemographic characteristics are from MIDUS 1. Mean age was 46.5 years, slightly more than half the sample was female, 6.3% were non-White, and 35.9% had completed a 4-year college degree or more. Data on other variables were from both MIDUS 1 and MIDUS 2. Between the two data collection points the average number of basic (MIDUS 1 = 0.06; MIDUS 2 = 0.15; $t(3,619)=-12.2$, $p<.001$) and intermediate ADL limitations (MIDUS 1 = 0.95; MIDUS 2 = 1.61; $t(3,619)=-20.2$, $p<.001$) rose significantly while the fraction of the sample reporting sleep problems did not change significantly (MIDUS 1 = 11.3; MIDUS 2 = 10.7; $\chi^2=0.91$, $p=0.33$). Of those who reported sleep problems at MIDUS 1, 38.9% continued to report sleep problems at MIDUS 2 (data not shown). The fraction of people who met criteria for depression on the CIDI-SF declined significantly between MIDUS 1 (12.0 %) and MIDUS 2 (10.1%; $\chi^2=10.32$, $p=.001$), and average number of chronic conditions increased significantly between MIDUS 1 and MIDUS 2 ($t(3,619)=28.89$, $p<.001$).

Poisson regression models were used to estimate the increase in basic and intermediate ADL limitations associated with reporting poor sleep at MIDUS 1 adjusted for MIDUS 1 sociodemographic characteristics and initial levels of functional limitations and MIDUS 2 health, health behavior, and depression. As shown in Table 2, reporting chronic sleep problems at MIDUS 1 was associated with significantly increased rates of both basic and intermediate ADL limitations. Compared to those without sleep complaints, respondents who reported chronic sleep problems in the prior year showed a 55% increase in basic ($p<.001$) and a 28% increase in intermediate ADL limitations ($p<.001$). Greater risk of increases in functional impairments was also associated with greater age, being female, being White (intermediate ADLs only), not having completed a 4-year college degree or more, greater numbers of chronic medical conditions, obesity, higher scores on the CIDI depression scale, and smoking either currently or in the past.

The likelihood of incident disability between MIDUS 1 and MIDUS 2 was estimated using logistic regression models; analytical samples were limited to those respondents without

ADL limitations at MIDUS 1. As shown in Table 3, compared to those with no sleep complaints, respondents who reported chronic sleep problems at MIDUS 1 were more than twice as likely to develop basic ADL limitations ($p<.001$) and 70% more likely to develop intermediate ADL limitations ($p<.05$). Age, being female, low educational attainment, being overweight or obese, more chronic conditions, depression, and smoking were all associated with likelihood of incident functional limitations at MIDUS 2.

Analyses that included age X sleep problems interaction terms showed that age significantly moderated the association of MIDUS 1 sleep problems and longitudinal increases in intermediate ADL limitations. Specifically, the rate of increases in limitations among younger and middle-aged adults (e.g. 45 year-olds) who reported sleep problems (increase of 1.04 limitations) was double that of peers with no sleep complaints (2.13 increase; interaction effect: $IRR = 0.98$, $p<.001$). This interaction is displayed in Figure 1. Age did not moderate the association between sleep problems and change in basic ADL limitations.

Analytical refinements

We probed these results in four ways to rule out potential alternative explanations of the observed associations.

First, 39% of full analytical sample reported chronic sleep problems at both MIDUS 1 and MIDUS 2. It is possible that the observed longitudinal associations for sleep complaints are accounted for by coincident poor sleep and functional limitations at MIDUS 2. To test this possibility, all regression models were re-estimated with an additional adjustment for sleep complaints at MIDUS 2. Inclusion of MIDUS 2 sleep complaints slightly reduced the coefficients for MIDUS 1 sleep complaints, but the associations remained robust ($p<.001$ in both basic and intermediate ADL models). In the logistic regression models, the likelihood that someone with chronic sleep problems would develop basic ADL limitations at MIDUS 2 declined from 133% that of someone without sleep complaints to 78%, but the effect remained statistically significant ($p=.001$). For intermediate ADL limitations, the odds declined from 79% to 69% and became marginally significant ($p=.05$). In all of these analyses, the coefficients and odds ratios associated with sleep problems at MIDUS 1 were consistently larger than those associated with sleep problems at MIDUS 2 (data not shown).

Second, as sleep complaints were assessed using a single item that was subjective and global in nature, we compared these responses to scores on a widely used measure of sleep quality, the Pittsburgh Sleep Quality Index²³ (PSQI; this measure was only used in a sub-sample of MIDUS 2 respondents ($n = 1,063$), so it was unavailable for longitudinal analyses). The PSQI is a 24-item scale assessing 7 different sleep components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Compared to respondents without sleep problems, those who reported sleep problems at MIDUS 2 had significantly higher scores on the PSQI ($M = 9.47$ vs. 5.47 , $t(997) = 153.81$, $p<.001$), indicating significantly poorer sleep quality.

Third, use of sleep medication in the context of sleep complaints may contribute to functional limitations. The only variable available at MIDUS 1 referred to the use of sedatives without a doctor's prescription; 105 MIDUS 1 respondents (2.3% of the sample)

reported taking such medication, and inclusion of this variable in longitudinal models did not affect the relationship between MIDUS 1 sleep problems and MIDUS 2 functional limitations (data not shown). MIDUS 2 data, in contrast, included a specific question about the use of sleeping pills as part of the PSQI. To gauge the association of sleep medication use and ADLs cross-sectionally at MIDUS 2, we regressed numbers of basic and intermediate ADL limitations (separate models) on the 7 individual PSQI components, adjusted for age, sex, race, and education. The results showed that only the sleep disturbance (assessing trouble sleeping) and daytime dysfunction (assessing sleepiness during waking hours) components were associated with ADL limitations ($p < .001$ for both); use of sleep medication was not independently associated with either type of ADL (data not shown).

Finally, sleep problems and functional limitations were both assessed using self-report measures, raising the possibility that unobserved subjective factors may underlie both sets of ratings. To probe this issue, we examined an objective measure of functional status – a 50 foot timed walk – and potential longitudinal effects of sleep complaints; walk time was measured in a sub-sample of MIDUS 2 respondents ($n = 1,063$). Linear regression models predicting walk time adjusted for sociodemographic, health, and health behavior covariates showed that on average respondents who reported chronic sleep problems at MIDUS 1 took more than 1 second longer to walk 50 feet than those who slept better (15.4 vs. 14.2 sec; $p < .05$); this association remained significant after adjusting for sleep problems at MIDUS 2 ($p < .05$).

DISCUSSION

The prospect of disability is a signature concern among aging adults, and as the population ages a better understanding of the causes of disability is increasingly important for individual health and quality of life as well as policies designed to improve overall population health. These analyses focused on subjectively poor sleep as a potential risk factor for disability. Reports of chronic sleep problems were associated with increases in basic and intermediate ADL limitations and with significantly greater odds of developing functional limitations at follow-up. In the case of basic ADL limitations, reporting poor sleep more than doubled the risk of incident disability. These associations were observed after accounting for a set of established disability risk factors, including advancing age, low educational attainment, chronic medical conditions, obesity, depression, and smoking. Moreover, with the exception of cross-time increases in intermediate ADL limitations, the relationship between sleep problems and disability did not vary with age (and for intermediate ADLs, differences based on sleep problems were more evident among younger and middle aged adults than older adults). Collectively, these results suggest that poor subjective sleep is a robust and independent risk factor for functional limitations, and that this risk is not limited to later life.

Impaired or insufficient sleep has been linked to a variety of diseases and associated risk factors. Population-based studies have consistently shown that routine sleep duration that is shorter or longer than the optimal amount (typically 7 hours a night) predicts greater risk of mortality.^{8–10,24} Objectively assessed low sleep quality, often associated with disruptions due to sleep-disordered breathing, increases the risk of hypertension, diabetes,

cardiovascular disease, stroke, disability, and mortality.^{25–28} Subjective sleep ratings have also been linked to a range of adverse health outcomes, including diabetes, cardiovascular disease, and cardiac mortality.^{14–16} In spite of these associations, relatively few studies have focused on disability risk associated with poor sleep, and fewer still have involved representative population samples. Regional studies in Italy²⁹ and China³⁰ have linked low subjective sleep quality to greater risk of disability, and a recent study in the US reported greater risk of incident disability in members of the clergy who reported sleep problems.¹⁷ The current study of a larger, community-based, nationally representative sample with a broader age range now adds robust support to the conclusion that poor sleep is an independent risk factor for disability in aging adults.

Poor sleep may lead to impaired function by way of a number of paths. Physical activity, for example, is protective against functional decline in aging men and women. Subjective reports of poor sleep are linked to fatigue³¹ that is often sufficient to limit daily activities in older adults.³² Physical activity in adults who sleep poorly may thus be reduced to levels that increase risk of functional limitations. Poor sleep is also linked to dysregulation of diverse physiological systems. For example, studies using both objective and subjective assessments show that naturally occurring poor sleep is associated with higher circulating levels of inflammatory proteins.^{33–37} In parallel experimental studies, sleep restriction reliably produces elevated levels of inflammation both acutely and chronically.^{38–41} Inflammation in turn is linked prospectively with increased risk of disability,⁴² and experimental studies highlight a role for inflammatory proteins in the loss of muscle tissue that can result in sarcopenia^{43,44} and associated functional limitations. Poor sleep has also been shown to increase risk of obesity prospectively,^{36,45,46} and obesity increases risk of disability.⁶ There are thus multiple behavioral and physiological routes by which sleep may be linked to subsequent disability risk, although specific mechanisms have yet to be elucidated.

This study has several important limitations. Principally, sleep problems and functional limitations were both reported by MIDUS respondents rather than assessed using objective measures. This leaves open the possibility that their associations are explained by one or more unmeasured variables that capture a common subjective dimension. A number of observations from the current study make this possibility less likely. In the sub-sample of respondents who completed an objective assessment of functional status – the timed walk – those who reported sleep problems 9–10 years earlier were significantly slower, independent of current sleep problems. Moreover, sleep problems were claimed by many MIDUS 1 respondents who reported no functional limitations, suggesting some independence between these measures, and those who did report sleep problems were twice as likely to develop substantial limitations in the intervening years. Finally, those who reported sleep problems had an average score on the PSQI, a widely used measure of sleep and sleep pathology, that was almost double that of people who reported none. All of these observations increase confidence that the observed links between sleep problems and functional status are not spurious. Another issue worth noting is that subjective reports of poor sleep often do not match the results of objective sleep assessments.^{13,47,48} Nonetheless, subjective complaints of poor sleep are meaningfully linked to health outcomes independently of objectively determined sleep patterns,⁴⁹ the implication being that subjective and objective assessments

capture unique aspects of sleep that are both important for understanding how sleep affects health.

Against these limitations are substantial strengths, including a large, nationally representative sample, a large time difference between the waves of data collections for assessing long-term change, and the availability of data with which to control for confounding and to probe for alternative explanations. The current results suggest that subjective reports of poor sleep significantly increase disability risk independently of demographic characteristics, socioeconomic status, health, or health behavior, and that such risk extends to middle-aged men and women as well as older adults. These results add to a growing literature citing the importance of sleep to good health and the resulting need for effective ways to promote good sleep in the general population.⁵⁰

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Figure 1.

Age X sleep problems interaction predicting longitudinal change in intermediate ADLs. Sleep problems were more likely to produce greater increases in intermediate ADL limitations among younger and middle-aged adults (<65 years old) than among older adults.

Table 1

Descriptive statistics for longitudinal sample (N = 3,620).

Variable	MIDUS 1 (1995–1996)			MIDUS 2 (2004–2006)		
	Mean (SD)	Range	%	Mean (SD)	Range	%
Age	46.5 (12.5)	20–75	--	--	--	--
Sex (% female)			55.2	--	--	--
Race (% non-White)			6.3	--	--	--
Educational attainment						
High school or GED			35.0	--	--	--
Some college			29.1	--	--	--
College or more			35.9	--	--	--
BADLs						
Number of limitations	0.06 (0.3)	0–2		0.15 (0.4)	0–2	
% with 1 or more BADLs			5.01			12.18
IADLs						
Number of limitations	0.95 (1.8)	0–7		1.61 (2.2)	0–7	
% with 1 or more IADLs			35.53			48.94
CIDI-SF depression (% Positive)			12.0			10.1
Chronic conditions	0.8 (1.1)	0–8		1.4 (1.5)	0–10	
BMI categories						
<25.00 (Normal weight)			41.4			32.3
25.00–29.99 (Overweight)			37.6			39.4
≥30.00 (Obese)			21.0			28.3
Smoking status						
Current smoker			25.2			19.5
Ex-smoker			40.7			48.9
Never smoked			34.1			31.6
Sleep problems (% yes)			11.3			10.7

Table 2

Basic and Intermediate ADL limitations at MIDUS 2 regressed on MIDUS 1 sleep problems, functional limitations, and covariates (N = 3,620). Estimates were from Poisson regression models, and incident rate ratios (IRR) are shown for ease of interpretation.

Variable	Basic ADLs		Intermediate ADLs	
	IRR	[95% CI]	IRR	[95% CI]
Age	1.03 ***	[1.02,1.04]	1.02 ***	[1.02,1.03]
Sex (female=1)	1.30 ***	[1.08,1.56]	1.29 ***	[0.07,0.15]
Race (non-White=1)	0.88	[0.64,1.21]	0.85 **	[0.76,0.94]
Educational attainment				
High school or GED	1.90 ***	[1.50,2.41]	1.30 ***	[1.22,1.39]
Some college	1.42 **	[1.10,1.85]	1.10 *	[1.02,1.18]
College or more	REF.		REF.	
ADLs at wave 1	1.88 ***	[1.62,2.19]	1.16 ***	[1.14,1.17]
Chronic conditions (MIDUS 2)	1.30 ***	[1.24,1.37]	1.17 ***	[1.15,1.19]
BMI categories (MIDUS 2)				
<25.00 (Normal weight)	REF.		REF.	
25.00–29.99 (Overweight)	1.13	[0.89,1.44]	1.12 **	[1.04,1.20]
>=30 (Obese)	1.80 ***	[1.42,2.28]	1.52 ***	[1.42,1.63]
CIDI-SF depression (MIDUS 2)	1.42 **	[1.12,1.79]	1.19 ***	[1.10,1.28]
Smoking status (MIDUS 2)				
Never smoked	REF.		REF.	
Ex-smoker	1.26 *	[1.04,1.53]	1.11 ***	[1.05,1.18]
Current smoker	1.52 **	[1.19,1.94]	1.41 ***	[1.31,1.52]
Sleep problems (MIDUS 1)	1.55 ***	[1.26,1.90]	1.28 ***	[1.20,1.37]

*
p<.05;

**
p<.01;

p<.001

Table 3

Logistic regression models predicting functional limitations at MIDUS 2. Odds ratios and 95% confidence intervals are shown. Basic and Intermediate ADL limitations were estimated in separate models. Only cases with no limitations at MIDUS 1 were included.

Variable	Basic ADLs (n = 3,244)		Intermediate ADLs (n = 1,329)	
	Odds Ratio	[95% CI]	Odds Ratio	[95% CI]
Age	1.04 ***	[1.03,1.05]	1.04 ***	[1.03,1.05]
Sex (female=1)	1.73 ***	[1.32,2.27]	1.49 ***	[1.22,1.82]
Race (non-White=1)	0.82	[0.46,1.46]	0.90	[0.61,1.35]
Educational attainment				
High school or GED	2.29 ***	[1.64,2.46]	1.39 **	[1.10,1.76]
Some college	1.55 *	[1.09,2.22]	1.21	[0.96,1.53]
College or more	REF.		REF.	
Chronic conditions (MIDUS 2)	1.54 ***	[1.40,1.69]	1.40 ***	[1.29,1.52]
BMI categories (MIDUS 2)				
<25.00 (Normal weight)	REF.		REF.	
25.00–29.99 (Overweight)	1.42 *	[1.01,1.99]	1.38 **	[1.11,1.73]
>=30.00 (Obese)	2.81 ***	[1.99,3.97]	2.32 ***	[1.78,3.02]
Depression (MIDUS 2)	1.42 #	[0.97,2.08]	1.82 **	[1.30,2.57]
Smoking status (MIDUS 2)				
Never smoked	REF.		REF.	
Ex-smoker	1.55 **	[1.17,2.06]	1.01	[0.82,1.25]
Current smoker	2.14 ***	[1.49,3.08]	2.26 ***	[1.69,3.01]
Sleep problems (MIDUS 1)	2.33 ***	[1.68,3.24]	1.70 **	[1.21,2.42]

p=.07;

*
p<.05;

**
p<.01;

p<.001