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Original Research Report

Feeling Older and the Development of Cognitive Impairment and Dementia

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Abstract

Objective: Subjective age is a biopsychosocial marker of aging associated with a range of outcomes in old age. In the domain of cognition, feeling older than one's chronological age is related to lower cognitive performance and steeper cognitive decline among older adults. The present study examines whether an older subjective age is associated with the risk of incident cognitive impairment and dementia.
Method: Participants were 5,748 individuals aged 65 years and older drawn from the Health and Retirement Study. Measures of subjective age, cognition, and covariates were obtained at baseline, and follow-up cognition was assessed over a 2- to 4-year period. Only participants without cognitive impairment were included at baseline. At follow-up, participants were classified into one of the three categories: normal functioning, cognitive impairment without dementia (CIND), and dementia.
Results: An older subjective age at baseline was associated with higher likelihood of CIND (odds ratio [OR] = 1.18; 1.09–1.28) and dementia (OR = 1.29; 1.02–1.63) at follow-up, controlling for chronological age, other demographic factors, and baseline cognition. Physical inactivity and depressive symptoms partly accounted for these associations.
Conclusion: An older subjective age is a marker of individuals' risk of subsequent cognitive impairment and dementia.

Keywords: Cognitive impairment—Dementia—Subjective age

The prevalence of dementia is expected to increase substantially in the coming decades with the rapidly growing number of older people worldwide. Dementia has considerable human costs, characterized by disability, physical and psychological burden among the affected individuals and their caregivers (Fisher et al., 2011; Okura et al., 2010) and a substantial monetary impact, ranging between US$157 billion and US$215 billion per year in the United States (Hurd, Martorell, Delavande, Mullen, & Langa, 2013). Therefore, the identification and understanding of the factors associated with cognitive impairment and dementia risk is a significant public health priority. A range of demographic, genetic, clinical, and behavioral factors have been linked with dementia (Terracciano et al., 2014). Among these factors, chronological age is the strongest risk factor for dementia (Daviglus et al., 2010), with incidence increasing rapidly with advancing age and reaching about one third of affected individuals among those 85 years and older (Hebert, Weuve, Scherr, & Evans, 2013). In addition to chronological age, a recent longitudinal study found that individuals holding more negative aging stereotypes had steeper hippocampal volume loss as they aged and at autopsy were found to have greater accumulation of amyloid plaques and neurofibrillary tangles (Levy et al., 2016). To build from current knowledge on the link between age and age stereotype on the risk of dementia, the present study sought to examine whether subjective age was associated with the risk of cognitive impairment and dementia.

Subjective age refers to how old or young individuals feel relative to their chronological age. A growing body of research suggests that subjective age is related to cognitive functioning in older adulthood. Individuals with a younger subjective age, for example, tend to have better episodic memory and executive function assessed 10 years later, independent of chronological age (Stephan, Caudroit, Jaconelli, & Terracciano, 2014). Using data from the Health and Retirement Study (HRS), Stephan, Sutin, Caudroit, and Terracciano (2016) found that an older subjective age was associated with worse performance on measures of immediate and delayed recall and was predictive of steeper declines in memory over a 4-year period. Although these findings suggest that subjective age is a potential predictor of impaired cognition, to our knowledge, no study to date has tested whether subjective age predicts who is at risk for incident cognitive impairment and dementia. Support for this hypothesis also comes from evidence that subjective age may contribute to and is influenced by a range of factors implicated in dementia risk. Indeed, individuals who feel older are more likely to experience frequent, daily stress (Kotter-Grühn, Neupert, & Stephan, 2015), and the accumulation of stress has been linked to dementia-related brain damage (Chao, Yaffe, Samuelson, & Neylan, 2014). An older subjective age is also related to more depressive symptoms (Choi & DiNitto, 2014; Stephan et al., 2014), and depression is associated with an increased risk of cognitive impairment and dementia (Barnes et al., 2012; Richard et al., 2013), and the neuropathological hallmarks of Alzheimer disease, cerebral amyloid, and tau deposition (Lavretsky et al., 2009). In addition, an older subjective age is associated with diabetes (Demakakos, Gjonca, & Nazroo, 2007), which has been linked with impaired cognition and dementia risk (Biessels, Staekenborg, Brunner, Brayne, & Scheltens, 2006; Reitz, Tang, Manly, Mayeux, & Luchsinger, 2007). Finally, feeling older than one's age is related to physical inactivity (Stephan et al., 2014, 2016), which is a behavioral risk factor for dementia (Blondell, Hammersley-Mather, & Veerman, 2014; Rovio et al., 2005). These studies thus suggest that individuals with an older subjective age have emotional, clinical, and behavioral profiles that may expose them to an increased risk of dementia-related outcomes. Therefore, building upon existing evidence and using longitudinal data from the HRS, the present study tested the hypothesis that an older subjective age is related to an increased risk of incident cognitive impairment and dementia. We further examined whether depressive symptoms, diabetes, smoking, and physical activity accounted for this association.

Method

Participants

Participants were drawn from the HRS, a nationally representative longitudinal study of Americans aged 50 years and older (grant number NIA U01AG009740). HRS participants are reinterviewed every 2 years, which includes a cognitive assessment. Starting in 2006, HRS implemented an enhanced face-to-face interview that included a psychosocial questionnaire that was left to participants at the end of the interview to complete at home and returned by mail to study offices. Subjective age was first assessed in the questionnaire in 2008 among half of the participants, and the other half completed it in 2010. Only participants aged 65 years and older were included in this study. Both samples were combined as the baseline, with a total of 8,227 participants with complete data on demographic factors, subjective age, and baseline cognition. Only individuals without cognitive impairment at baseline were included, leading to the exclusion of 1,921 participants. Follow-up cognitive measures were obtained from the 2010 and 2012 waves for the participants of the 2008 sample and from the 2012 wave for the participants of the 2010 sample. Thus, the interval between baseline and follow-up was 2 to 4 years. Five hundred thirty-four participants without follow-up cognitive data were excluded, leaving a total of 5,772 participants with complete data. With outliers on subjective age removed (±3 *SD* from the mean: N = 24), the final sample was composed of 5,748 individuals aged from 65 to 98 years (Mean = 73.69, *SD* = 6.24), had an average of 13.10 (*SD* = 2.63) years of education, and were 59% women and 91% White.

Individuals in the final longitudinal sample were younger, $t(6280) = 12.12$, $p < .001$; more educated, $t(6280) = -3.04$, $p < .01$; felt younger, $t(6280) = 4.62$, $p < .001$; were more likely to be female, $\chi^2(1, 6282) = 12.20$, $p < .001$; and had higher baseline cognition, $t(6280) = -7.83$, $p < .001$, than individuals with incomplete data at follow-up ($N = 534$). There was no difference in race between the two groups, $\chi^2(1, 6282) = 0.34$, $p = .56$. In addition, the longitudinal sample had fewer depressive symptoms, $t(6251) = 7.62$, $p < .001$; higher level of both vigorous, $t(6106) = 7.94$, $p < .001$; and moderate physical activity, $t(5676) = 9.71$, $p < .001$, and fewer cases of diabetes, $\chi^2(1, 6231) = 14.01$, $p < .001$, than the sample not assessed at follow-up. There was no difference between the two groups for smoking, $\chi^2(1, 6282) = 0.65$, $p = .42$.

Measures

Subjective age.—Subjective age was assessed by asking participants to specify, in years, how old they felt. Proportional discrepancy scores were calculated by subtracting participants' chronological age from their felt age, and these difference scores were divided by chronological age (Brothers, Miche, Wahl, & Diehl, in press; Kotter-Grühn & Hess, 2012; Stephan et al., 2016). A negative value reflected a youthful subjective age, whereas a positive value indicated an older subjective age.

Cognition.—Consistent with past research in the HRS (Clark et al., 2013; Crimmins, Kim, Langa, & Weir, 2011; Davydow, Levine, Zivin, Katon, & Langa, 2015; Saczynski et al., 2015), cognitive impairment was assessed using the modified Telephone Interview for

Cognitive Status (TICSm). A 27-point composite score was computed from a test of immediate and delayed recall to assess short-term memory, a serial 7 subtraction test to assess working memory and a backward counting test to assess mental processing speed. Cut scores used to classify respondents were based upon past findings in the HRS (Crimmins et al., 2011; Davydow et al., 2015; Saczynski et al., 2015). A score of 12 to 27 defined normal cognitive function, a score of 7 to 11 indicated cognitive impairment without dementia (CIND), and a score of 6 or less defined dementia. These cutoffs have been validated against the diagnosis performed in the Aging, Demographics, and Memory Study (ADAMS; Crimmins et al., 2011). In the ADAMS, the diagnosis of normal functioning, CIND, and dementia was assigned based upon neuropsychological testing that included measures of verbal and visual immediate and delayed memory, language, attention, executive function, orientation, praxis, intellect, and reading ability (Langa et al., 2005). These measures, along with medical history, clinical assessment, and neurological examination were available to a consensus expert panel that made the diagnosis (Langa et al., 2005). Crimmins et al. (2011) found that the TICSm had a weighted accuracy of 69.2% in the correct classification of participants in their ADAMS diagnosis as normal, CIND, or dementia. In addition, the prevalence of CIND and dementia in the HRS estimated using these cutoffs was close to those estimated using neuropsychological assessment of the ADAMS (Crimmins et al., 2011).

Covariates.— Several covariates were included, such as age (in years), sex (coded as 1 for women and 0 for men), race (coded as 1 for White and 0 for other), and educational level (in years). In additional analyses, variables likely to account for the relation between subjective age and dementia-related risk were also included. Depressive symptoms were assessed using an 8-item version of the Centers for Epidemiologic Studies Depression (CES-D) scale (Wallace et al., 2000). Participants were asked to report whether they had experienced eight specific symptoms for much of the past week. A total depressive symptom score was computed based on the sum of these items ($\alpha = .81$). They were also asked whether they had been diagnosed with diabetes. History of smoking was coded as 1 for current/former smokers and 0 for never smokers. Physical inactivity was assessed by asking participants to rate how frequently they participated in vigorous and moderate activities by answering two questions using a scale ranging from 1 (*more than once a week*) to 4 (*hardly ever or never*). Specifically, they were asked how often they take part in sports or activities that are vigorous, such as running or jogging, swimming, cycling, aerobics or gym workout, tennis, or digging with a spade or shovel, and how often they take part in sports or activities that are moderately energetic such as gardening, cleaning the car, walking at a moderate pace, dancing, and floor or stretching exercises.

Data Analysis

Logistic regression was used to test whether subjective age was associated with the risk of incident cognitive impairment and dementia. A first analysis examined whether subjective age was related to the risk of cognitive impairment, including both dementia and CIND, at follow-up. Separate analyses were conducted to examine the association between subjective age and the risk of incident CIND and dementia at follow-up. The basic models controlled for age, sex, education, race, time interval, and baseline cognition. In additional analyses, depressive symptoms, history of smoking, diabetes, and both vigorous and moderate physical activity used as a continuous measure were added as covariates.

Results

Descriptive statistics are presented in Table 1. Of the total sample with normal cognitive functioning at baseline, 17.03% of participants were classified as cognitively impaired at follow-up (N = 979), including 15.40% with CIND (N = 885) and 1.63% with dementia (N = 94).

Logistic regression revealed that an older subjective age at baseline was related to an increased likelihood of future cognitive impairment (TICSm < 12), controlling for demographic covariates, time interval, and baseline cognition (Table 2). For every standard deviation increase in an older subjective age, the risk of cognitive impairment increased by 19%. This association was reduced but remained significant when adjusting for depressive symptoms, diabetes, physical inactivity, and smoking (Table 2). Among this set of variables, only low vigorous physical activity was found to increase the likelihood of cognitive impairment.

We repeated the above analyses to examine separately the CIND (TICSm 7–11) and dementia outcomes (TICSm < 7). We found that an older subjective age was related to a higher likelihood of CIND at follow-up, controlling for demographic factors and baseline cognition (Table 2). A 1 *SD* increase in the tendency to feel older than one's age was associated with an 18% increased risk of CIND. Adjusting for depressive symptoms, diabetes, vigorous and moderate physical activity, and smoking reduced the size of this association but it remained significant (Table 2). Higher depressive symptoms and low vigorous physical activity were related to higher risk of CIND over the follow-up period. Finally, feeling older was associated with a higher likelihood of dementia, controlling for covariates (Table 2). A 1 *SD* increase in older subjective age was related to a 29% increased risk of dementia at follow-up, after accounting for the effects of basic demographic factors. Depressive symptoms, diabetes, low moderate physical activity, and smoking accounted for part of this association, as indicated

Table 1. Characteristics of the Total Sample, and of the Normal Functioning, Cognitive Impairment No Dementia, and Dementia Groups

	Total sample (*N* = 5748)		Normal functioning (*N* = 4,769)		Cognitive impairment (*N* = 979)		Cognitive impairment no dementia (*N* = 885)		Dementia (*N* = 94)	
Variables	*M*/%	*SD*	*M*/%	*SD*	*M*/%	*SD*	*M*/%	*SD*	*M*/%	*SD*
Sex (% female)	59%	—	59%	—	57%	—	55%	—	69%	—
Age (years)	73.69	6.24	73.09	5.90	76.60	6.97	76.45	6.93	77.98	7.20
Education	13.10	2.63	13.31	2.54	12.07	2.79	12.07	2.81	12.03	2.64
Ethnicity (% White)	91%	—	92%	—	86%	—	86%	—	89%	—
Smoking (current/former smoker)	52%	—	52%	—	51%	—	51%	—	49%	—
Diabetes	22%[b]	—	21%	—	25%	—	26%	—	21%	—
Depressive symptoms	1.07[b]	1.65	1.00	1.60	1.40	1.85	1.39	1.85	1.49	1.87
Vigorous physical activity	3.03[b]	1.27	2.98	1.29	3.31	1.14	3.30	1.15	3.43	1.05
Moderate physical activity	2.08[b]	1.22	2.02	1.20	2.38	1.28	2.34	1.28	2.71	1.28
Subjective age[a]	−0.16	0.14	−0.17	0.14	−0.13	0.15	−0.13	0.15	−0.12	0.12
Baseline cognition score	16.34	2.83	16.74	2.79	14.37	2.13	14.44	2.14	13.77	1.90

[a]Subjective age = (Felt Age − Chronological Age)/Chronological Age.
[b]Due to missing data: *N* = 5,702 for diabetes, *N* = 5,725 for depressive symptoms, *N* = 5,585 for vigorous physical activity, and *N* = 5,188 for moderate physical activity.

by the slight reduction in the effect size (from OR = 1.29 to OR = 1.27); only low moderate physical activity, however, was associated with higher likelihood of dementia (Table 2), which suggested that physical inactivity mediated the association between subjective age and dementia. Of note, across the analyses, the effect size for subjective age was almost comparable to the effect size for physical inactivity. Additional analyses were conducted with cognition as a continuous measure, which confirmed the overall pattern of results (Supplementary Table S1). An older subjective age was related to lower future cognition, controlling for covariates. This association was slightly reduced with the inclusion of depression, diabetes, vigorous and moderate physical activity, and smoking, but remained significant. In supplemental analyses, we also examined the nonlinear relations between subjective age and cognitive impairment, CIND, and dementia. The results revealed that beyond linear relationship, the risk of cognitive impairment and CIND was stronger for individuals with the oldest subjective age (Supplementary Table S2).

Discussion

Using a large longitudinal sample of older adults, the present study found that an older subjective age at baseline predicted an increased risk of incident cognitive impairment and dementia. This finding extends recent evidence that feeling older is associated with a steeper cognitive decline in old age (Stephan et al., 2016) by providing the first evidence of its relation with dementia-related outcomes.

The association between subjective age and cognition is likely to be mediated by both emotional and behavioral pathways (Stephan et al., 2014, 2016). Individuals who feel older than their chronological age have worse cognitive performance and steeper cognitive decline in part because they have more depressive symptoms (Stephan et al., 2016) and are less physically active (Stephan et al., 2014). These pathways may also explain the association between feeling older and cognitive impairment and dementia, given that both depression and physical inactivity are recognized risk factors for dementia (Richard et al., 2013; Rovio et al., 2005). And, indeed, in the present study, adjustment for depression and physical inactivity accounted for part of the association. In particular, physical inactivity, measured as low frequency of vigorous and moderate physical activity, was associated with risk of cognitive impairment, CIND, and dementia, and depressive symptoms were related to CIND. These findings indicate that a physically inactive lifestyle and, to a lesser extent, the depressive symptoms associated with an older subjective age may explain part of its relation with higher risk of impaired cognition and dementia.

In addition to the variables tested in this study, other biological pathways are likely to account for the link between an older subjective age and cognitive impairment. Indeed, individuals with an older subjective age tend to have higher levels of C-reactive protein (Stephan, Sutin, & Terracciano, 2015b), a biomarker of systemic inflammation associated with cognitive impairment and dementia (Kravitz, Corrada, & Kawas, 2009; Noble et al., 2010). Subjective age is also sensitive to physiological processes, such as lower pulmonary and muscular functions (Stephan, Sutin, & Terracciano, 2015a), predictive of dementia-related risk in later life (Boyle, Buchman, Wilson, Leurgans, & Bennett, 2010; Vidal et al., 2013). Psychological processes may also operate. Feeling older, for example, is associated with complaints

Table 2. Logistic Regression Predicting Follow-up Cognitive Impairment and Dementia from Baseline Subjective Age

	Cognitive impairment		CIND		Dementia	
Predictor	Model 1[a]	Model 2[b]	Model 1[c]	Model 2[b]	Model 1[d]	Model 2[b]
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age	1.08 (1.06–1.09)***	1.08 (1.06–1.09)***	1.07 (1.06–1.09)***	1.08 (1.06–1.09)***	1.11 (1.07–1.14)***	1.11 (1.07–1.15)***
Sex	.97 (.83–1.13)	.97 (.81–1.15)	.92 (.78–1.07)	.91 (.76–1.09)	1.73 (1.09–2.74)*	1.94 (1.07–3.52)*
Race	.58 (.46–.73)***	.59 (.46–.76)***	.56 (.44–.71)***	.57 (.44–.73)***	.95 (.47–1.94)	1.09 (.42–2.83)
Education	.90 (.87–.93)***	.90 (.87–.92)***	.90 (.87–.93)***	.90 (.87–.92)***	.92 (.85–.99)*	.92 (.84–1.00)*
Time interval	1.51 (1.30–1.76)***	1.57 (1.33–1.85)***	1.41 (1.21–1.66)***	1.45 (1.22–1.72)***	3.30 (2.10–5.18)***	3.72 (2.23–6.19)***
Baseline cognition	.39 (.35–.43)***	.40 (.36–.44)***	.40 (.36–.45)***	.42 (.37–.47)***	.23 (.16–.32)***	.20 (.14–.31)***
Subjective age	1.19 (1.10–1.28)***	1.16 (1.06–1.26)**	1.18 (1.09–1.28)***	1.15 (1.05–1.25)**	1.29 (1.02–1.63)*	1.27 (.94–1.72)
Depression		1.08 (1.00–1.17)		1.09 (1.00–1.18)*		1.00 (.50–1.97)
Smoking		1.16 (.97–1.38)		1.15 (.96–1.38)		1.26 (.75–2.12)
Diabetes		1.09 (.90–1.31)		1.10 (.90–1.34)		.83 (.46–1.48)
Vigorous physical activity		1.11 (1.01–1.22)*		1.11 (1.00–1.22)*		1.14 (.84-1.55)
Moderate physical activity		1.08 (.99–1.18)		1.06 (.97–1.16)		1.39 (1.06–1.83)*

Notes: N = 5,748. CIND: Cognitive Impairment No Dementia.

[a] $N = 5{,}748$ ($N_{CI} = 979$).

[b] $N = 5{,}059$ ($N_{CI} = 847$) for cognitive impairment, $N = 4{,}978$ ($N_{CIND} = 766$) for CIND, and $N = 4{,}293$ ($N_{Dementia} = 81$) for dementia due to missing data on some covariates.

[c] $N = 5{,}654$ ($N_{CIND} = 885$).

[d] $N = 4{,}863$ ($N_{Dementia} = 94$).

*p <.05. **p <.01. ***p <.001.

about memory (Hülür, Hertzog, Pearman, & Gerstorf, 2015; Pearman, Hertzog, & Gerstorf, 2014), which may be precursors to cognitive impairment (Kaup, Nettiksimmons, LeBlanc, & Yaffe, in press; Kryscio et al., 2014). In addition, an older subjective age is related to the frequent experience of stress (Kotter-Grühn et al., 2015) that may generate potential dementia-related brain damages over time. Finally, other psychosocial pathways may explain the link between subjective age and risk of cognitive impairment and dementia. An older subjective age, for example, may be due to the assimilation of negative age stereotypes and negative social cues about aging (Kotter-Grühn & Hess, 2012; Stephan et al., 2015a). Individuals who hold more negative stereotypes about aging are at greater risk for the development of biomarkers of Alzheimer's disease, including a steeper decline in hippocampal volume and accumulation of amyloid plaques and neurofibrillary tangles (Levy et al., 2016). Individuals who feel older than their chronological age may have a greater risk of dementia-related outcomes because they have internalized negative aging stereotypes that are potentially threatening to their cognitive functioning.

The present study adds to a substantial interest in the identification of markers of dementia-related risk. Beyond chronological age, this study suggests that the subjective experience of age may play a role as a meaningful biopsychosocial marker that is associated with future risk of impaired cognition and dementia. Indeed, the age individuals feel captures a range of psychosocial, health-related, and biological factors and processes (Stephan et al., 2015a) that are likely to convert into worsening cognitive functioning over time. Therefore, from a practical perspective, assessment of subjective age may improve the early identification of individuals at risk of future cognitive impairment, who may benefit from close monitoring and dementia-related preventive efforts and treatments. In addition, an older subjective age and cognitive impairment have deleterious effects for individuals' quality of life. Intervention that target subjective age and/or cognition may be beneficial for maintaining older individuals' quality of life.

The strengths of the present study include a detailed examination of different categories of cognitive impairment, the use of a large national sample of older adults, and the control of several covariates of interest. There are also several limitations. First, the selective attrition of the sample, composed of younger, more educated, and healthier individuals, limits the generalizability of the findings. Second, this study does not have a clinical diagnosis of either cognitive impairment or dementia. However, the screening instrument and the cut points used in the HRS have been validated against clinical diagnosis of dementia (Crimmins et al., 2011). Further research is needed to replicate and extend these results using different screening methods and instruments, including clinical diagnoses of cognitive impairment and dementia. Third, the association between subjective age and cognitive impairment was observed over a 2- to 4-year period, with a stronger risk of impaired cognition and dementia when the time interval from baseline was longer. Future research is needed to examine whether such association persists over longer periods and whether subjective age changes along with cognitive impairment and dementia. In particular, the extent to which changes in subjective age are predictive of future dementia-related outcomes deserves particular attention. The present study measured subjective age 2 to 4 years before cognitive impairment and dementia, among normal functioning individuals at baseline. However, although we only included individuals with normal functioning at baseline, we cannot exclude the possibility that at the time of measurement, subjective age had already changed along with the underlying brain-related changes that lead to cognitive impairment and dementia over time.

Despite these limitations, the results provide clear evidence that an older subjective age is related to a higher risk of incident cognitive impairment and dementia and thus provide support for the role of subjective age as a marker of older individuals' subsequent cognitive functioning.

Supplementary Material

Supplementary data is available at *The Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* online.

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