Cognitive function and psychological well-being: findings from a population-based cohort

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Abstract

Background: depression is associated with poor cognitive function, though little is known about the relationship between psychological well-being and cognitive function.
Objective: to investigate whether psychological well-being is associated with levels of cognitive function.
Design: nationally representative population-based cohort study.
Setting and participants: 11,234 non-institutionalised adults aged 50 years and over of the English Longitudinal Study of Ageing in 2002.
Methods: psychological well-being was measured using the CASP-19, and cognitive function was assessed using neuropsychological tests of time orientation, immediate and delayed verbal memory, prospective memory, verbal fluency, numerical ability, cognitive speed and attention. The relation of psychological well-being to cognitive function was modelled using linear regression.
Results: on a global cognitive score combining all cognitive tests, those in the fifth quintile of psychological well-being scored an average of 0.30 SD units higher than those in the lowest quintile (95% CI 0.24–0.35) after adjustment for depressive symptoms and sociodemographics. This association remained after additional adjustment for physical health and health behaviours. The same pattern of association was observed for men and women, and across all cognitive domains.
Conclusions: in a large population of community living adults, higher levels of psychological well-being were associated with better cognitive function.

Keywords: *cognition, cognitive function, psychological well-being, risk factors, elderly*

Introduction

Understanding successful as well as pathologic aging is a public health and research priority as the number of older adults is increasing worldwide [1]. Cognitive function declines during late adulthood, although there are marked individual differences in the rate of decline [2]. It is therefore important to understand the predictors, determinants and consequences of these changes. Poor cognitive function and cognitive decline are associated with poor physical health, particularly cardiovascular disease and diabetes, as well as depression and low education and socioeconomic status [3]. However, an individual's health reflects a combination of physical, mental and social well-being that cannot be fully accounted for by measures of disease status alone [4].

Depression is known to be associated with poor levels of cognitive function and increased levels of age-related cognitive decline [3, 5]. However, evidence is accumulating that psychological well-being is relatively independent from the absence of psychological distress or pathology, and may play an independent role in the prediction of health-related outcomes [6]. For example, Ostir and colleagues found that positive affect appears to protect against incidence of stroke across a 6-year period, even when depression levels were controlled for [7]. Similarly, Pitkala and colleagues found that a positive life orientation (optimism) predicted low rates of both mortality and institutionalisation across a 10-year period [8]. Psychological well-being may reduce stress by enhancing psychological resources [9], and increase neural efficiency [10]. There is also experimental evidence to

suggest that inducing positive mood states influences cognitive performance over short periods [11, 12], and it is possible that high levels of psychological well-being are beneficial for cognitive function over longer time periods. Conversely, deteriorating levels of cognitive function might also lead to reduced levels of psychological well-being. To our knowledge no large population-based study has yet examined the relationship between psychological well-being and cognitive function. The objective of the present study, therefore, was to examine whether high levels of psychological well-being are associated with better cognitive function.

Methods

Participants

Data are from a sample of 11,234 non-institutionalised adults who participated in the Health Survey for England (HSE) and were followed up in the English Longitudinal Study of Ageing (ELSA) in 2002. The core ELSA sample is limited to adults aged 50 years or over, and is drawn from the HSE sample by postcode sector (geographic area), stratified by health authority and proportion of households in non-manual socioeconomic groups. Ethical approval for ELSA Wave 1 was granted from the Multicentre Research and Ethics Committee and informed consent was obtained from all participants. Households were included in ELSA if one or more individuals living there was aged 50 or over. Comparisons with census data suggest that the ELSA sample is representative of the English population aged 50 and over [13].

Cognitive function

The neuropsychological tests incorporated in ELSA in 2002 to assess cognitive function are summarised below and described in detail elsewhere [14]. Time orientation was assessed using questions relating to day and date from the Mini-Mental State Examination (MMSE) [15]. Immediate and delayed verbal memory were assessed using a 10-word learning task from the Health and Retirement Study (HRS) [16]. This involved 10 common nouns being presented aurally by computer at the rate of one word every 2 s. Participants were then asked to recall as many words as possible immediately, and also after a short delay during which they completed other cognitive tests. Four different randomly assigned word lists were used to ensure that household members were given different versions of the test. Prospective memory was assessed by asking participants to remember to carry out two instructions later in the session. First, writing their initials in the top left-hand corner of a page attached to a clipboard when it was handed to them. Second, remembering to remind the interviewer to record the time when the interviewer announced that the cognitive section had finished. The first task was closely based on a task incorporated in the MRC Cognitive Function and Ageing Study (MRC CFAS) [17], and the second was a similar task to one used in the Rivermead Behavioral Memory Test [18]. The verbal fluency task examined how many words participants were able to produce from a particular category

in 1 min, in this case naming as many animals as possible. The same task has been widely used, and the present version was taken from the CAMCOG-R [19]. Numerical ability was assessed using six questions involving simple calculations based on everyday situations. These numeracy items were developed for the ELSA, and have also been incorporated in the HRS [16]. Cognitive speed and attention were assessed using a letter cancellation task from the MRC National Study of Health and Development (MRC NSHD) [20]. Participants were asked to cross out as many of the 65 target letters (P and W) as possible in 1 min, on a page incorporating 780 letters in a grid. The total number of letters searched provides a measure of cognitive speed. The ratio of correctly identified target letters to all target letters within the scanned section provides a measure of attention.

Because the scoring of each individual cognitive test varies, test scores were standardised to give a mean of 0 and a standard deviation of 1 (z-scores), where high scores represent high levels of cognitive function. Scores representing global cognitive function were obtained by standardising the summed z-scores on all tests.

Psychological well-being

Psychological well-being was measured using the CASP-19, a self-completion questionnaire [21]. The CASP-19 incorporates 19 Likert-scored items relating to perceptions of control, autonomy, self-realization and pleasure. Respondents indicate the degree to which each item applies to them on a scale of 'never' (scored 0) to 'often' (scored 3), to give a total score out of 57. Representative items include 'I look forward to each day' and 'I feel that my life has meaning'.

Statistical analysis

In order to examine whether psychological well-being is associated with cognitive function, we used linear regression models with adjustment for a wide range of potential confounders that are known to be associated with cognitive function [3,5]. In these regression models, we divided total CASP-19 scores into quintiles to aid interpretation.

We identified respondents with depressive symptoms using a version of the Center for Epidemiologic Studies Depression Scale (CES-D) [22]. The eight-item version of the CES-D was developed for the Established Populations for Epidemiologic Study of the Elderly (EPESE) [23]. Items refer to the degree to which the respondent had experienced depressive symptoms such as loneliness, feeling depressed, restless sleep and feeling sad, over the past week. The CES-D and the CASP-19 were moderately correlated in the present study ($\tau = 0.40$, $P < 0.001$), as consistent with previous research [6]. We classified those who reported four or more depressive symptoms as having significant depressive symptoms, a cut-off point that has been found to produce comparable results to the 16-symptom cut-off for the well-validated 20-item CES-D scale [24].

Sociodemographic variables were age, sex, household wealth quintiles (including financial, housing and physical

wealth, but not pension wealth), socioeconomic position (National Statistics Socioeconomic Classification 3 or NS-SEC3) [25] and educational qualifications (no qualifications, intermediate qualifications and degree or higher qualifications). Health behaviours were tobacco smoking (never smoked, past smoker, current smoker), alcohol consumption (non-drinker, up to once a day, more than once a day) and participation in physical activity (hardly ever or never take part, mild activity, moderate activity and strenuous activity). Physical health variables were self-reported medical history [stroke, diabetes or high blood sugar, ischaemic heart disease (heart attack, angina, congestive heart failure), hypertension and dementia), and sensory impairment (those rating their eyesight or hearing as poor, or registered blind].

We carried out all analyses using Stata SE version 9.2 [26]. First, we analysed the sample with complete data, and then we repeated the analyses using 10 imputed datasets [27]. We used the ICE program, which creates multiple imputed datasets for an original dataset with missing values (ICE: Multiple imputation by the MICE system of chained equations, updated version, software for Windows, available from http://www.stata-journal.com/software/sj5-4). We utilised cluster correction due to the complex survey design and official ELSA survey weights [13].

Results

Table 1 shows the summary statistics for the variables included in the study, indicating the number of missing values. The average age of the 11,234 participants was 65.2 (SD 10.4) years, with just over half of the sample female ($n = 6,123$, 54.5%). A large proportion of the sample had no educational qualifications ($n = 4,775$, 42.5%) and were currently or formerly employed in routine or manual occupations ($n = 5,147$, 45.8%). The patterns of potential confounders observed are in keeping with those observed in the general population.

A comparison between those with complete data ($n = 8,955$) and individuals who had missing data ($n = 2,279$) indicated that those with missing data were on average older (69.1 versus 64.2 years; $P < 0.001$), more likely to be female (61.3% versus 52.8%; $P < 0.001$), and less well educated (58.9% versus 38.5% with no qualifications; $P < 0.001$). We conducted analyses using complete data and the imputed datasets. As the resulting regression coefficients did not vary substantially, we present results from the complete data.

Multiple regression analyses were performed in order to investigate whether psychological well-being is associated with global cognitive function (Table 2). In both the basic and fully adjusted models levels of psychological well-being were clearly associated with levels of cognitive function. Those in the fifth quintile of psychological well-being scored an average of 0.30 SD units higher than those in the lowest quintile after adjustment for depressive symptoms and sociodemographics. This association was attenuated to 0.13 SD units though remained significant after additional adjustment for physical health and health behaviours. The size of this asso-

Table 1. Baseline characteristics of the study population

Variable	Number (%)	Mean (SD)	Missing number (%)
Overall cognitive function	10,620 (94.5)	0.0 (1.0)	614 (5.5)
CASP-19	9,300 (82.8)	42.5 (8.7)	1,934 (17.2)
CES-D depressive symptoms	1,792 (16.0)		293 (2.6)
Age	11,234 (100.0)	65.2 (10.4)	0 (0.0)
Female	6,123 (54.5)		0 (0.0)
Household wealth quintiles			
Highest	2,163 (19.3)		99 (0.9)
4	2,193 (19.5)		
3	2,239 (19.9)		
2	2,251 (20.0)		
Lowest	2,289 (20.4)		
Educational qualifications			
Degree/higher	2,476 (22.0)		19 (0.2)
Intermediate	3,964 (35.3)		
None	4,775 (42.5)		
Socioeconomic status (NS-SEC)			
Managerial and professional	3,251 (28.9)		204 (1.8)
Intermediate	2,632 (23.4)		
Routine and manual	5,147 (45.8)		
Physical activity participation			
None	972 (8.7)		21 (0.2)
Mild	1,203 (10.7)		
Moderate	4,934 (43.9)		
Strenuous	4,104 (36.5)		
Tobacco smoking			
Current smoker	1,999 (17.8)		14 (0.1)
Ex-smoker	5,232 (46.6)		
Never smoked	3,989 (35.5)		
Alcohol consumption			
More than once a day	490 (4.4)		17 (0.2)
Up to once a day	9,389 (83.6)		
Non-drinkers	1,338 (11.9)		
Medical history			
Stroke	481 (4.3)		7 (0.1)
Diabetes mellitus	830 (7.4)		7 (0.1)
Ischaemic heart disease	1,465 (13.0)		7 (0.1)
Hypertension	4,260 (37.9)		7 (0.1)
Dementia	49 (0.4)		8 (0.1)
Sensory impairment	922 (8.2)		10 (0.1)

ciation was equivalent to the decrement in cognitive function observed for an additional 4 years of age in the fully adjusted model.

Psychological well-being was significantly associated with performance in all individual cognitive domains in linear regression models adjusted for depressive symptoms, age, sex and education [(lowest to highest CASP-19 quintile) $\beta \geq 0.10$, 95% CI 0.04–0.16, $P \leq 0.001$]. In full covariate models all of these associations remained significant [(lowest to highest CASP-19 quintile) $\beta \geq 0.07$, 95% CI 0.01–0.13, $P \leq 0.014$], with the exception of numerical ability ($P = 0.150$) and attention ($P = 0.058$).

We also conducted a series of sensitivity analyses in order to examine the robustness of the regression models. First, we calculated regression models separately for men

Table 2. Linear regression models illustrating levels of global cognitive function in standard deviation units by quintiles of psychological well-being

Psychological well-being (CASP-19 quintiles)	Model 1: Basic adjusted model[a]		Model 2: Fully adjusted model[b]	
	β (95% CI)	P	β (95% CI)	P
Lowest	Ref.	.	Ref.	.
2nd	0.16 (0.11–0.22)	<0.001	0.08 (0.03–0.14)	0.002
3rd	0.24 (0.18–0.30)	<0.001	0.12 (0.07–0.18)	<0.001
4th	0.28 (0.22–0.33)	<0.001	0.13 (0.08–0.19)	<0.001
Highest	0.30 (0.24–0.35)	<0.001	0.13 (0.07–0.19)	<0.001

Population weights are used to adjust for the sampling design.
[a] Adjusted for depressive symptoms, age, sex and education.
[b] Adjusted for depressive symptoms, age, sex, education, household wealth, socioeconomic status, tobacco smoking, alcohol consumption, physical activity, history of medical conditions (stroke, diabetes, hypertension, cardiovascular disease, dementia) and sensory impairment.

and women to examine for sex effects. The patterns of association observed for men and women were highly similar to the general model described above. Psychological well-being also remained significantly associated with cognitive function when we excluded participants with a history of diagnosed dementia or stroke ($n = 516$).

Discussion

Our data suggest that high psychological well-being is robustly associated with better cognitive function in middle-aged and older adults. Those in the fifth quintile of psychological well-being scored 0.30 SD units higher than those in the lowest quintile after basic adjustment, and 0.13 SD units in the full covariate model. The pattern of association was the same for men and women, and across all cognitive domains.

This study has a number of strengths including the large sample that is representative of the English population [13]. We adjusted for a wide range of potential confounders, including depressive symptoms, physical health, sensory function, health-related behaviours and sociodemographics. The CASP-19 has been developed as a measure of quality of life in older adults, and a number of studies demonstrate its validity [21]. Cognitive function was measured using a wide range of validated neuropsychological tests. Many of these tests are identical to those used in other seminal ageing studies, which should facilitate future research attempting to replicate the current findings.

Some methodological limitations should also be considered when assessing these findings. While the present study provides valuable new information about the association between psychological well-being and cognitive function, the causal direction remains unclear. In addition, our sample excluded those residing in institutions and those who responded through proxies. This is likely to have biased our study towards those with higher levels of psychological well-being and cognitive function [8].

Psychological well-being may be associated with levels of cognitive function through multiple pathways. Keltner and Bonanno observed that positive affect, as measured by genuine laughter and smiling, predicted the adaptive response to stress in bereaved adults [28]. Similarly, Steptoe and colleagues discovered that positive affect in middle-aged adults is associated with reduced neuroendocrine, inflammatory and cardiovascular activity [9]. Chronic stress evokes persistent hyperactivity of the hypothalamic-pituitary-adrenal axis [29], leading to elevated cortisol levels and atrophy of the hippocampus. Psychological well-being may therefore help to maintain cognitive function by protecting against chronic stress.

Psychological well-being may make socializing, intellectual and physical activities more likely, which may in turn influence neural efficiency and levels of cognitive function. This notion is consistent with the environmental complexity hypothesis which suggests that the engagement in an active lifestyle may result in functionally more efficient neural networks that maintain cognitive function and protect against dementia [30]. Alternatively, the engagement in neuroprotective activities may also result in higher levels of psychological well-being. Similarly, reduced levels of cognitive function may lead to lower levels of psychological well-being.

To our knowledge our study is the first to examine the relationship between psychological well-being and cognitive function in a large population-based sample. Our findings are important as psychological well-being was associated with better cognitive function after controlling for the influence of depressive symptoms and a wide range of additional potential confounders. In the fully adjusted model, the difference in cognitive function between those in the highest and lowest well-being quintiles was equivalent to the decrement in cognitive function associated with four additional years of age. Further research is necessary to explore the causal mechanisms underlying this relationship.

Key points

- Depression is associated with poor cognitive function, though to our knowledge no previous population-based study has examined the relationship between psychological well-being and cognitive function.
- The study aimed to determine if psychological well-being, as measured by the CASP-19, was associated with performance on multiple neuropsychological tests of cognitive function.
- Higher levels of psychological well-being were associated with better global cognitive function and performance in multiple cognitive domains.

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Conflicts of interest

The authors have no conflicts of interest.

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