Is the relationship between subjective age, depressive symptoms and activities of daily living bidirectional?

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Abstract

Objectives: The aim of the current study was to investigate the prospective association between subjective age and depressive symptoms and activities of daily living (ADLs), and to test for reciprocal relationships.

Methods: We used data from 9,886 respondents aged 50 years and over who participated in the English Longitudinal Study of Ageing (ELSA). We fitted a series of multiple regression models to analyse the relationships between subjective age, depressive symptoms and ADL limitations over a four-year period.

Results: Following adjustment for demographic, social, cognitive, lifestyle and health factors, we found that having an older subjective age independently predicted increased ADL limitations (*B* = -0.16, 95% *CI* -0.25, -0.07) and greater depressive symptoms (*B* = -0.40, 95% *CI* -0.57, -0.23). By contrast, we observed no significant associations between depressive symptoms and ADL limitations and future subjective age in the fully-adjusted model.

Conclusion: In conclusion, older subjective age is associated with future depression and functional health, but the reverse pattern is confounded by initial health and social factors. These findings indicate that an individual's age identity may have an important effect on both depressive symptoms and activities of daily living.

Keywords: age identity; subjective age; depression; activities of daily living; ELSA

Introduction

Subjective age or self-perceived age is an important feature of later life, since it is relevant to appraisals of health and physical limitations, satisfaction with aging, cognitive fitness and wellbeing (Larzelere et al., 2011). Discrepancies between chronological age and subjective age are often wider in older age than earlier in life (Kastenbaum et al., 1972; Kotter-Grühn et al., 2009) and most older adults feel younger than their chronological age (Hughes et al., 2013; Rubin and Berntsen, 2006). Longitudinal population studies have demonstrated that individuals who feel older than their chronological age have reduced longevity (Kotter-Grühn et al., 2009; Markides and Pappas, 1982; Rippon and Steptoe, 2015; Uotinen et al., 2005), poorer psychological wellbeing (Choi and DiNitto, 2014; Mock and Eibach, 2011), and poorer cognitive, functional and physical health (Demakakos et al., 2007; Stephan et al., 2015a, 2014; Westerhof et al., 2014) compared with people who have a younger subjective age. Greater subjective age has also been associated with increased risk of hospitalisation, higher concentrations of C-reactive protein, and more rapid development of cognitive impairment (Stephan et al., 2017, 2016, 2015b).

There have been few studies of reciprocal relationships between subjective age and emotional and functional health outcomes (Spuling et al., 2013), with the majority of existing research focusing on subjective age as a predictor of future health (Kotter-Grühn et al., 2016; Westerhof et al., 2014). Older adults with younger subjective age identities are more likely to have better subjective wellbeing, life satisfaction and are less likely to experience elevated depressive symptoms (Barak and Stern, 1986; Barrett, 2003; Choi and DiNitto, 2014; Keyes and Westerhof, 2012; Mock and Eibach, 2011; Westerhof and Barrett, 2005). Previous longitudinal studies have demonstrated that having a younger perception of age was potentially protective of

declining functional health (Stephan et al., 2015a). Conversely, some work indicates that psychosocial and biomedical factors such as perceived age discrimination, lower grip strength, and higher waist circumference may explain older subjective age (Stephan et al., 2015c). Others have shown that better mental health is an important correlate or predictor of subjective age (Bergland et al., 2014; Infurna et al., 2010) and it has been argued that having a younger subjective age may help to maintain self-esteem and wellbeing over time (Weiss and Lang, 2012).

The aim of the current study was to investigate the direction of the association between subjective age and depression and impaired activities of daily living (ADLs) in a large sample of older adults in England. Investigating the direction of the association would enable us to further establish whether there is a reciprocal relationship. The second aim was to establish the extent to which the associations were explained by existing socio-demographic and health factors as these may affect or explain some of the differences in the findings observed previously. It is plausible that in each case there is a bidirectional relationship. People with impaired ADLs may feel older than their actual age, and conversely feeling older might lead to beliefs that one's activities are limited, and make individuals perceive impairments more vividly. In the case of elevated depressive symptoms, depressed mood could make people feel older, and conversely feeling older might make a person more depressed. This is in line with recent empirical studies which have demonstrated that when individuals perceive aging to be fixed and inevitable this may lead to perceptions of age related losses whilst when individuals perceive that age related changes can be modified this leads to a more optimistic outlook of the future (Weiss et al., 2016). Similarly, a recent study of 3,427 respondents from the Midlife in the United States (MIDUS) study indicated that individuals who had better functional health or cognitive function made more favourable

social comparisons of their cognitive function and overall health and in turn reported younger subjective ages in contrast with those with poorer health (Hughes and Lachman, 2016). Therefore, taken together this suggests that when individuals make more negative health related comparison or perceive such changes as inevitable due to age, they may be more likely to identify with an older subjective age, whereas if they feel these factors are malleable or have a more positive perception of their health they may feel younger than their actual age.

Declining physical function can serve as an indicator of current health status and frailty (Clegg et al., 2013). There is substantial evidence that cognitive function, depression, social isolation, co-morbidities or disease burden, poor self-rated health, smoking and low levels of physical activity are associated with declining functional health at older ages (Stuck et al., 1999). Some of the key predictors of depressive symptoms at older ages include female sex, functional limitations, cognitive impairments, poor self-rated health, chronic health conditions and lack of social networks, along with prior depressive symptoms (Cole and Dendukuri, 2003; Djernes, 2006). It is possible that subjective perceptions of age partly reflect socio-demographic factors such as wealth and education, along with limitations in social activity, social isolation or lifestyle factors (Barrett, 2003; Infurna et al., 2010; Westerhof and Barrett, 2005), all of which are potentially related to health outcomes. Further, it has been argued that subjective perceptions of age, along with our own attitudes to age and aging are not static and will be influenced by developmental changes along with cultural factors, socio-economic resources and experiences amongst others across the life-course (Diehl et al., 2014).

In our study we sought to test the following hypotheses: (1) Having an older subjective age at baseline will be associated with increased depressive symptoms and greater ADL limitations four years later; (2) older adults who report increased depressive symptoms or ADL

limitations at baseline will have an older subjective age four years later; (3) the predicted bidirectional associations between subjective age, depressive symptoms and limited ADLs will remain after socio-demographic and health factors are taken into account. All analyses adjusted for the baseline level of the outcome variable. We also took into account demographic factors such as socioeconomic status and education, measures of cognitive function, social engagement, health behaviours and physical health.

Methods

Participants

This study involved analysis of people who took part in the fourth (2008-09) and sixth (2012-13) waves of the English Longitudinal Study of Ageing (ELSA). ELSA is a national cohort study which began in 2002 to study aging and health in adults aged 50 years and over living in England and the sample is broadly representative of the English population (Steptoe et al., 2013a). The sample is reassessed every two years and every four years for a health examination, and is periodically refreshed to ensure a representation of younger participants. Data are collected each wave using computer-assisted personal interviews (CAPI), and self-completion questionnaires. The fourth wave of ELSA involved 9,886 core participants.

Measures

Subjective age. ELSA participants were asked 'How old do you feel you are?' as part of the main home interview at Waves 4 and 6. Wave 4 was chosen as the baseline for this analysis because this is the first wave in which the subjective age measure was included in the main CAPI interview; it was next repeated in Wave 6. In line with previous research we calculated a proportional discrepancy score by subtracting subjective age from chronological age and dividing the difference score by chronological age (Rubin and Berntsen, 2006; Weiss and Lang,

2012). A positive value indicates a younger subjective age while a negative value indicates an older subjective age (i.e., an individual who scored 0.10 feels 10% younger than their actual age and a participant who scored -0.10 feels 10% older than their actual age). Eleven individuals who said that they felt that they were younger than ten years old were excluded from analyses because of uncertainty about whether they had understood the question. Including these eleven participants in the analyses produced similar results to those reported in the current study.

Depressive symptoms. Depressive symptoms were measured using the eight-item Center for Epidemiological Studies Depression Scale (CES-D) (Steffick, 2000). We did not include responses to the item on loneliness in order to avoid overlap with the loneliness scale (Cacioppo et al., 2010). Total scores ranged from 0 to 7, with higher scores indicating increased depressive symptoms.

Activities of daily living (ADLs). Respondents were asked whether they had difficulty with any of six ADLs: dressing, walking across a room, bathing or showering, eating, getting in or out of bed and using the toilet. Scores ranged from 0 to 6 with higher scores indicating greater difficulties.

Covariates. We obtained data on age, sex, marital status (married/non-married), education, wealth and current employment status during the home interview. Education was measured by the highest educational qualification attained and divided into three groups - low (no educational qualifications), intermediate (O Levels, Certificate of Secondary Education or equivalent), and high (A Levels or equivalent through to higher degrees). Total non-pension wealth, defined as the sum of financial worth, physical worth (such as business wealth, land or jewellery), and housing wealth after deducting debts, was categorised into quintiles for the purposes of analysis. It is regarded as a robust indicator of socioeconomic resources in ELSA

(Demakakos et al., 2016). Current employment status indicated whether or not a respondent was currently employed (full-time, part-time, or self-employed), retired or in another situation (for example, unemployed or looking after the home or family).

Cognitive function was measured in terms of memory, combining scores for immediate recall (number of ten aurally presented words recalled) and delayed recall (recall of these same words after the performance of intervening tasks).

Social engagement was assessed with two measures: social isolation and loneliness. We created an index of social isolation by giving a point if the respondent was not married or living with a partner, had less than monthly contact (including face-to-face, telephone or written/e-mail contact) with each of children, other family members, and friends, and if they did not participate in organisations, such as, social clubs or resident groups, religious groups or committees, as described previously (Steptoe et al., 2013b). Scores ranged from 0 to 5, with higher scores indicating greater social isolation. Loneliness was measured with the three-item, short form of the Revised UCLA loneliness scale (Hughes et al., 2004). Respondents were asked how often they felt they lacked companionship, felt left out or felt isolated from others around them, with response options of hardly ever, some of the time and never. Scores ranged from 3 to 9 with higher scores indicating greater loneliness.

Health behaviours included smoking (current/ not current) and physical activity. Physical activity was coded as a dichotomous variable based on moderate to vigorous leisure-time activity reported once a week or less than once a week.

Finally, we assessed baseline health with two measures: first, participants rated their health as either excellent, very good, good, fair or poor, with a higher rating indicating poorer self-rated health. Second, we asked respondents whether they had a physician diagnosis of

coronary heart disease (CHD), cancer, stroke, diabetes, arthritis and chronic lung disease. A point was given for each diagnosis referred to, giving a possible score of 0 to 6.

Statistical Analyses

First, Pearson's correlations were used to examine the relationship between subjective age and all covariates at baseline (wave 4). Next we conducted a series of multivariable regression models with depressive symptoms, ADL limitations and subjective age as the outcome variables.

Subjective age as a predictor of later depressive symptoms or ADL limitations. We fitted six linear regression models for each of the two outcome variables (depressive symptoms and ADL limitations at wave six). Separate analyses were carried out for depression and limited ADLs. The first model adjusted for age, sex, subjective age and either baseline depressive symptoms or ADL limitations. In subsequent models we added socio-demographic characteristics (wealth, education and work status, model 2), cognitive function and social engagement (model 3), health behaviours (model 4) and physical health (model 5) to the baseline model. In the final, fully adjusted model (model 6) we included socio-demographic characteristics, cognitive function, social engagement, health behaviours, physical health and both baseline depressive symptoms and ADLs.

Depressive symptoms or ADL limitations as predictors of later subjective age. The same six models were fitted as before, but in this instance subjective age at wave six was the outcome variable and depressive symptoms or ADL limitations at wave four were independent variables. The first model adjusted for age, sex, baseline subjective age and either baseline depressive symptoms or limited ADLs. Subsequently, we added socio-demographic

characteristics (model 2), social engagement and cognitive function (model 3), health behaviours (model 4) and physical health (model 5) to the first model. In the final model (model 6) we adjusted for all previous measures. Two sets of models were run, one for depressive symptoms and a second for ADL limitations. The final, fully-adjusted model was common to both.

To investigate the influence of missing data, we imputed missing values using multivariate imputation by chained equations, and 50 datasets were imputed. We included all variables from the analyses in the imputation model. Estimates from these analyses were combined using Rubin's rules (Rubin, 1996). All analyses reported here refer to the imputed datasets. Results are presented as unstandardized regression coefficients (B) and all data were analysed using STATA 14.2 (StataCorp LP, College Station, TX).

Results

Table 1 shows the sample characteristics at wave 4 (2008-09). As it can be seen, at baseline participants felt on average 17% younger than their actual age. Imputed data showed very similar percentages and means as observed data. One of the reasons for missing data was that some of the measures used (for example, social isolation and loneliness) were assessed as part of the self-completion questionnaire which was only returned by about 80% of respondents. Individuals who did not complete the subjective age measure tended to be older, less wealthy, less educated and reported poorer self-rated health in comparison with those who completed the measure. Further, a higher proportion reported elevated depressive symptoms, and had higher limited ADL scores. A similar pattern was observed for the 1,394 participants who were lost to attrition or had died before Wave 6. Most of the missing data on the key dependent and

independent variables was a result of attrition from the study, rather than selective non-response to these items.

The bivariate correlations between subjective age, depressive symptoms and ADLs are presented in Table 2. Feeling younger than chronological age was positively correlated with education ($p<0.001$), memory ($p<0.001$) and physical activity ($p<0.001$), and negatively correlated with depressive symptoms, limited ADLS, loneliness, number of physician diagnosed health conditions and self-rated health (all $p<0.001$).

Subjective Age as a Predictor of Future Depressive Symptoms or ADL Limitations

In the unadjusted models between subjective age and future depressive symptoms or ADL limitations, subjective age explained around 8% of the variance in future depression scores and 7% of the variance in ADL scores. Table 3 summarises the multiple linear regression models for the prospective relationship between subjective age and depressive symptoms and for the relationship between subjective age and ADL limitations. It is worth noting that the results detailed below are the same as those for complete case models.

Depressive symptoms. Having an older subjective age was significantly associated with greater depressive symptoms four years later ($B = -0.72$, $p <0.001$), adjusting for age, sex and baseline depressive symptoms (model 1). Indicating that each unit increase in subjective age (i.e. feeling younger) is associated with 0.72 decrease in depression score. The association remained significant ($B = -0.67$, $p <0.001$) after accounting for socio-demographic characteristics (model 2). Adjustment for cognitive function and social engagement (model 3) and health behaviours (model 4) had a modest impact on the associations between subjective age and depressive symptoms. However, baseline physical health (model 5) had a more pronounced impact on the relationship between subjective age and depressive symptoms, reducing the association by

around 39% (B = -0.44, p<0.001). In the fully adjusted model (model 6) having an older subjective age remained a significant independent predictor of future depressive symptoms after all covariates were taken into account (B = -0.40, p<0.001). Altogether the predictors explained around 35% of the variance in depressive symptoms. In the final model, other significant predictors of elevated depressive symptoms included female sex, higher levels of loneliness, greater limited ADLs, lower levels of physical activity, being a current smoker, increased number of physician diagnosed health conditions and poorer self-rated health (Supplementary Table 1).

ADL limitations. The results for ADL limitations were similar to those for depressive symptoms. Having an older subjective age was associated with increased ADL limitations four years later (B =-0.40, p <0.001), after adjusting for age, sex and baseline ADLs (Model 1). Subsequent models had limited effects on the association between subjective age and future ADL limitations (models 2-4). The addition of physical health measures (model 5) to the baseline model reduced the association more markedly (B =-0.23, p<0.001). But in the final fully adjusted model (model 6), feeling older than actual age remained a significant independent predictor of ADL limitations (B = -0.16, p<0.001). Apart from subjective age, the factors that were independently associated with ADL limitations in the final model included increasing chronological age, having existing difficulties with ADLs, higher levels of depressive symptoms and loneliness, participation in vigorous to moderate physical activity less than once a week, greater number of physician diagnosed conditions and poorer self-rated health (Supplementary Table 1). The final model accounted for around 46% of the variance in ADL scores.

Elevated Depressive Symptoms or ADL Limitations as Predictors of Future Subjective Age

Table 4 summarises the multiple linear regression models for the prospective relationship between depressive symptoms and future subjective age and for the relationship between ADL limitations and subjective age. In the unadjusted associations with future subjective age, depressive symptoms and limited ADLs explained around one and two per-cent of the variance in future subjective age scores, respectively. Whilst subjective age at wave four accounted for approximately 25% of the variance in subjective age scores four years later.

Depressive symptoms. Depressive symptoms predicted subjective age four years later (B = -0.01, p<0.001) after controlling statistically for age, sex and baseline subjective age (model 1). In subsequent models, the relationship between depressive symptoms and future age remained little changed (models 2-4). Adjustment for physical health measures (model 5) attenuated the association between depressive symptoms and subjective age. (B=-0.001, p=0.68) In the final fully-adjusted model (model 6) there remained no significant relationship between depressive symptoms and future subjective age (B =0.001, p=0.73).

ADL Limitations. ADL limitations at baseline predicted future subjective age independently of age, sex and baseline subjective age (B = -0.01, p <0.001). Adjustment for socio-demographic factors (model 2) and cognitive function and social engagement (model 3) and health behaviours (model 4) reduced the association but it remained significant. The addition physical health (B = -0.004, p=0.098) measures to the baseline model attenuated the association between ADL limitations and future subjective (model 5). In the fully adjusted model (model 6), we found that ADL limitations were not a significant independent predictor of future subjective age.

Besides baseline subjective age, the other key independent predictor of having a younger subjective age four years later was better self-rated health (Supplementary Table 2). The inclusion of all factors explained around 28% of the variance in subjective age scores.

Discussion

In a large national sample of older adults, we observed that subjective age is negatively related to both depressive symptoms and limited ADLs. Participants who felt older than their actual age reported higher depressive symptoms and ADL scores four years later. The associations were substantially reduced by covariates, notably baseline health status. Nevertheless, the relationships remained independently significant in the fully adjusted models. Conversely, ADL limitations at baseline predicted future subjective age after adjustment for age, sex and baseline subjective age. However, once all covariates had been taken into account, ADL limitations no longer predicted future subjective age. Baseline depressive symptoms were not significantly associated with future subjective age. As expected, the results of both directional analyses revealed that the strongest confounding effects were pre-existing physical illness and poorer self-rated health. Factors such as sex, wealth, education, social engagement and memory had a limited effect. The findings suggest that functional limitations and depression have complex but important relationships with how old an individual feels.

The results for depression are in accordance with other longitudinal studies that have demonstrated that having an older subjective age is associated with increased depressive symptoms (Choi and DiNitto, 2014; Spuling et al., 2013). One explanation is that feeling younger may reflect resilience, mastery, sense of control and satisfaction with aging (Kotter-Grühn et al., 2009; Westerhof and Barrett, 2005). Mock and Eibach (2011) demonstrated that an

individual's attitude towards aging moderated the association between feeling older and wellbeing. In other words, the effect of the observed association between subjective age and wellbeing was dependent upon aging attitudes – if respondents had more negative attitudes towards aging then feeling older than their age had a negative impact upon wellbeing but if they had more favourable attitudes towards aging then feeling older did not have such a negative impact on wellbeing. Since evidence from empirical studies has demonstrated that resistance to negative age stereotypes may potentially help to protect against the development of psychiatric conditions (Levy et al., 2014b), these findings might have implications for future interventions for depressive symptoms.

Our results for ADLs and subjective age are similar to those found for depressive symptoms, whereby subjective age was an independent predictor of future ADL limitations but not the other way around. Our finding is in accordance with some but not all of the previous literature. A German study of 3,038 adults aged 40 years and older found no longitudinal association between subjective age and functional health in either direction (Spuling et al., 2013). Spuling and colleagues speculate that a six-year lag between baseline and follow-up measurements may have been too long to detect an association. However, they also note that the study participants may have had above average physical and functional health and this may partly account for their findings. However, a study using data from Midlife in the United States (MIDUS) demonstrated that self-reported functional health was significantly related to future subjective age in participants aged 32 to 84 years old over a ten-year period (Hughes and Lachman, 2016). Similarly, having a younger subjective age was associated with faster walking speed and less decline in gait speed over a two to four-year period in participants aged 65 years and over (Stephan et al., 2015a). It is possible that our findings may underestimate the

associations between subjective age and depression and limited ADLs, as participants who dropped out of the study before wave 6 tended to report older subjective ages, greater depressive symptoms, and more limited ADLs in comparison with those who remained in the study.

In both directional analyses, existing physical health explained much of the relationship between subjective age and depressive symptoms and ADL limitations, with factors such as sex, wealth, education, social engagement and memory having a limited effect. This suggests that existing health conditions have a marked effect on how old a person feels they are and is in accordance with previous research.

Strengths and limitations

One of the main strengths of this study is the use of a large sample of older adults living in private households in England. Further, in the analyses we were able to control for a wider range of socio-demographic and health measures than has been common in this literature, with additional adjustment for cognitive, social and behavioural factors. To the best of our knowledge there are few studies in the literature bidirectional associations between depression and ADL limitations and subjective age of a similar size or national scope. The findings of this study have added to the current literature on subjective age by investigating bidirectional relationships between subjective age and both ADL limitations and depressive symptoms, in order to further understand the possible mechanisms linking subjective age and health. It has also added to the handful of existing studies which have examined the relationship between subjective age and functional health or depressive symptoms.

There are several limitations to this study. Firstly, due to our choice of analytic method we are not able to say with certainty whether the longitudinal relationship between subjective age and depressive symptoms is stronger or weaker than that between subjective age and ADLs. A

further possible limitation is use of a single item to measure subjective age. Some researchers have argued that the construct is multidimensional so it may not be captured in a single measure as there may other domains of subjective age which may reflect more upon factors, such as, physical or societal changes (Diehl et al., 2015; Kastenbaum et al., 1972; Kornadt et al., 2016; Kotter-Grühn et al., 2016). Recent studies have also indicated that subjective appraisals of age are quite changeable on a day to day, or even a moment to moment basis (Kotter-Grühn et al., 2015). However, the single-item subjective age measure has been shown to be a robust measure and has a similar predictive power to multi-dimensional measures of self-perceptions of ageing (Kotter-Grühn et al., 2009; Westerhof et al., 2014). Moreover, the item used in this study is simple and brief, so it has the potential to be employed as a practical tool to identify those individuals most at risk. It has previously been demonstrated that the promotion of positive age stereotypes may be a possible mechanism through which older adults may recover from certain functional limitations or disability (Levy et al., 2012) and evidence from empirical studies suggests that subjective age has the potential to be changed so interventions may be possible (Levy et al., 2014a; Stephan et al., 2013). This could be achieved by identifying individuals who feel older than their actual age, targeting of health messages, and promoting positive health behaviours and attitudes to aging. For example, changing perceptions of aging might have favorable effects on emotional health and functional status. Further, a recent longitudinal study demonstrated that the relationship between depressive symptoms and ADLs (and vice-versa) was mediated by health behaviours and social engagement (Ohrnberger et al., 2017), suggesting that interventions addressing health behaviours and social engagement may help to reduce depression and functional limitations. Similarly, helping people overcome the limitations of functional impairment might increase morale and optimism about aging.

Conclusion

This study has demonstrated that an individual's age identity may have an important effect on both depressive symptoms and functional limitations. While we found limited evidence to support the hypothesis that associations with subjective age are bidirectional, this study has been able to show that how old an individual feels may affect emotional wellbeing and limit day-to-day activities. It also indicates that further research is required to understand why individuals may perceive themselves to be older or younger than their chronological age and how this measure may be used to identify individuals at risk.

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Table 1. Descriptive characteristics of study participants

	Wave 4 N (% Missing)	***Wave 4 M(SD)/%***	***Wave 6 N (% Missing)***	***Wave 6 M(SD)/%***
Subjective Age	9,298 (5.9)	0.17 (0.21) (Range: -1.83 to 0.84)	7,343 (25.7%)	0.18 (0.20) (range: -1.68 to 0.85)
Depressive symptoms (0-7)	9,464 (4.3)	1.29 (1.76)	7,546 (23.7%)	1.21 (1.71)
ADLs (0-6)	9,880 (0.06)	0.39 (1.00)	7,831 (20.8%)	0.42 (1.07)
Age (years)	9,886 (0)	66.2 (9.7)		
Female	9,886 (0)	55.2%		
Married	9,884 (0.02)			
Wealth	9,589 (3.0)			
Lowest 1		17.9%		
2		19.6%		
3		20.0%		
4		20.8%		
Highest 5		21.6%		
Education	9,687 (2.0)			
Lower		28.6%		
Intermediate		30.3%		
Higher		41.1%		
Employment Status	9,877 (0.09)			
Retired		53.8%		
Employed		32.9%		
Other		13.3%		
Memory (0-20)	9,549 (3.4)	10.32 (3.64)		
Social isolation (0-5)	8,023 (18.8)	1.55 (1.08)		
Loneliness (3-9)	8,252 (16.5)	4.21 (1.55)		
Vigorous or moderate activity ≥ 1/week	9,881 (0.05)	74.7%		
Current smoker	8,820 (10.8)	15.4%		
Doctor diagnosed health conditions	9,810 (0.8)	0.69 (0.82)		

	(0-6)		
Self-rated health	(1-5)	9,585 (3.0)	2.81 (1.11)

Table 2. Correlations for all variables at wave 4

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Subjective age	-													
2. Depressive symptoms	-0.23***	-												
3. ADLs	-0.16***	0.29***	-											
4. Chronological age	-0.001	0.04	0.17***	-										
5. Sex	-0.01	0.16***	0.01	0.02	-									
6. Wealth	0.02	-0.20***	-0.17***	-0.05***	-0.07***	-								
7. Education	0.05***	-0.13***	-0.13***	-0.23***	-0.17***	0.36***	-							
8. Employment status	-0.01	0.02*	-0.05***	-0.60***	0.01	-0.03**	0.08***	-						
9. Memory	0.08***	-0.12***	-0.17***	-0.38***	0.10***	0.21***	0.30***	0.17***	-					
10. Social isolation	-0.02	0.09***	0.07***	0.02	0.02	-0.16***	-0.08***	0.01	-0.04***	-				
11. Loneliness	-0.12***	0.36***	0.16***	0.03	0.10***	-0.18***	-0.10***	0.04***	-0.10***	0.18***	-			
12. Physical activity	0.11***	-0.24***	-0.32***	-0.19***	-0.09***	0.22***	0.19***	0.05**	0.19***	-0.09***	-0.14***	-		
13. Smoking	0.01	0.09***	0.09**	-0.14***	0.01	-0.20***	-0.10***	0.11***	-0.02	0.10***	0.07***	-0.09***	-	
14. Physician diagnosed health conditions	-0.13***	0.22***	0.31***	0.28***	0.06***	-0.19***	-0.16***	-0.16***	-0.19***	0.05***	0.13***	-0.22***	0.01	-
15. Self-rated health	-0.28***	0.39***	0.40***	0.16***	0.02	-0.27***	-0.22***	-0.05***	-0.23***	0.08***	0.23***	-0.33**	0.12***	0.43***

* $p<0.05$; ** $p<0.01$; *** $p \leq 0.001$

Table 3. Prospective associations between subjective age at wave 4 and depressive symptoms and limitations in activities of daily living at wave 6 (N=9,886)

	Depressive Symptoms				Activities of Daily Living (ADLs)			
Subjective age	***B* (95% *CI*)**	***β (SE)***	***p***	***R^2***	***B* (95% *CI*)**	***β (SE)***	***p***	***R^2***
Model 1: age, sex & baseline measure	-0.72 (-0.88, -0.55)	0.09 (0.08)	<0.001	0.30	-0.40 (-0.49, -0.30)	0.07 (0.05)	<0.001	0.44
Model 2: model 1 + socio-demographic factors[1]	-0.67 (-0.83, -0.51)	0.08 (0.08)	<0.001	0.32	-0.39 (-0.46, -0.28)	0.07 (0.05)	<0.001	0.44
Model 3: model 1 + cognitive function & social engagement[2]	-0.64 (-0.81, -0.47)	0.08 (0.08)	<0.001	0.32	-0.32 (-0.41, -0.23)	0.06 (0.05)	<0.001	0.44
Model 4: model 1 + health behaviours[3]	-0.67 (-0.83, -0.51)	0.08 (0.08)	<0.001	0.31	-0.34 (-0.43, -0.26)	0.06 (0.05)	<0.001	0.45
Model 5: Model 1 + physical health[4]	-0.44 (-0.61, -0.27)	0.05 (0.08)	<0.001	0.33	-0.23 (-0.32, -0.14)	0.04 (0.05)	<0.001	0.45
Model 6: fully-adjusted[5]	-0.40 (-0.57, -0.23)	0.08 (0.08)	<0.001	0.35	-0.16 (-0.25, -0.07)	0.03 (0.05)	0.001	0.46

Note. *CI* = confidence interval

[1] Wealth, education, and employment status; [2] Memory, social isolation and loneliness; [3] Smoking and physical activity; [4] Self-rated health and number of physician diagnosed health conditions (CHD, cancer, diabetes, chronic lung disease, stroke and arthritis); [5]Age, sex, wealth, education, employment status, baseline depressive symptoms, ADLs, social isolation, loneliness, memory, smoking, physical activity, physician diagnosed health conditions and self-rated health

Table 4. Multiple linear regression of the prospective relationship between depressive symptoms and limitations in activities of daily living at wave 4 and subjective age at wave 6 (N=9,886)

	Depressive Symptoms				Activities of daily living (ADLs)			
Subjective age	***B* (95% *CI*)**	***β (SE)***	***p***	***R^2***	***B* (95% *CI*)**	***β (SE)***	***p***	***R^2***
Model 1 age, sex & baseline self-perceived age	-0.01 (-0.008, -0.002)	-0.04 (0.001)	<0.001	0.27	-0.01 (-0.016, -0.006)	-0.005 (0.002)	<0.001	0.27
Model 2: model 1 + socio-demographic factors[1]	-0.004 (-0.007, -0.001)	-0.004 (0.001)	0.003	0.27	-0.010 (-0.015, -0.005)	-0.005 (0.003)	<0.001	0.27
Model 3: model 1 + cognitive function & social engagement[2]	-0.004 (-0.007, -0.001)	-0.003 (0.001)	0.013	0.27	-0.010 (-0.015, -0.005)	-0.003 (0.003)	<0.001	0.27
Model 4: model 1 + health behaviours[3]	-0.004 (-0.006, -0.001)	-0.003 (0.001)	0.006	0.27	-0.009 (-0.014, -0.004)	-0.003 (0.003)	0.001	0.27
Model 5: model 1 + physical health[4]	-0.001 (-0.003, 0.002)	-0.005 (0.001)	0.676	0.27	-0.004 (-0.010, 0.001)	-0.002 (0.003)	0.098	0.27
Model 6: fully-adjusted[5]	0.001 (-0.003, 0.004)	0.005 (0.001)	0.723	0.28	-0.003 (-0.009, 0.002)	-0.002 (0.002)	0.205	0.28

Note. *CI* = confidence interval

[1] Wealth, education, and employment status; [2] Memory, social isolation and loneliness; [3] Smoking and physical activity; [4] Self-rated health and number of physician diagnosed health conditions (CHD, cancer, diabetes, chronic lung disease, stroke and arthritis); [5]Age, sex, education, employment status, wealth, baseline depressive symptoms, ADLs, social isolation, loneliness, memory, smoking, physical activity, physician diagnosed health conditions and self-rated health