Physical and mental health characteristics of adults with subjective cognitive decline: A study of 3,407 people aged 18-81 years from an MTurk-based U.S. national sample

Ryan Van Patten[1,2,3], Tanya T. Nguyen[1,2,3], Zanjbeel Mahmood[2,4], Ellen E. Lee[1,3], Rebecca E. Daly[1,3], Barton W. Palmer[1,2,3], Tsung-Chin Wu[1,3], Xin Tu[1,3], Dilip, V. Jeste[1,3,5¶*], Elizabeth W. Twamley[1,2,3¶]

[1]Department of Psychiatry, University of California San Diego, La Jolla, California, United States of America

[2]Veterans Affairs San Diego Healthcare System, San Diego, California, United States of America

[3]Sam and Rose Stein Institute for Research on Aging, University of California San Diego, La Jolla, California, United States of America

[4]San Diego State University/University of California San Diego Joint Doctoral Program in Clinical Psychology, San Diego, California, United States of America

[5]Department of Neurosciences, University of California San Diego, La Jolla, California, United States of America

*Corresponding Author:
E-mail: djeste@health.ucsd.edu (DVJ)

¶DVJ and EWT are Joint Senior Authors

Abstract

Subjective cognitive decline (SCD), or internal feelings of reduced mental capacity, is of increasing interest in the scientific, clinical, and lay community. Much of the extant literature is focused on SCD as a risk factor for Alzheimer's disease in older adults, while less attention has been paid to non-cognitive health correlates of SCD across adulthood. Consequently, we investigated physical and mental health correlates of SCD in younger, middle-aged, and older adults. We recruited 3,407 U.S. residents through Amazon's Mechanical Turk, an online labor market. Participants completed a 90-item self-report survey questionnaire assessing sociodemographic characteristics, physical health, sleep, depression, anxiety, loneliness, wisdom, self-efficacy, and happiness. Overall, 493/1930 (25.5%) of younger adults (18-49) and 278/1032 (26.9%) of older adults (50 or older) endorsed the SCD item. Multivariate analysis of variance and follow-up *t*-tests revealed worse physical and mental health characteristics in people endorsing SCD compared to those who did not, with effect sizes primarily in the medium to large range. Additionally, age did not moderate relationships between SCD and physical and mental health. Results suggest that SCD is associated with a diverse set of negative health characteristics such as poor sleep and high body mass index, and lower levels of positive factors including happiness and wisdom. Effect sizes of psychological correlates of SCD were as large as (or larger than) those of physical correlates, indicating that mental health and affective symptoms may be critical to consider when evaluating SCD. Overall, findings from this large, national U.S. sample suggest the presence of relationships between SCD and multiple psychological and perceived health factors; our results also show that SCD may be highly prevalent in both younger and older adults, suggesting that it be assessed across the adult lifespan.

Introduction

A self-reported decline in cognitive abilities – i.e., subjective cognitive decline (SCD) – is a common complaint in older adults with and without objective cognitive deficits (1). A burgeoning literature in the field of aging research focuses on examining the utility of SCD as an indicator of underlying pathological age-associated cognitive decline years before the onset of the objective, measurable symptoms identifiable in mild cognitive impairment (MCI) and dementia (2). However, whether or not SCD represents an early clinical manifestation of Alzheimer's disease (AD) pathology remains to be determined. Studies supporting the utility of SCD have found it to be associated with AD neurochemical biomarkers (3). Moreover, in a recent review, Jessen and colleagues (4) concluded that SCD increases risk for pathological cognitive decline on a population level, but that most people with SCD will not convert to MCI and dementia. In contrast, other studies have found inconsistent associations between SCD and objective cognitive functioning in preclinical disease phases (1) and, in some cases, even MCI (5). Moreover, some researchers have reported no relationship between SCD and neuropathological biomarkers of AD (6), and others have found subjective complaints to be an innocuous condition with little risk for future cognitive decline (7–9).

SCD base rates in older adults are high (27-43% in people in their 60s and 70s; 1), evidence for SCD as a risk factor for future cognitive decline is inconclusive (4), and the costs of comprehensive workups for those reporting SCD can be high (10). Moreover, current evidence demonstrates that SCD in the absence of objective cognitive symptoms is associated with worse physical health (11), subjective and objective sleep disturbance (12–14), and psychiatric symptom severity (11,14–16). Negative personality traits (e.g., neuroticism and lower general perceived self-efficacy) have also been linked to SCD in older adults (11,16,17), underscoring the importance of assessing socioemotional health in the context of SCD. Consequently, it is important to investigate non-cognitive correlates of SCD in order to better elucidate the full clinical syndrome and appropriately direct physical and mental healthcare resources.

Relative to older adults, non-cognitive correlates of SCD remain under-investigated in non-clinical samples of younger adults, who are unlikely to experience objective cognitive decline due to neurodegeneration, despite SCD being reported with equal frequency across all ages (18–22). In comparison to older adults who more frequently attribute their SCD to intrinsic, age-associated cognitive decline, younger adults are more likely to attribute SCD to extrinsic, modifiable causes, such as stress, multitasking, and concentration problems (20,21,23). However, the evaluation of SCD in younger adults has been restricted primarily to clinical and medical populations (24–26). The few studies that recruited non-clinical younger and older adults found correlates of SCD to be similar across the two age groups, underscoring the importance of stress, sleep disturbance, and psychiatric symptom severity in SCD across the lifespan (14,19–21,27). However, measures of physical functioning were not consistently and/or comprehensively examined across these studies. Moreover, these studies vary in their recruitment methods and research setting (e.g., memory clinics, surveys explicitly informing participants of the nature of the survey), which may influence prognostically-relevant sample sociodemographic/clinical characteristics (28).

Most of the studies in the exiguous lifespan SCD literature have been conducted in geographically restricted areas (e.g., Korea (27); Paris suburb (21); Portugal (18)), with no prior investigations in a demographically representative and age-diverse U.S. sample. Furthermore, studies within the overall SCD literature have not examined the role of psychological constructs such as wisdom, resilience, and loneliness across the adult lifespan and this information is of essential importance in situating SCD amongst important health-related constructs. As such, the aims of the current study were to comprehensively characterize physical and mental health correlates of SCD across the lifespan in a large, demographically diverse US sample. We recruited participants using Amazon's Mechanical Turk (AMT), an online labor market allowing for the rapid acquisition of high quality data at low cost (29–33). Based on previously reviewed literature, we hypothesized that, compared to participants who do not endorse SCD (SCD-), those who endorse SCD (SCD+) would report worse physical and mental health.

Furthermore, because of the well-known impact of aging on cognition, we explored the moderating effect of age on the relationship between SCD status and mental/physical health.

Methods

Participants

We recruited 3,407 people, aged 18-81, from AMT (see Table 1). Participants completed a 90-item online survey during a five-week period in spring 2019. The description of the survey, visible on AMT read, *"We are looking for people to answer questions about a variety of topics, including age, gender, mood, wisdom, and sleep, among others."* We described the survey in general terms so as to reduce sampling bias and enhance generalizability. Interested participants consented to the study by selecting a hyperlink, which routed them to the questionnaire, presented via SurveyGizmo.

……. Table 1 About Here ……..

We paid each worker $1.00 for survey completion. Inclusion criteria were the following: 1) ≥18 years old, 2) English-speaking, 3) residing in the U.S., and 4) a Human Intelligence Task Approval rate >90% (32). We initially recruited 2,289 participants and found that the age distribution was skewed toward younger adults. In order to balance the sample with respect to age, we added 250 more participants aged 35-45, 500 participants aged 45-55, and 368 participants aged 55+, leading to the initial sample size of 3,407.

Although AMT workers provide high quality data overall (29,31,33–38), a subset may be inattentive or may provide invalid data for other reasons. In order to address this issue, we excluded participants who provided impossible or highly improbable answers to survey items. Specifically, we excluded participants who, 1) completed the survey in <270 seconds (n=104), 2) reported values for height and weight leading to a body mass index (BMI)<16 (n=165), 3) reported fewer total close friends than the number of close friends seen at least once per month (n=252), 4) reported their height at <3 feet or >7 feet (n=42), 5) reported living with ≥20 people in their household (n=12), and/or 6) reported owning ≥40 pets (n=3). Overall, 336 participants provided one invalid response, 86 participants provided two

invalid responses, 22 participants provided three invalid responses, and 1 participant provided four invalid responses. Applying these exclusion criteria resulted in 445 (13.1%) participants being excluded, leaving a final sample of 2,962 participants for analysis.

This project, including a request for a waiver of documented consent, was reviewed through the UC San Diego Human Research Protections Program by an IRB Chair and/or the IRB Chair's designee and certified as exempt from IRB review under 45 CFR 46.104(d), Category 2.

Materials

Within the 90-item survey, we measured SCD with a single item ("*Have you noticed a decline in your memory and thinking that is worrisome to you? [Yes/No]"*). We attempted to minimize the length of the survey as much as possible; consequently, we selected empirically-supported abbreviated versions of all measures with the exception of the San Diego Wisdom Scale (SD-WISE), which does not have a short form. We measured multiple sociodemographic characteristics including age, sex, education, race, annual income, marital status, and employment status. To assess physical health, we administered one item inquiring about frequency of flossing (once per week, 2-3 times per week, 4-6 times per week, or daily; 39), two items measuring height and weight to calculate body mass index (BMI), one item asking whether or not any medications are taken for medical conditions, the 12-item Medical Outcomes Survey-Short Form (assessing physical and mental health related quality of well-being; 39), the 4-item Patient-Reported Outcomes Measurement Information System (PROMIS) Sleep Disturbance-short form (41), and the 1-item PROMIS sleep apnea question (41). We measured depression with the 2-item Patient Health Questionnaire (PHQ-2; 42) and anxiety with the 2-item version Generalized Anxiety Disorder scale (43). We measured loneliness with the 4-item version of the UCLA Loneliness Scale (44), using the anchors from the third edition of the UCLA scale, *never*, *rarely*, *sometimes*, and *always*, rather than those of Russel et al. (44), *never*, *rarely*, *sometimes*, and *often*. Measures of positive psychological factors included the 24-item SD-WISE (45), the 2-item Connor-Davidson Resilience Scale (46), and the 4-item Happiness Factor from the Center for Epidemiologic Studies-Depression scale (47). The SD-WISE

includes the following subscales: Decisiveness, Emotional Regulation, Pro-Social Behaviors, Social Advising, and Tolerance for Divergent Values. We assessed social self-efficacy using four items, with minor wording modifications, from the Social Self-Efficacy Scale (48,49) that was originally developed for use with adolescents. These four items were selected for age-appropriateness and included: (1) "*How well can you become friends with other people?*," (2) "*How well can you have a chat with an unfamiliar person?*," (3) "*How well can you tell other people that they are doing something you don't like?*," and (4) "*How well can you succeed in preventing quarrels with other people?*".

Statistical Analyses

We analyzed the data using SPSS 26.0. We first examined distributional characteristics of all continuous variables. For those that were highly skewed, we used appropriate non-parametric tests. Next, we tested our hypothesis with SCD group as the between-subjects predictor ("independent") variable and physical and mental health scores as outcome ("dependent") variables Casual inference cannot be established with this cross-sectional data, but our main focus was to test whether SCD status predicted physical and mental health levels. We ran an omnibus multivariate analysis of variance (MANOVA), followed by independent samples *t*-tests for each continuous variable; due to low missing data rates (<4% for all variables and <1% for all variables except for frequency of flossing), we used the classic MANOVA procedure rather than the generalized estimating equations procedure (50). For the two categorical outcome variables (presence or absence of medications and sleep apnea), we conducted χ^2 tests. With regard to the exploratory analysis, we conducted 2-group (SCD+ versus SCD-) X 2-age cohort (older: 50+ versus younger: 18-49) ANOVAs on the physical and mental health variables listed in Table 1 in order to examine the possible moderating effect of age. We dichotomized age into two groups in order to contrast younger adults with older adults, given that the majority of the current SCD literature exists in aging populations. Although some researchers define older adults beginning in the 60s, we were interested in "young-old" adults, and our sample of "old-old" adults was small, likely due to our use of an internet-based data collection platform (AMT).

We report appropriate effect sizes for all statistical tests – partial η^2 for the MANOVA, Cohen's *d* for *t* tests, and Cramer's *V* for χ^2 tests. We used the False Discovery Rate to control for Type I error, with alpha set at $p<.05$. The False Discovery Rate predicts and controls individual false positive results, while simultaneously maintaining a high level of statistical power relative to familywise error rate methods such as the Bonferroni correction (51). All statistical tests were two-tailed.

Results

Overall, 493/1930 (25.5%) of younger adults (18-49) and 278/1032 (26.9%) of older adults (50 or older) endorsed the SCD item, $\chi^2(1)=.68$, $p=.41$. For continuous variables with non-normal distributions, results from non-parametric tests (Mann Whitney *U*s) mirrored those from parametric statistics. For ease of interpretation, we present the parametric results for all continuous variables. Of the demographic variables, sex, education, employment status, and annual income differed significantly across the two groups; however, when we added these variables to the models as covariates, results did not differ. For ease of interpretation, we provide unadjusted parameters.

With respect to our hypothesis that the SCD+ group would report worse physical and mental health compared to the SCD- group, the MANOVA was statistically significant, $F(11, 2937)=46.47$, $p<.001$, $\lambda=0.85$, $\eta_p^2=.15$. In univariate analyses, all physical and mental health variables differed in the hypothesized direction, with the exception of SD-WISE Tolerance for Diverging Values subscale. Specifically, compared to the SCD- group, the SCD+ group reported higher BMI, greater rate of taking medications for medical conditions, less frequent flossing, worse overall self-reported physical health, higher rates of self-reported sleep disturbance and sleep apnea, worse overall mental health, higher rates of depression, anxiety, and loneliness, and lower scores on scales for resilience, happiness, wisdom, and self-efficacy (see Table 1). Moreover Cohen's *d* effect sizes were primarily in the medium (0.50) to large (0.80) range. When we split the sample by age (18-49 and 50+) for the exploratory analysis, interaction terms for the 2-SCD group X 2-Age group ANOVAs were all non-significant, suggesting that age did not moderate the relationship between SCD and physical or mental health.

Discussion

Most research efforts to investigate SCD have been focused on understanding its relationship to objective cognitive decline (52,53) and its importance as an early risk factor for MCI and dementia in older adults (4,54). Although the literature on SCD as a marker of early cognitive decline in older adults is growing rapidly, much less is known about SCD as a general construct, especially its physical and mental health correlates in non-clinical populations across the adult lifespan. The present study evaluated self-reported physical and psychological correlates of SCD in a large survey sample of adults aged 18-81. As hypothesized, both younger and older adults who endorsed SCD exhibited worse self-reported physical health symptoms and psychological traits/states compared to those who did not endorse SCD. Compared to SCD- participants, SCD+ participants had higher mean BMI, were more likely to take medications for medical conditions, were more likely to have sleep apnea or other sleep disturbances, and were less likely to floss. They also reported worse physical well-being, worse mental well-being, higher depression and anxiety symptoms, greater loneliness, and lower levels of resilience, happiness, wisdom, and self-efficacy. Age did not moderate the relationship between SCD and either physical or psychological functioning. Overall, our findings are consistent with previous literature suggesting that SCD is associated with worse physical health (11), subjective and objective sleep disturbance (12–14), and psychiatric symptom severity (11,14–16), and that SCD correlates are similar across the lifespan in both younger and older adults (19,21,27). To our knowledge, this study is the first large-scale investigation of SCD rates to include a non-clinical sample of younger adults in the U.S. Notably, the prevalence of SCD did not differ between younger and older adults, which was unexpected. Previous studies have reported similar rates of SCD in younger adults (approximately 25-29%) but higher rates in older adults (20,27). A possible explanation for the lack of difference in SCD between younger and older adults is that our older adult sample recruited through AMT may be different than those in other clinical studies. Nevertheless, other studies have found SCD to be as frequent, though qualitatively different, in young adults compared to older adults (18,21).

Depression and anxiety symptoms demonstrated the strongest relationships to SCD, with moderate-to-large (Cohen's $d \geq 0.70$) effect sizes. This finding is consistent with earlier studies, which suggest that the relationship between SCD and symptoms of depression and anxiety is complex. Depression moderates the relationship between SCD and objective cognitive impairment (14,55). Moreover, although depression and anxiety are closely related and highly comorbid, they are associated with different risk factors; pure anxiety tends to be associated with a wide range of stress-related factors, none of which are associated with pure depression (56). One factor common to both is personal mastery, or perceived behavioral control, which may be a cognitive psychological marker of trait vulnerability for both depression and anxiety (56). Depression interacts with personal mastery and general self-efficacy such that the association between depressive symptoms and SCD may be stronger in participants with higher feelings of perceived mastery and social self-efficacy (11). Our data revealed that individuals who endorsed SCD exhibited lower levels of self-efficacy. Memory complaints may reflect a general state of diminished psychological or mental well-being, which was also observed in this study.

We also observed strong associations between SCD and negative/positive psychological factors, including loneliness, resilience, happiness, and wisdom (Cohen's $d \geq 0.30$). In each case, SCD was related to higher levels of negative and lower levels of positive psychological factors, and effect sizes of psychological correlates were as large as (or larger) than those of physical correlates, suggesting that psychological features may be associated with SCD as much as physical functioning. These results represent a unique contribution to the current SCD literature and have important clinical implications. The associations between SCD and negative/positive psychological factors point to possible areas of intervention. For example, increasing one's subjective cognitive experience may improve resilience and happiness and decrease levels of loneliness; conversely, interventions aimed at improving psychological factors may improve one's subjective cognitive experience.

Wisdom is a complex, multidimensional personality trait that is comprised of several specific components, including pro-social behaviors such as empathy and compassion, emotional regulation, self-reflection or insight, acceptance of divergent values, decisiveness, and social advising (57–59). Although

it is often conflated with intelligence, wisdom encompasses cognitive, affective, and reflective dimensions (60). Among the wisdom subscales of the SD-WISE, the cognitive (decisiveness) and affective (emotional regulation) components of wisdom were the strongest correlates of SCD. The decisiveness component entails the cognitive abilities and dispositional qualities related to making decisions. The emotional regulation component pertains to the ability to maintain emotional homeostasis. Although the latter can be reflective of psychological distress, one of the items (e.g., *I cannot filter my negative emotions*) also involves an aspect impulse control related to frontal executive functions, specifically response inhibitory (57). Thus, it is not surprising that individuals with SCD would have lower decisiveness and emotional regulation. At the same time, it is worth stress that positive traits are potentially modifiable. There is growing literature on interventions designed to enhance levels of positive traits such as resilience and components of wisdom including emotional regulation (61,62).

In addition, individuals with SCD reported greater loneliness, which has been previously identified as a major risk factor for adverse mental and physical health outcomes, including cognitive decline and dementia (63–66). (Please see our companion paper, Nguyen et al. (67), for description of detailed analyses of loneliness and associated factors within this MTurk sample.)

With regard to physical functioning, SCD had the strongest relationship with self-reported sleep disturbances and overall physical well-being, consistent with previous literature (27). Disrupted sleep can contribute to both subjective and objective experiences of cognitive impairment (12,68). Similarly, presence of sleep disorders – namely, obstructive sleep apnea (OSA) – has been associated with SCD. Although cognitive deficits have been well documented in patients with OSA, the relationship between SCD and objective impairment in OSA remains unclear (69). SCD in combination with subjective sleep disturbance and OSA may represent early prodromal signs for developing MCI or dementia (70).

The present study has notable strengths. It includes a large sample of nearly 3,000 adults across the adult lifespan with sociodemographic diversity in terms of gender, race, and socioeconomic status. Utilization of the AMT online crowdsourcing marketplace allowed for access to thousands of research participants from demographically diverse backgrounds from around the US, without geographic

restrictions (29). Recruitment through internet samples may reduce biases from traditional samples (71) and better approximate US census data (72–76). Moreover, we took the precaution of using general terms to describe the survey so as to reduce sampling bias and enhance generalizability. Although the unsupervised nature of data collection potentially reduces reliability and validity, many studies have shown that AMT data quality is equivalent to that acquired in controlled settings (29,31–33,38,76) and excluded participants who provided impossible or highly implausible responses to survey items to ensure validity of results. Furthermore, our study included a comprehensive assessment of physical and mental health factors, including positive and negative psychological traits/states, which, to our knowledge, have never been simultaneously investigated in the context of SCD. Overall, our findings provide a more comprehensive understanding of the physical and psychological characteristics, above and beyond psychopathology, associated with SCD.

Nevertheless, this investigation also had several limitations. The presence of SCD was determined using a single yes-no question, rather than a more detailed method of inquiry or standardized measure, which restricted our ability to assess SCD severity and capture complaints in specific cognitive domains. Many self-report measures have been used to investigate SCD (77), but there is no established gold standard method of assessment (78). Moreover, in our experience, this mode of assessment is more pragmatic and consistent with typical clinical practice, and most individuals with impairments in other cognitive domains (e.g., attention/concentration, language, executive function) often perceive these problems as memory difficulties. Due to restrictions of the AMT platform, all data are self-report, which has well known limitations due to recall and response bias (79,80). Although the assessment of subjective cognitive decline requires self-report by definition, this represents a limitation with regard to reports of physical health and functioning. Relatedly, we did not administer performance-based cognitive tests to determine objective cognitive impairment. Finally, the cross-sectional design limits our ability to draw causal inferences regarding SCD and its correlates, and future prospective longitudinal studies are needed to clarify these relationships.

Conclusions

Notwithstanding these limitations, the current study contributes to important research aimed at better understanding the non-cognitive aspects of SCD. Our findings help to characterize the wide range of physical and psychological correlates of SCD. Notably, although definitive causal conclusions are limited by reliance on subjective self-reports, the effect sizes of psychological correlates of SCD were as large as (or larger) than those of physical correlates, indicating that mental health and psychological features are critical to consider when evaluating SCD.

Acknowledgements

The authors thank all the study participants for their contributions to this work.

Funding

Funding for this study was provided, in part, by the National Institute of Mental Health T32 Geriatric Mental Health Program (grant MH019934 to DVJ [PI]), by the Stein Institute for Research on Aging at the University of California, San Diego, and by the K23 MH118435 to TTN [PI].

References

1. Reid LM, Maclullich AMJ. Subjective memory complaints and cognitive impairment in older people. Dement Geriatr Cogn Disord. 2006;22(5–6):471–85.

2. Jessen F, Amariglio RE, van Boxtel M, Breteler M, Ceccaldi M, Chételat G, et al. A conceptual framework for research on subjective cognitive decline in preclinical Alzheimer's disease. Alzheimers Dement. 2014 Nov;10(6):844–52.

3. Visser PJ, Verhey F, Knol DL, Scheltens P, Wahlund L-O, Freund-Levi Y, et al. Prevalence and prognostic value of CSF markers of Alzheimer's disease pathology in patients with subjective cognitive impairment or mild cognitive impairment in the DESCRIPA study: a prospective cohort study. Lancet Neurol. 2009 Jul;8(7):619–27.

4. Jessen F, Amariglio RE, Buckley RF, van der Flier WM, Han Y, Molinuevo JL, et al. The characterisation of subjective cognitive decline. Lancet Neurol. 2020 Mar;19(3):271–8.

5. Edmonds EC, Delano-Wood L, Galasko DR, Salmon DP, Bondi MW, Alzheimer's Disease Neuroimaging Initiative. Subjective cognitive complaints contribute to misdiagnosis of mild cognitive impairment. J Int Neuropsychol Soc. 2014 Sep;20(8):836–47.

6. Garcia-Ptacek S, Cavallin L, Kåreholt I, Kramberger MG, Winblad B, Jelic V, et al. Subjective cognitive impairment subjects in our clinical practice. Dement Geriatr Cogn Dis Extra. 2014 Sep;4(3):419–30.

7. Hessen E, Eckerström M, Nordlund A, Selseth Almdahl I, Stålhammar J, Bjerke M, et al. Subjective cognitive impairment is a predominantly benign condition in memory clinic patients followed for 6 years: the Gothenburg-Oslo MCI Study. Dement Geriatr Cogn Dis Extra. 2017 Feb 2;7(1):1–14.

8. Hollands S, Lim YY, Buckley R, Pietrzak RH, Snyder PJ, Ames D, et al. Amyloid-β related memory decline is not associated with subjective or informant rated cognitive impairment in healthy adults. J Alzheimers Dis. 2015;43(2):677–86.

9. Mol MEM, van Boxtel MPJ, Willems D, Jolles J. Do subjective memory complaints predict cognitive dysfunction over time? A six-year follow-up of the Maastricht Aging Study. Int J Geriatr Psychiatry. 2006 May;21(5):432–41.

10. Beck C, Cody M, Souder E, Zhang M, Small GW. Dementia diagnostic guidelines: methodologies, results, and implementation costs. J Am Geriatr Soc. 2000 Oct;48(10):1195–203.

11. Comijs HC, Deeg DJH, Dik MG, Twisk JWR, Jonker C. Memory complaints; the association with psycho-affective and health problems and the role of personality characteristics: a 6-year follow-up study. J Affect Disord. 2002 Nov;72(2):157–65.

12. Lauriola M, Esposito R, Delli Pizzi S, de Zambotti M, Londrillo F, Kramer JH, et al. Sleep changes without medial temporal lobe or brain cortical changes in community-dwelling individuals with subjective cognitive decline. Alzheimers Dement. 2017 Jul 1;13(7):783–91.

13. Miley-Akerstedt A, Jelic V, Marklund K, Walles H, Åkerstedt T, Hagman G, et al. Lifestyle factors are important contributors to subjective memory complaints among patients without objective

memory impairment or positive neurochemical biomarkers for Alzheimer's disease. Dement Geriatr Cogn Dis Extra. 2018 Nov 28;8(3):439–52

14. Stenfors CUD, Marklund P, Magnusson Hanson LL, Theorell T, Nilsson L-G. Subjective cognitive complaints and the role of executive cognitive functioning in the working population: a case-control study. PLoS One. 2013 Dec 26;8(12):e83351.

15. Balash Y, Mordechovich M, Shabtai H, Giladi N, Gurevich T, Korczyn AD. Subjective memory complaints in elders: depression, anxiety, or cognitive decline? Acta Neurol Scand. 2013 May;127(5):344–50.

16. Slavin MJ, Brodaty H, Kochan NA, Crawford JD, Trollor JN, Draper B, et al. Prevalence and predictors of "subjective cognitive complaints" in the Sydney Memory and Ageing Study. Am J Geriatr Psychiatry. 2010 Aug;18(8):701–10.

17. Steinberg SI, Negash S, Sammel MD, Bogner H, Harel BT, Livney MG, et al. Subjective memory complaints, cognitive performance, and psychological factors in healthy older adults. Am J Alzheimers Dis Other Demen. 2013 Dec;28(8):776–83.

18. Ginó S, Mendes T, Maroco J, Ribeiro F, Schmand BA, de Mendonça A, et al. Memory complaints are frequent but qualitatively different in young and elderly healthy people. Gerontology. 2010;56(3):272–7.

19. Ponds R, van Boxtel MPJ, Jolles J. Age-related changes in subjective cognitive functioning. Educ Gerontol. 2000 Jan;26(1):67–81.

20. Ponds RW, Commissaris KJ, Jolles J. Prevalence and covariates of subjective forgetfulness in a normal population in the Netherlands. Int J Aging Hum Dev. 1997;45(3):207–21.

21. Derouesné C, Lacomblez L, Thibault S, LePoncin M. Memory complaints in young and elderly subjects. Int J Geriatr Psychiatry. 1999 Apr;14(4):291–301.

22. Begum A, Dewey M, Hassiotis A, Prince M, Wessely S, Stewart R. Subjective cognitive complaints across the adult life span: a 14-year analysis of trends and associations using the 1993, 2000 and 2007 English Psychiatric Morbidity Surveys. Psychol Med. 2014 Jul;44(9):1977–87.

23. Vestergren P, Nilsson L-G. Perceived causes of everyday memory problems in a population-based sample aged 39–99. Appl Cogn Psychol. 2011;25(4):641–6.

24. Au A, Cheng C, Chan I, Leung P, Li P, Heaton RK. Subjective memory complaints, mood, and memory deficits among HIV/AIDS patients in Hong Kong. J Clin Exp Neuropsychol. 2008 Apr;30(3):338–48.

25. Weis J, Poppelreuter M, Bartsch HH. Cognitive deficits as long-term side-effects of adjuvant therapy in breast cancer patients: 'subjective' complaints and 'objective' neuropsychological test results. Psychooncology. 2009 Jul;18(7):775–82.

26. Rayner G, Wrench J, Wilson S. Differential contributions of objective memory and mood to subjective memory complaints in refractory focal epilepsy. Epilepsy and Behav. Nov;19(3):359–64

27. Lee JE, Ju YJ, Park E-C, Lee SY. Effect of poor sleep quality on subjective cognitive decline (SCD) or SCD-related functional difficulties: results from 220,000 nationwide general populations without dementia. J Affect Disord. 2020 Jan 1;260:32–7.

28. Rodríguez-Gómez O, Abdelnour C, Jessen F, Valero S, Boada M. Influence of sampling and recruitment methods in studies of subjective cognitive decline. J Alzheimers Dis. 2015 Sep 24;48 Suppl 1:S99–107.

29. Buhrmester M, Kwang T, Gosling SD. Amazon's Mechanical Turk: a new source of inexpensive, yet high-quality, data? Perspect Psychol Sci. 2011 Jan;6(1):3–5.

30. Hara K, Adams A, Milland K, Savage S, Callison-Burch C, Bigham JP. A data-driven analysis of workers' earnings on Amazon Mechanical Turk. In: Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18. Montreal QC, Canada Association for Computing Machinery; 2018. (CHI '18). p. 1–14.

31. Litman L, Robinson J, Rosenzweig C. The relationship between motivation, monetary compensation, and data quality among US- and India-based workers on Mechanical Turk. Behav Res Methods. 2015 Jun;47(2):519–28.

32. Mason W, Suri S. Conducting behavioral research on Amazon's Mechanical Turk. Behav Res Methods. 2012 Mar;44(1):1–23.

33. Sprouse J. A validation of Amazon Mechanical Turk for the collection of acceptability judgments in linguistic theory. Behav Res Methods. 2011;43(1):155–67.

34. Coppock A. Generalizing from survey experiments conducted on Mechanical Turk: a replication approach. Political Sci Res Methods. 2019 Jul;7(3):613–28.

35. Hauser DJ, Schwarz N. Attentive Turkers: MTurk participants perform better on online attention checks than do subject pool participants. Behav Res Methods. 2016 Mar;48(1):400–7.

36. Horton JJ, Rand DG, Zeckhauser RJ. The online laboratory: conducting experiments in a real labor market. Exp Econ. 2011 Sep 1;14(3):399–425.

37. Mortensen K, Hughes TL. Comparing Amazon's Mechanical Turk platform to conventional data collection methods in the health and medical research literature. J Gen Intern Med. 2018 Apr;33(4):533–8.

38. Peer E, Vosgerau J, Acquisti A. Reputation as a sufficient condition for data quality on Amazon Mechanical Turk. Behav Res Methods. 2014 Dec;46(4):1023–31.

39. Hujoel PP, Cunha-Cruz J, Kressin NR. Spurious associations in oral epidemiological research: the case of dental flossing and obesity. J Clin Periodontol. 2006 Aug;33(8):520–3.

40. Ware JE, Snow KK, Kosinski M, Gandek B. Health survey manual and interpretation guide. The Health Institute, New England Medical Center; 1997.

41. Cella D, Riley W, Stone A, Rothrock N, Reeve B, Yount S, et al. Initial adult health item banks and first wave testing of the Patient–Reported Outcomes Measurement Information System (PROMIS^{TM}) network: 2005–2008. J Clin Epidemiol. 2010 Nov;63(11):1179–94.

42. Kroenke K, Spitzer RL, Williams JBW. The Patient Health Questionnaire-2: validity of a two-item depression screener. Med Care. 2003 Nov;41(11):1284–92.

43. Kroenke K, Spitzer RL, Williams JBW, Monahan PO, Löwe B. Anxiety disorders in primary care: prevalence, impairment, comorbidity, and detection. Ann Intern Med. 2007 Mar 6;146(5):317–25.

44. Russell D, Peplau LA, Cutrona CE. The revised UCLA Loneliness Scale: concurrent and discriminant validity evidence. J Pers Soc Psychol. 1980 Sep;39(3):472–80.

45. Thomas ML, Bangen KJ, Palmer BW, Martin A, Avanzino JA, Depp C, et al. A new scale for assessing wisdom based on common domains and a neurobiological model: the San Diego Wisdom Scale (SD-WISE). Journal of Psychiatric Research. 2019 Jan 1;108:40–7.

46. Davidson J. Connor-Davidson Resilience Scale (CDRISC) Manual. Unpublished. Accessible at www.cdrisc.com; 2018.

47. Fowler JH, Christakis NA. Dynamic spread of happiness in a large social network: longitudinal analysis over 20 years in the Framingham Heart Study. BMJ. 2008 Dec 4;337:a2338.

48. Muris P. Relationships between self-efficacy and symptoms of anxiety disorders and depression in a normal adolescent sample. Pers Individ Dif. 2002 Jan 19;32(2):337–48.

49. Zullig KJ, Teoli DA, Valois RF. Evaluating a brief measure of social self-efficacy among U.S. adolescents. Psychol Rep. 2011 Dec;109(3):907–20.

50. Tang W, He H, Tu X. Applied Categorical and Count Data Analysis. New York, NY: Chapman & Hall/CRC; 2012.

51. Benjamini Y, Hochberg Y. Controlling the false discovery rate: a practical and powerful approach to multiple testing. J R Stat Soc Series B Stat Methodol. 1995;57(1):289–300.

52. Kielb S, Rogalski E, Weintraub S, Rademaker A. Objective features of subjective cognitive decline in a United States national database. Alzheimers Dement. 2017 Dec;13(12):1337–44.

53. Koppara A, Wagner M, Lange C, Ernst A, Wiese B, König H-H, et al. Cognitive performance before and after the onset of subjective cognitive decline in old age. Alzheimers Dement (Amst). 2015 Jun;1(2):194–205.

54. Snitz BE, Wang T, Cloonan YK, Jacobsen E, Chang C-CH, Hughes TF, et al. Risk of progression from subjective cognitive decline to mild cognitive impairment: the role of study setting. Alzheimers Dement. 2018;14(6):734–42.

55. Reid M, Parkinson L, Gibson R, Schofield P, D'Este C, Attia J, et al. Memory Complaint Questionnaire performed poorly as screening tool: validation against psychometric tests and affective measures. J Clin Epidemiol. 2012 Feb;65(2):199–205.

56. Beekman AT, de Beurs E, van Balkom AJ, Deeg DJ, van Dyck R, van Tilburg W. Anxiety and depression in later life: co-occurrence and communality of risk factors. Am J Psychiatry. 2000 Jan;157(1):89–95.

57. Meeks TW, Jeste DV. Neurobiology of wisdom: a literature overview. Arch Gen Psychiatry. 2009 Apr 1;66(4):355-65.

58. Thomas ML, Bangen KJ, Palmer BW, Sirkin Martin A, Avanzino JA, Depp CA, et al. A new scale for assessing wisdom based on common domains and a neurobiological model: the San Diego Wisdom Scale (SD-WISE). J Psychiatr Res. 2019 Jan;108:40–7.

59. Jeste DV, Lee EE. The emerging empirical science of wisdom: definition, measurement, neurobiology, longevity, and interventions. Harv Rev Psychiatry. 2019 Jun;27(3):127–40.

60. Ardelt M, Jeste DV. Wisdom and hard times: the ameliorating effect of wisdom on the negative association between adverse life events and well-being. J Gerontol B Psychol Sci Soc Sci. 2018 10;73(8):1374–83.

61. Lee E, Bangen K, Avanzino J, Hou B, Ramsey M, Eglit G, et al. Meta-analysis of randomized controlled trials to enhance components of wisdom: pro-social behaviors, emotional regulation, and spirituality. JAMA Psychiatry. Forthcoming 2020.

62. Treichler EBH, Glorioso D, Lee EE, Wu T-C, Tu XM, Daly R, et al. A pragmatic trial of a group intervention in senior housing communities to increase resilience. Int Psychogeriatr. 2020 Feb;32(2):173–82.

63. Hawkley LC, Cacioppo JT. Loneliness matters: a theoretical and empirical review of consequences and mechanisms. Ann Behav Med. 2010 Oct;40(2):218–27.

64. Boss L, Kang D-H, Branson S. Loneliness and cognitive function in the older adult: a systematic review. Int Psychogeriatr. 2015 Apr;27(4):541–53.

65. Tilvis RS, Kähönen-Väre MH, Jolkkonen J, Valvanne J, Pitkala KH, Strandberg TE. Predictors of cognitive decline and mortality of aged people over a 10-year period. J Gerontol A Biol Sci Med Sci. 2004 Mar;59(3):268–74.

66. Wilson RS, Krueger KR, Arnold SE, Schneider JA, Kelly JF, Barnes LL, et al. Loneliness and risk of Alzheimer disease. Arch Gen Psychiatry. 2007 Feb 1;64(2):234-40.

67. Nguyen T, Lee E, Daly R, Wu T, Tang Y, Tu X, et al. Predictors of loneliness by age decade: study of psychological and environmental factors in 2,843 community-dwelling Americans aged 20-69 years. Forthcoming.

68. Alhola P, Polo-Kantola P. Sleep deprivation: impact on cognitive performance. Neuropsychiatr Dis Treat. 2007 Oct;3(5):553–67.

69. Vaessen TJA, Overeem S, Sitskoorn MM. Cognitive complaints in obstructive sleep apnea. Sleep Med Rev. 2015 Feb;19:51–8.

70. Yaffe K, Laffan AM, Harrison SL, Redline S, Spira AP, Ensrud KE, et al. Sleep-disordered breathing, hypoxia, and risk of mild cognitive impairment and dementia in older women. JAMA. 2011 Aug 10;306(6):613–9.

71. Gosling SD, Vazire S, Srivastava S, John OP. Should we trust web-based studies? A comparative analysis of six preconceptions about internet questionnaires. Am Psychol. 2004 Mar;59(2):93–104.

518 72. Berinsky AJ, Huber GA, Lenz GS. Evaluating online labor markets for experimental research:
519 Amazon.com's Mechanical Turk. Polit Anal. 2012;20(3):351–68.

520 73. Casler K, Bickel L, Hackett E. Separate but equal? A comparison of participants and data gathered
521 via Amazon's MTurk, social media, and face-to-face behavioral testing. Comput Human Behav. 2013
522 Nov;29(6):2156–60.

523 74. Eriksson K, Simpson B. Emotional reactions to losing explain gender differences in entering a risky
524 lottery. Judgm Decis Mak. 2010;5(3):5.

525 75. Ipeirotis PG. Demographics of Mechanical Turk. Rochester, NY: Social Science Research Network;
526 2010 Mar. Report No.: ID 1585030.

527 76. Johnson DR, Borden LA. Participants at your fingertips: using Amazon's Mechanical Turk to
528 increase student–faculty collaborative research. Teach Psychol. 2012 Oct;39(4):245–51.

529 77. Rabin LA, Smart CM, Crane PK, Amariglio RE, Berman LM, Boada M, et al. Subjective cognitive
530 decline in older adults: an overview of self-report measures used across 19 international research
531 studies. J Alzheimers Dis. 2015 Sep 24;48 Suppl 1:S63-86.

532 78. Molinuevo JL, Rabin LA, Amariglio R, Buckley R, Dubois B, Ellis KA, et al. Implementation of
533 subjective cognitive decline criteria in research studies. Alzheimers Dement. 2017 Mar;13(3):296–
534 311.

535 79. Janssens ACJW, Kraft P. Research conducted using data obtained through online communities:
536 ethical implications of methodological limitations. PLoS Med. 2012 Oct 23;9(10):e1001328.

537 80. Stone A, Bachrach C, Jobe J, Kurtzman H, Cain V. The science of self-report: Implications for
538 research and practice. Psychology Press; 1999.

539

540

541

Table 1. Demographic Characteristics, Physical Health, and Mental Health by Group.

	SCD (n = 771) Mean (SD)/Percentage	No SCD (n = 2191) Mean (SD)/Percentage	*t* or χ^2	*p*	FDR-adjusted *p*	Cohen's *d* or Cramer's *V*
Demographic Characteristics						
Age	43.16 (12.97); range = 18-73	43.44 (13.47); range = 18-81	0.50	.62	.64	0.02
Gender (% Female)	482/769 (63%)	1186/2187 (54%)	18.93	< .001	< .001	.08
Years of Education	n = 768	n = 2185	5.00	< .001	< .001	0.21
Less than a high school diploma	4 (<1%)	19 (<1%)				
High school degree or equivalent	392 (51%)	845 (39%)				
Bachelor's degree	272 (35%)	963 (44%)				
Master's or doctorate	100 (13%)	358 (16%)				
Race	n = 766	n = 2180	3.82	.43	.47	.04
African American	66 (9%)	156 (7%)				
American Indian/Alaska Native	10 (1%)	12 (<1%)				
Asian	40 (5%)	155 (7%)				
Multi-Racial	20 (3%)	63 (3%)				
Native Hawaiian or Pacific Islander	3 (<1%)	6 (<1%)				
Other	6 (<1%)	20 (<1%)				
White	621 (81%)	1768 (81%)				
Latinx origin (% endorsed)	79/762 (10.4%)	196/2175 (9.0%)	1.22	.27	.29	.02
Income (per year)	n = 762	n = 2165	3.20	.001	.001	0.14
< $35,000	397 (52%)	965 (44%)				
$35,000 – $74,000	254 (33%)	834 (38%)				
≥ $75,000	111 (14%)	366 (17%)				
Married or living in a marriage-like relationship (% endorsed)	427/771 (55%)	1225/2191 (56%)	.064	.80	.80	.01
Employment status	n = 762	n = 2178	9.05	.03	.04	.03
Employed full time	462 (60%)	1394 (64%)				
Employed part-time	118 (15%)	332 (15%)				
Unemployed/unable to work	87 (11%)	172 (8%)				
Other	95 (12%)	280 (13%)				
Physical Health						
BMI	28.33 (7.72)	27.15 (6.51)	3.83	< .001	< .001	0.30
Medications for medical conditions (% endorsed)	398/771 (52%)	712/2191 (32%)	89.02	< .001	< .001	.17
Frequency of flossing	--	--	6.40	< .001	< .001	0.28
SF-12 Physical Health	44.41 (10.75)	49.32 (9.44)	11.26	< .001	< .001	0.49
PROMIS Sleep Disturbances	54.03 (8.66)	49.01 (8.92)	13.72	< .001	< .001	0.57
Sleep apnea item (% endorsed)	104/771 (13%)	158/2191 (7%)	27.88	< .001	< .001	.10

Mental Health						
SF-12 Mental Health	39.72 (11.83)	47.87 (11.15)	16.70	< .001	< .001	0.71
CDRS-2 Total	4.95 (1.68)	5.76 (1.64)	11.70	< .001	< .001	0.49
PHQ-2 Total	2.51 (1.84)	1.21 (1.55)	17.54	< .001	< .001	0.76
GAD-2 Total	2.59 (1.88)	1.35 (1.64)	16.25	< .001	< .001	0.70
UCLA Loneliness 4-item	9.76 (2.55)	8.39 (2.59)	12.64	< .001	< .001	0.53
CES-D Happiness Scale	6.47 (3.36)	8.71 (3.23)	16.31	< .001	< .001	0.68
SD-WISE Total	3.54 (0.49)	3.78 (0.49)	11.34	< .001	< .001	0.49
Decisiveness	3.13 (0.90)	3.59 (0.87)	12.47	< .001	< .001	0.52
Emotional Regulation	3.00 (0.82)	3.56 (0.82)	16.53	< .001	< .001	0.68
Pro-Social Behaviors	3.82 (0.65)	4.01 (0.64)	7.22	< .001	< .001	0.29
Social Advising	3.57 (0.71)	3.68 (0.63)	4.26	< .001	< .001	0.16
Tolerance for Divergent Values	3.84 (0.67)	3.88 (0.63)	1.44	.15	.17	0.06
Social Self-Efficacy	12.85 (3.43)	13.86 (3.27)	7.28	< .001	< .001	0.30

Note. BMI = body mass index; CDRS = Connor Davidson Resilience Scale-2 item; CES-D = Center for Epidemiologic Studies-Depression scale; GAD-2 = Generalized Anxiety Disorder scale, 2-item; PHQ-2 = Patient Health Questionnaire, 2-item; PROMIS = Patient-Reported Outcomes Measurement Information System; SCD = subjective cognitive decline; SD-WISE = San Diego Wisdom Scale; UCLA = University of California Los Angeles.

542