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BRIEF REPORT

Feeling Older and Risk of Hospitalization: Evidence From Three Longitudinal Cohorts

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Objective: Subjective age is a biopsychosocial marker of aging with a range of health-related implications. Using 3 longitudinal samples, this study examined whether subjective age predicts hospitalization among older adults. ***Method:*** Participants were adults aged from 24 to 102 years old, drawn from the 1995–1996 and 2004–2005 waves of the Midlife in the United States Survey (MIDUS, $N = 3209$), the 2008 and 2012 waves of the Health and Retirement Study (HRS, $N = 3779$), and the 2011 and 2013 waves of the National Health and Aging Trends Study (NHATS, $N = 3418$). In each sample, subjective age and covariates were assessed at baseline and hospitalization was assessed at follow-up. ***Results:*** Consistent across the 3 samples, participants who felt subjectively older at baseline had an increased likelihood of hospitalization (combined effect size: 1.17, 95% CI 1.11–1.23), controlling for age, sex, race, and education. Further adjusting for disease burden and depression reduced the magnitude of the association between subjective age and hospitalization in the 3 samples, but it remained significant in the MIDUS and HRS. ***Conclusion:*** This study provides consistent evidence that subjective age predicts incident hospitalization. Subjective age assessment can help identify individuals at greater risk of hospitalization, who may benefit from prevention and intervention efforts.

Keywords: depressive symptoms, disease burden, hospitalization, subjective age

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Hospitalization in old age is a significant life event with a range of adverse outcomes. Hospitalization accelerates disability in activities of daily living and declines in function (Zisberg, Shadmi, Gur-Yaish, Tonkikh, & Sinoff, 2015) as well as cognition (Wilson et al., 2012). Such hospitalization-related declines could lead to rehospitalization (Jencks, Williams, & Coleman, 2009), precipitate nursing home placement (Goodwin, Howrey, Zhang, & Kuo, 2011), and culminate in higher mortality risk (Sleiman et al., 2009). Therefore, beyond poor health, identifying the factors that contribute to older adults' risk of hospitalization is critical to prevent these adverse consequences and the substantial cost of health care service utilization. The present study examined whether individuals' subjective age, which refers to how old or young they feel relative to their chronological age, could be one risk factor for hospitalization.

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Subjective age is a novel biopsychosocial marker of aging that is associated with a range of health-related outcomes, independent of chronological age. Specifically, feeling older than one's age is related to increased risk of depression (Choi & DiNitto, 2014), higher disease burden (Demakakos, Gjonca, & Nazroo, 2007), systemic inflammation (Stephan, Sutin, & Terracciano, 2015a), and faster cognitive decline (Stephan, Sutin, Caudroit, & Terracciano, in press). In addition, an older subjective age has been related to premature mortality (Kotter-Grühn, Kleinspehn-Ammerlahn, Gerstorf, & Smith, 2009). Furthermore, subjective age is sensitive to the biological aging of critical body systems that are involved in health and functioning (Stephan, Sutin, & Terracciano, 2015b). In particular, markers of better muscular and pulmonary function, and lower adiposity are reflected in a younger subjective age (Stephan et al., 2015b). Therefore, subjective age shows promise as an indicator of individuals at risk for worsening health leading to hospitalization. However, despite existing evidence for the health-related outcomes of subjective age, no study has yet tested whether it contributes to risk of hospitalization.

Using data from three large longitudinal cohorts that differed in age and time of assessment, the present study tested the hypothesis that an older subjective age is prospectively associated with an increased risk of incident hospitalization. In addition, the study tested the extent to which chronic conditions and depressive symptoms accounted for this association.

Method

Participants

Participants were drawn from the Midlife in the United States Survey (MIDUS), the Health and Retirement Study (HRS), and the National Health and Aging Trends Study (NHATS). All participants provided informed consent for participation. The analytic sample included individuals who provided complete data on the variables of interest at baseline and follow-up. At baseline, individuals with a recent history of hospitalization, that is in the past 12 months for the MIDUS ($N = 359$) and the NHATS ($N = 919$), and the last two years in the HRS ($N = 1,281$), were excluded from the primary analyses.

The MIDUS is a national survey of noninstitutionalized English-speaking adults. The MIDUS I study was supported by the John D. and Catherine T. MacArthur Foundation Research Network on Successful Midlife Development, and the MIDUS II was supported by a grant from the National Institute on Aging (P01-AG020166). The first (1995–1996, MIDUS I) and the second (2004–2005) waves were used in the present study. The MIDUS survey complied with institutional review board standards of the University of Wisconsin and of the Harvard Medical School. Data from 3209 participants aged from 24 to 75 years (46% male, Mean age = 47.22, $SD = 12.22$) were analyzed. The HRS is a nationally representative longitudinal study of Americans aged 50 and older and their spouses. The HRS is sponsored by the National Institute of Aging (Grant No. NIA U01AG009740) and conducted by the University of Michigan. Data from the 2008 and 2012 waves were used, leaving a sample of 3779 participants with complete data (39% male, mean age = 67.63, $SD = 9.05$, age range = 50–96 years). The NHATS is a nationally representative prospective cohort study of Medicare enrollees aged 65 years and older. NHATS is funded by the National Institute on Aging (NIA-U01AG032947) and conducted by the Johns Hopkins Bloomberg School of Public Health. For the present study, data from the 2011 and 2013 waves were analyzed. Complete data were obtained from 3418 participants (42% male, mean age = 76.47, $SD = 7.36$, age range = 65–102 years). Attrition analyses for the three samples are reported in online supplemental material.

Measures

Subjective age. In the three samples, participants were asked to specify, in years, how old they felt. Consistent with previous research (Stephan et al., 2015), proportional discrepancy scores were calculated by subtracting chronological age from felt age, divided by chronological age. A positive value indicated an older subjective age. Responses three standard deviations above or below the mean were considered outliers and were excluded (Stephan et al., 2015). Based on this criteria 40 participants from MIDUS, 64 from HRS, and 51 from NHATS were excluded.

Hospitalization. At follow-up, MIDUS participants were asked how many times they had been hospitalized overnight in the last 12 months. The number of hospitalization was converted to a dichotomous variable of hospitalized versus not hospitalized. HRS and NHATS participants were asked whether they had an overnight hospital stay (yes/no) in the last two years and 12 months, respectively.

Covariates. In line with existing research on the prediction of hospitalization (Wilson et al., 2014), age (in years), sex (coded as 1 for men and 0 for women), race (coded as 1 for white and 0 for other), and educational level were included as demographic covariates given their association with the risk of hospitalization. Educational level was reported in years in the HRS. In MIDUS, education was reported on a scale composed of 12 intervals corresponding to sequential educational milestones, ranging from 1 (*no grade school*) to 12 (*doctoral level degree*). In the NHATS, the scale ranged from 1 (*No schooling completed*) to 9 (*Master's, professional or doctoral degree*). In addition, disease burden and depression were included to examine whether poor physical and psychological health could account for the association between subjective age and hospitalization. In the three samples, the sum of diagnosed conditions (i.e., high blood pressure, diabetes, cancer, lung disease, heart condition, stroke, osteoporosis or arthritis) was computed to obtain a measure of disease burden. Depressive symptoms were assessed with the Composite International Diagnostic Interview Short Form scales (CIDI-SF; score ranging from 0 to 7; Kessler, Andrews, Mroczek, Ustun, & Wittchen, 1998) in the MIDUS, an 8-item version of the Centers for Epidemiologic Research Depression (CES-D; score ranging from 0 to 8; Wallace et al., 2000) in the HRS, and the Patient Health Questionnaire-2 (PHQ-2; score ranging from 1 to 4; Kroenke, Spitzer, & Williams, 2003) in the NHATS.

Data Analysis

In each sample, logistic regressions were used to examine the association between subjective age at baseline and risk of hospitalization at follow-up. The baseline model tested the association between subjective age and hospitalization, controlling for age, sex, education, and ethnicity. In the second model, depressive symptoms and disease burden were added. The odds ratios from the three samples were combined using a random model meta-analysis with the comprehensive meta-analysis software.

Results

Descriptive statistics for the three samples, including the rate of hospitalization at follow-up, are presented in Table 1. Supplemen-

Table 1
Baseline Characteristics of the Samples

	MIDUS		HRS		NHATS	
Variable	*M*/%	*SD*	*M*/%	*SD*	*M*/%	*SD*
Age (years)	47.22	12.22	67.63	9.05	76.47	7.36
Sex (% male)	46%	—	39%	—	42%	—
Race (% white)	94%	—	85%	—	77%	—
Education	7.24	2.47	12.87	3.00	5.34	2.25
Subjective age	−.16	.15	−.17	.15	−.17	.16
Depressive symptoms	.63	1.73	1.13	1.75	1.41	.62
Disease burden	2.18	2.22	1.76	1.20	2.32	1.47
Hospitalization (% hospitalized)	13%	—	24%	—	22%	—

Note. MIDUS: $N = 3209$; HRS: $N = 3779$; NHATS: $N = 3418$. Education, depression, disease burden, and hospitalization were assessed using different methods in the three samples (see Method).

Table 2
Logistic Regression Predicting Follow-Up Hospitalization From Baseline Subjective Age

	MIDUS		HRS		NHATS	
Predictor	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)
Age	1.04 (1.03–1.05)***	1.04 (1.03–1.05)***	1.04 (1.03–1.05)***	1.04 (1.03–1.05)***	1.03 (1.01–1.04)***	1.02 (1.01–1.04)***
Sex	.99 (.80–1.21)	1.05 (.85–1.31)	1.14 (.98–1.33)	1.15 (.98–1.35)	1.09 (.92–1.29)	1.18 (.99–1.40)
Race	.72 (.48–1.08)	.74 (.49–1.12)	1.08 (.87–1.35)	1.16 (.93–1.46)	.84 (.70–1.03)	.88 (.72–1.07)
Education	.87 (.78–.97)**	.89 (.80–.99)*	1.00 (.97–.1.02)	1.01 (.98–1.04)	.87 (.80–.95)**	.91 (.84–1.00)*
Subjective age	1.24 (1.12–1.39)***	1.19 (1.06–1.33)**	1.17 (1.08–1.26)***	1.11 (1.02–1.20)*	1.12 (1.03–1.21)*	1.05 (.96–1.14)
Depression		1.08 (.98–1.20)		1.09 (1.01–1.18)*		1.15 (1.06–1.24)**
Disease burden		1.09 (1.05–1.14)***		1.28 (1.20–1.37)***		1.21 (1.14–1.28)***

Note. MIDUS: $N = 3209$; HRS: $N = 3779$; NHATS: $N = 3418$.
* $p < .05$. ** $p < .01$. *** $p < .001$.

tal analysis revealed that prior experience of hospitalization was associated with an older subjective age at baseline in the MIDUS and the HRS but not in the NHATS (supplemental Table 1). In the three samples, participants who felt subjectively older at baseline had an increased likelihood of hospitalization, controlling for demographic covariates (see Table 2). Overall, the results suggested that for every standard deviation increase in an older subjective age (e.g., an increased tendency to feel older than one's age) at baseline, the risk of future hospitalization increased by 10% (NHATS) to almost 25% (MIDUS). A random effect meta-analysis of the three samples produced a combined effect size of 1.17 (95% CI: 1.11–1.23), with little variation across samples ($Q = 2.30$, $p = .32$, $I^2 = 13$). The analyses were repeated without excluding individuals with recent hospitalizations at baseline, and revealed that the association between subjective age and future hospitalization persisted when controlling for prior hospitalization (supplemental Table 2). Adjusting for disease burden and depression reduced the magnitude of the association between subjective age and hospitalization in the three samples (see Table 2), but it remained significant in the MIDUS, the HRS, and the three samples combined (1.11, 95% CI: 1.04–1.18; $Q = 3.01$, $p = .22$, $I^2 = 33$).

Discussion

Using three large longitudinal cohorts of older adults, the present study tested whether subjective age is associated with hospitalization. As expected, the results revealed that an older subjective age predicted higher risk of incident hospitalization, independent of chronological age and other demographic factors. This association was consistent across the three samples and different time periods.

This study provides novel evidence that subjective age is a risk factor for hospitalization. The health and psychological correlates of subjective age may explain this association. Indeed, an older subjective age is predictive of worse physical and mental health (Choi & DiNitto, 2014; Demakakos et al., 2007), which may necessitate health service use. Additional analysis confirmed this assumption and revealed that disease burden and depressive symptoms accounted for part of the association between subjective age and hospitalization. Disease burden and depressive symptoms had a noticeable impact especially in the NHATS sample, which was the oldest of the three samples. There could also be other biological pathways, in addition to diagnosed diseases, that explain this association. The higher inflammation associated with feeling older (Stephan et al., 2015a) increases vulnerability to acute conditions that require hospitalization. Subjective age is also sensitive to nonpathophysiological processes indicative of muscular, pulmonary, and metabolic functions (Stephan et al., 2015b) that are likely to convert to illness and health service use over time. Cognitive processes are also likely to operate. An older subjective age, for example, is associated with lower cognition and steeper cognitive decline (Stephan et al., 2015), which have recently been related to an increased rate of hospitalization (Wilson et al., 2014). Finally, individuals who feel older than their age are more likely to be sedentary (Stephan et al., 2015), which may amplify the risk of developing or worsening chronic conditions leading to hospital stay.

Taken as a whole, this study suggests that subjective age, with demographic, cognitive, behavioral, and health-related factors, could be a valuable tool to help identify individuals at risk of future hospitalization. Individuals with an older subjective age may benefit from standard interventions, for example through physical activity and exercise programs, which may reduce their risk of depression and chronic disease, and ultimately their hospitalization risk. In addition, such programs may also directly target subjective age. Indeed, it is likely that exercise and physical activity may promote a younger subjective age, by fostering its determinants such as respiratory and muscular functions, self-rated health, and positive affect (Stephan et al., 2015b). Successful activity programs may also challenge negative aging stereotypes and promote positive attitudes toward aging and youthful self-perceptions. Future research could test whether programs that promote a more active lifestyle have an impact on subjective age and ultimately on hospitalization risk.

The current study had several limitations that should be considered when interpreting the results. In the three samples, hospitalization was self-reported. Hospitalization is a significant event that should be recalled with some accuracy, but self-report biases are still possible. Future research is needed to replicate the present findings using Medicare claims among those aged 65 years and older. In addition, this study focused only on the predictive role of subjective age on hospitalization. Supplemental analyses did suggest that hospitalization may lead individuals to feel older; further research is needed to identify the reciprocal relations between

subjective age and hospitalization over time. Despite these limitations, this study provides new evidence that subjective age, a biopsychosocial marker of aging, is a consistent predictor of hospitalization across three large national samples of middle age and older adults.

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