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Personality and survival in older age: the role of lifestyle behaviors and health status

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Highlights

- Higher levels of extraversion were associated with a 14% reduction in mortality.
- Independent of levels of neuroticism and openness, high extraversion was associated with up to 65% lower mortality rate.
- An active and engaged lifestyle may explain the beneficial effect of high extraversion on survival.

ABSTRACT

Objective: We intended to assess the relationship between personality and survival in an older population and to explore the role of lifestyle behaviors and health status as potential mediators.

Design: Population-based cohort study.

Setting: Swedish National study of Aging and Care in Kungsholmen, Sweden.

Participants: 2298 adults aged 60 or more years, without dementia or depression, followed for 11 years.

Measurements: Personality (extraversion, neuroticism, and openness) was assessed with a shortened version of the NEO-Five Factor Inventory. We tested whether personality affected mortality and examined the potential mediating effect of health status (body mass index, number of chronic diseases, impairment in instrumental activities of daily living, and C-reactive protein) and lifestyle behaviors (leisure activities, social network, smoking, and alcohol consumption).

Results: Over 11 years of follow-up, higher levels of extraversion were associated with a 14% reduction in mortality. Examination of different combinations of personality traits showed that independent of levels of neuroticism and openness, high extraversion was associated with up to 65% lower mortality. Decomposing the effect of extraversion on mortality, we found that the

majority (44%) of the beneficial effect was mediated by healthy lifestyle behaviors. Health status accounted for 5% of the association.

Conclusion: Extroverted people, who are characterized by higher optimism and high self-efficacy, are prone to healthier behaviors and better health, which may result in longer survival. These results highlight the importance of a healthy lifestyle in survival.

Key words: Neuroticism; extraversion; openness; survival; elderly people; population-based study

INTRODUCTION

The term "personality" refers to individual differences in characteristic patterns of thinking, feeling, and behaving (1). The widespread hypothesis that personality affects health and lifespan is supported by growing evidence of its influence on health-related factors (2, 3), such as obesity (4) and smoking (5, 6), two major determinants of morbidity and mortality (7). Moreover, personality traits affect physiological responses to stressful events, which can negatively impact health and survival (3).

Neuroticism, extraversion, and openness to experience are broad dimensions of personality and are related to mortality. Studies on the association between different personality traits and survival in older people have had inconsistent findings. Three studies have found that a high level of neuroticism is a risk factor for survival (8-10), two that it is a protective factor (11, 12), and others that there is no relationship between neuroticism and survival (13-16). Most studies have reported that extraversion does not predict survival (8, 10-14, 16), but others have reported that it does (9, 15, 17). Some previous researchers have found an inverse association between high openness and mortality (15-17), but this finding was not confirmed by others (8, 10, 12, 13). These discrepancies may be explained partly by differences in sample size, composition of the study population, length of follow-up, instruments used to assess personality, and potential mediators that were taken into account.

Most of the studies on the topic have focused on the independent contributions of individual personality traits without exploring their possible combined effect (18). In a previous study, we reported that the combination of low neuroticism and high extraversion had the strongest effect on dementia risk (19), which is related to survival. Thus, it is reasonable to hypothesize that both

single personality traits and different combinations of personality traits may be related to mortality in old age in different ways. Further, few studies to date have attempted to explore the mechanisms underlying the personality-survival association by focusing on lifestyles and health behaviors. Thus, these pathways are only vaguely understood (20).

This study examined the relationship between personality and survival in a cohort of cognitively healthy people aged 60+ years. The cohort was followed up for up to 11 years. Specifically, we first explored the extent to which extraversion, neuroticism, and openness were independently associated with mortality and whether the mortality rate varied for different combinations of personality traits. Second, we aimed to determine the role of lifestyle behaviors and health status as potential mediators of the influence of personality on survival.

METHOD

Study sample

Participants were derived from the Swedish National study of Aging and Care in Kungsholmen (SNAC-K) (21). SNAC-K is an ongoing longitudinal study in central Stockholm. It includes a random sample of people aged 60+ years who live either at home or in institutions. The sample was selected from 11 age cohorts: 60, 66, 72, 78, 81, 84, 87, 90, 93, 96, and 99+ years. To compensate for attrition at follow-up, the 2 youngest and the 4 oldest age groups were oversampled. Between 2001 and 2004, 3363 (response rate 73.3%) undertook the baseline examination. In the current analyses, we excluded people with a diagnosis of dementia (n=241) or a Mini Mental State Examination (MMSE) score lower than 24 (n=108), those with a diagnosis of depression (n=49) or a Montgomery-Åsberg Depression Rating Scale (MADRS)

score lower than 9 (n=18), and those living in an institution (n=30). Moreover, information on personality traits was missing for 621 people, which left 2298 people in the current study.

All participants or a proxy (in the case of cognitively impaired people) provided written informed consent. The Regional Ethical Review Board in Stockholm, Sweden, approved the protocols of the SNAC-K study.

Case ascertainment

Over the 11-year study period (January 2001−March 2012), we documented 608 deaths (26.5%). Information on survival status was ascertained via linkage with the Swedish Cause of Death Register at the National Board of Health and Welfare.

Assessment of personality traits

Personality was assessed with Swedish translation of the NEO Five-Factor Inventory (NEO-FFI) (22). The original version rates 60 items in five domains, whereas the present study used 36 items in 3 domains: extraversion, neuroticism, and openness to experience. Each item was rated on a 3-point Likert scale ranging from 1 (disagree), to 2 (neither agree nor disagree), and 3 (agree). Overall, the NEO-FFI provides a psychometrically sound measure of the original NEO Personality Inventory scales. In 2 previous cohorts, high correlations have been found between traits assessed by the NEO-FFI scales and the same traits assessed by the NEO Personality Inventory scales (8). The correlation ranged from a low of 0.75 for conscientiousness to a high of 0.89 for neuroticism in one cohort and from 0.77 for agreeableness to 0.92 for neuroticism in another cohort. In addition, correlation analyses provide evidence that the scales also have convergent and discriminant validity (23). Participants who completed only part of the scale

(n=265) were imputed a "2" for missing items (24). After having assigned a positive score to reverse-keyed items, we calculated the 3 personality raw sum-scores and subsequently converted them into T-scores after z-score transformation in accordance with NEO-FFI procedure (25). Personality traits were then divided into 3 categories: low (T-score < 45), moderate (T-score 45−55), and high (T-score > 55) (24).

Assessment of sociodemographic characteristics

Data on age, sex, and education were obtained from the participants through a personal interview by trained nurses who followed standard protocols (21). Education was measured as the highest level of formal education and categorized as elementary school (grade 1–9), high school (grade 10–12), and university or above.

Assessment of health status

We assessed the health status of each participant, taking number of chronic conditions, body mass index (BMI), disability, and general levels of inflammation into consideration. On the basis of clinical examination, medical history, laboratory data, and current drug use, the examining physician diagnosed and recorded all chronic diseases in accordance with the ICD-10 at baseline and follow-ups. The number of co-occurring chronic conditions present in at least 5% of the participants was summed and categorized as none, 1, and 2 or more. Using measurements taken by the study nurses, we calculated BMI as weight in kilograms divided by the square of height in meters, and we used standard cut-offs to categorize the participants as overweight (BMI > 25), normal weight (20−25), or underweight (< 20). Disability was defined as dependence in at least 1 of the 8 instrumental activities of daily living (I-ADL). General levels of inflammation in the body were assessed by measuring C-reactive protein (CRP) in accordance with standard

procedure. In the present analysis, the level of CRP was categorized as low (CRP < 5 mg/L), high (5−9 mg/L), and very high level (> 9 mg/L). Each measure of health status was given a score of 0 (high risk), 1 (moderate risk), or 2 (low risk) in accordance with the measure's association with the mortality rate (**Supplementary Table 1)**. The overall measure of health status was the sum of the individual measures of health status. Possible scores ranged from 0 to 8.

Assessment of lifestyle behaviors

We took the following lifestyle behaviors into consideration: 1) smoking habits, 2) alcohol consumption, 3) leisure activity, and 4) social network. Data on smoking history and alcohol consumption were collected with a standard questionnaire. Smoking status was categorized as current, former, and never. Alcohol consumption was categorized as never/occasional (a glass per month), light/moderate (less than 4 glasses a week for men; less than 2 glasses for a week for women), and heavy (more than 5 glasses a week for men; more than 3 glasses a week for women).

Information on leisure activities was obtained with a self-administered questionnaire that asked whether the participants engaged in any of a list of predefined activities during the past 12 months; activities were grouped in the same way as in a previous study (26). Mental activities included those for which the predominant component was mental and were coded as 0 (no activities or 1 activity), 1 (2 or 3 activities), and 2 (more than 3 activities). Social activities included those for which the predominant component was interaction with other people and were coded as 0 (no activities), 1 (1 activity) or 2 (more than 1 activity). Physical activities included those for which the predominant component was physical exercise and were scored as 0

(performed less than once a week), 1 (performed at least once a week), and 2 (performed more than once a week). Finally, the 3 types of activities were summed into a leisure activity index and coded as low (score 0−1), moderate (2−3), or intense (4−6). Items describing social network size included in the analyses were: marital status, living alone, number of children, frequency of contacts with relatives or friends, and number of people the participant could talk with. The social support measure included satisfaction with the aforementioned contacts, perceived material and psychological support, and sense of affinity with or being part of a group. A social network variable that included social network size and support was computed by converting all variables scores into z-scores and averaging them as limited, moderate, or rich in accordance with the score tertiles. Each lifestyle factor was given a score of 0 (high risk), 1 (moderate risk), or 2 (low risk) in accordance with its association with mortality rate **(Supplementary Table 1)**. The overall measure of lifestyle behaviors was the sum of the different lifestyle behaviors' scores and ranged from 0 to 8.

Statistical analysis

Internal consistency of personality traits was verified with Cronbach's alpha. The differences between baseline characteristics of the study sample and survival status were examined with the Chi-square test for categorical variables and the Student's t-test for continuous variables. Parametric survival models were used to estimate the mortality rate associated with personality traits.

We first examined the relationship between each separate trait and survival and then examined the relationship between all traits and survival, adjusting each trait for the other traits. In both analyses, we controlled for sociodemographic characteristics. Personality was used as both a

continuous and a categorical variable. Multiplicative interactions among personality traits were tested using categorical variables as well as continuous variables. The presence of additive interaction between personality traits was tested using a previously proposed formula as a measure of relative excess risk due to interaction (RERI) (27). To test the null hypothesis (RERI = 0), we computed the estimated variance of RERI by using the multivariate delta method (28). We also tested for interaction between personality traits and sex and personality traits and age.

Second, on the basis of the findings from the first set of analyses, we investigated the relationship between survival and the combination of the dichotomized personality traits "high" (the upper tertile of extraversion and neuroticism and upper 2 tertiles of openness) and "low" (the lower 2 tertiles of extraversion and neuroticism and the lower tertile of openness). Finally, we explored the extent to which the lifestyle behaviors and health status scores explained the personality-mortality association. The mediating effects of those scores were analyzed with generalized structural equation modeling, which allowed us to estimate the direct and indirect effect of personality on mortality rate. The associations between the exposure (personality trait) and the mediators (lifestyle behaviors and health status) were assessed with linear regression models, and the association between the exposure and the outcome (mortality rate) was assessed with survival models. Age, sex, and education were adjusted as potential confounders in all the models.

To take into account the possible interaction between the overall measure of lifestyle behaviors and health status, we first tested the statistical interactions between the 2 variables and then performed a sensitivity analysis that excluded the most fragile participants. These were the people who had at least 1 physical impairment and 2 chronic diseases at baseline.

To take missing data on personality into account, we carried out the following sensitivity analyses. First, for those people for whom data on personality were completely missing (21%), we created an indicator variable. This variable was equal to 1 if a given observation was missing in the personality traits and to 0 otherwise. Then we performed logistic regression with missing value as the outcome to test whether any of the other variables, including mortality, were associated with the outcome. Second, we excluded the people with partial missing data on personality from the analyses (these people had received an imputed score of "2"). Statistical analyses were performed with Stata, version 14.1 (StataCorp, TX, USA).

RESULTS

The Cronbach's alpha coefficient was 0.77 for extraversion, 0.81 for neuroticism, and 0.64 for openness, which suggests a moderate to high level of internal consistency. Over the 11 years of follow-up, 608 people died (26.5%). Participants who died were more likely than participants who survived to be men; older; have a lower level of education, worse health status, and a limited social network; and to have a low level of participation in leisure activities Those who died during the follow-up period were lower in extraversion and openness and higher in neuroticism than those who survived (**Table 1**).

Table 1 here

Table 2 presents the associations between personality traits and the mortality rates after adjustment for sociodemographic characteristics. Higher levels of extraversion were associated with a decreased mortality rate. Specifically, every standard deviation increase in extraversion was associated with 14% decreased mortality rate (SE=0.04, z=-3.14, p-value<0.01, **Model 1**). A higher level of neuroticism was associated with increased mortality rate (HR=1.10, 95% CI: 1.01−1.20, **Model 1**). No association was found between openness and mortality (**Model 1**).

Higher levels of extraversion were independently related to a lower mortality rate in **Model 2**, which included all the 3 personality traits, whereas the effects of other personality traits were no longer present (**Table 2**).

Table 2 here

Personality has been defined as "the characteristics or blend of characteristics that make a person unique" (29), and this definition emphasizes the uniqueness of the individual and consequently adopt an idiographic view. Because the combination of personality traits would better distinguish individual differences in personality, we examined the possible interactions among these personality traits and verified whether the mortality rate varied for different combinations of the 3 traits. There was no indication of multiplicative interaction among the personality traits as categorical variable (all p-values > 0.05), while a significant multiplicative interaction between extraversion and openness as continuous variable was found, but not among the other personality traits (**Supplementary Table 2** and **Supplementary Figure 1**). Moreover, significant additive interactions were found between extraversion and neuroticism (RERI=0.3, 95% CI: 0.0−05, p-value < 0.05) and between extraversion and openness (RERI=0.4, 95% CI: 0.1−0.6, p-value < 0.01). In **Table 3**, we report the hazard ratio of mortality for different combination of personality traits after adjustment for age, sex, and education. Three of the 4 combinations that included high extraversion (+) were associated with lower mortality rates. A lower mortality rate was detected in people who had a high level of extraversion and a low level of openness, irrespective of neuroticism, and in those who had a high level of openness and a low level of neuroticism (estimated reduced mortality rates between 28% and 65% for different combinations). A lower mortality risk was also observed in people who had a low level of extroversion but a high level of openness and a low level of neuroticism (approximately 30% reduced mortality rate) (**Table 3**).

No evidence of significant interactions were found between personality traits and sex or personality traits and age (all p-values > 0.05).

Table 3 here

Since extraversion was the only personality trait that independently predicted mortality rate, all the other personality traits were dropped from the mediation analysis. **Figure 1** displays the fully adjusted path model that tested the indirect effect from high extraversion and mortality through each of the potential mediators after adjustment for age, sex, and education. The total effect of high extraversion on mortality given by the sum of the different paths (a1*b1+a2*b2) was significant (β=-1.18, 95% CI: -0.27−-0.08, z-test=-3.72, p-value < 0.001) (**Figure 1**). Path c in **Figure 1** shows the direct effect. Every standard deviation increase in extraversion score was associated with a higher lifestyle behavior score (β=0.42, 95% CI: 0.35−0.48, z-test=12.26, p-value < 0.001, indicated by path a1) and a higher health status score (β =0.05, 95% CI: 0.00−0.10, z-test=1.64, p-value = 0.05, indicated by path a2). Through each path, extraversion led to a lower mortality rate over the 11 years of follow-up (β ranging from -0.18 to -0.20, corresponding to a reduction in mortality rate of approximately 20% as indicated by paths b1 and b2 in **Figure 1**). Examination of the indirect effects of each specific mediator revealed that higher levels of extraversion predicted mortality rate to a greater extent through lifestyle behaviors (explained 44% of the association) than through health status (explained only 5% of the association).

Figure 1 here

We found no evidence of a significant interaction between the lifestyle behaviors and health status (HR=0.99, 97% CI: 0.88−1.06). Moreover, after excluding people with at least 1 disability in IADL and 2 chronic diseases (n=243), we found that lifestyle behaviors explained up to 62% of the personality-mortality association.

To take the missing data into account, we performed a logistic regression model, checking whether missing observations in personality traits were associated with other variables. We found that participants who did not report any information about their personality traits were more likely to be 80+ years old (OR=1.40, 95% CI: 1.03−1.89, z-test=2.25, p-value=0.025), not to drink alcohol (OR=1.49, 95% CI: 1.14−1.93, z-test=3.00, p-value< 0.001) or to be heavy drinkers (OR=1.55, 95% CI: 1.04−2.30, z-test=2.16, p-value< 0.031), and less likely to be engaged in intense leisure activities (OR=0.69, 95% CI: 0.49−0.97, z-test=-2.17, p-value=0.030). Similar results were observed after we excluded people missing part of the data on personality (data not shown).

DISCUSSION

We measured 3 personality traits (extraversion, neuroticism, and openness) in a cohort of 2298 cognitively healthy older people and followed them up for up to 11 years (mean: 8 years) to determine their survival status. We found that every standard deviation increase in extraversion was associated with a 14% lower mortality rate. By examining combinations of personality traits, we found that independent of levels of neuroticism and openness, high extraversion was associated with a lower mortality rate, although a 26% lower mortality rate was also observed in people with low levels of extraversion but high levels of openness and low levels of neuroticism. When we decomposed the effect of extraversion on mortality risk, we found that lifestyle behaviors explained 44% of the extraversion-mortality association, whereas health status accounted for only 5% of the association.

Previous research on the association between personality traits and survival in community-dwelling older people has yielded inconsistent results. The inverse association between extraversion and mortality in our analysis confirms the results of several previous studies (9, 15, 17, 30) but not others (8, 10-14, 16). Neuroticism has also been associated with both higher (8-10) and lower (11, 12) mortality risk in previous studies of community-dwelling older people. There are also studies that did not find any associations between neuroticism and mortality (13-16). In line with these studies, we did not find any association between neuroticism and survival. More studies are warranted to understand the discrepancies in findings across studies. We found no association between openness to experience and mortality in our study. This result is consistent with previous findings (8, 10, 12, 13), which were confirmed in a meta-analysis of 76150 participants from 7 cohorts (mean age at baseline=50.9 years) with a mean follow-up time of 5.9 years (31).

To the best of our knowledge, no previous study has examined the associations between different combinations of personality traits and mortality in older people. Our finding that people with high levels of extraversion had a lower mortality rate independent of their levels of neuroticism and openness is consistent with the results of previous studies on dementia incidence (19). Yet we found also that in people with low levels of extraversion, the combination of a low level of neuroticism and a high level of openness might reduce the risk of dying by 26%. People who score low in neuroticism are more emotionally stable and less reactive to stress than those with high neuroticism scores. It is therefore conceivable that people with low levels of neuroticism and high levels of openness to experience, which has been defined as an adaptive defense style (24), have greater problem solving and strategy-finding abilities, which could ultimately result in a lower mortality rate irrespective of extraversion.

Overall, these results suggest that extraversion dominated the effects of other personality traits on survival. This is reasonable because people with higher extraversion are characterized by greater optimism, higher self-efficacy, and an external attribution style (32), which may benefit them by reducing the impact of environmental stressors (33). Moreover, previous studies have reported an association between extraversion and healthy lifestyle factors (34-36) and between extroversion and a reduced risk of disability and diseases (37, 38). In addition, in line with these observations, the results of our mediation analysis also revealed that people who scored high in extraversion were more likely to be engaged in a healthier and socially integrated life, both of which are related to a reduced risk of dying. These results support the health-behavioral hypothesis, which suggests that certain personality traits are associated with engaging in or abstaining from some behavioral factors that ultimately affect health (3, 39).

The first strength of the study is that personality traits were assessed with psychometrically established measures. Second, the reliability of the assessment of personality and other relevant variables was strengthened because we studied a cognitively healthy cohort. Third, we studied the relationship between different combinations of personality traits and mortality risk. Fourth, we took into account a number of confounders and examined their mediating effects on the extraversion-mortality association. The limitations of the study include the lack of information about conscientiousness and agreeableness, the other 2 traits on the comprehensive NEO-FFI, which are also associated with mortality (8, 12). In particular, we cannot exclude the possibility that part of the protective effect associated with extraversion might be explained by conscientiousness, which has been associated with longer survival in previous studies (8, 12). Moreover, to keep the workload reasonable for participants, especially for the oldest old people,

we chose to use a 3-point assessment instead of the original 5-point assessment of the original NEO-FFI. Indeed, previous researchers have suggested that a 5-point scale may be less reliable than a simpler Likert assessment in people with diminished cognitive resources, such as those with intellectual disability (40) and those who are illiterate (41). Because of age-associated decreases in attentional resources, a 5-point Likert assessment might be less reliable in people aged 80+ than a simpler scale. It is consistent with this view that the authors of a previous study on the evolution of personality in patients with mild cognitive impairment chose to assess personality with the short form of the original NEO Personality Inventory, as it appears to be an instrument well-suited for use by people with mild cognitive impairment (42). Even though we used a short and simplified form, a consistent number of participants were missing values for personality traits (22%). They differed from the study population in that they were older (80+ years) and had unhealthy lifestyles (were heavy drinkers and had a sedentary lifestyle). Thus, our results may have either over- or underestimated the potential benefit of the lifestyle factors. Furthermore, although we excluded participants who had a diagnosis of dementia or depression, depressive symptoms, or cognitive impairment and controlled for a number of confounders, it is still possibility that residual confounding might play a role in the associations we studied.

In summary, the current study provides evidence that personality traits exert an effect on survival in advanced age. In particular, high extraversion is associated with longer survival, independent of the level of the other personality traits. Importantly, the beneficial effect on survival occurs via an active and engaged lifestyle. These findings may have significant clinical and public health relevance. Understanding pathways between personality and survival can help health professionals identify at-risk populations and move toward a targeted interventions.

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CONFLICTS OF INTEREST

None.

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FIGURES LEGENDS

Figure 1 Fully adjusted path model

Estimates are β with the corresponding 95% confidence interval. The confidence interval that does not include the null value shows a statistical significant association.

Model was adjusted for age, sex, and education.

The health status (score range 0−8) includes: number of chronic diseases, disability in IADL, level of C-reactive protein, and body mass index

The lifestyle behaviors (score range 0−8) includes: smoking habits, alcohol consumption, engagement in leisure activities, and social network

Table 1 Baseline characteristics of the study sample by survival status

Characteristics		Survival status after 11-year follow-up			
		% of the 1690 alive	% of the 608 deceased	*p*-value	t or χ^2 (df)
Socio-demographic					
Sex	Men	36.3%	44.9%	0.08	2.998 (1)
	Women	63.7%	55.1%		
Age, mean (SD)		69.2 (8.4)	79.8 (9.2)	< 0.01	-34.421 (2915)
Education	Elementary	18.3%	31.7%	< 0.01	143.079 (2)
	High school	40.2%	41.6%		
	University or above	41.4%	26.6%		
Health status					
BMI, mean (SD)		26.1 (3.9)	25.3 (4.3)	< 0.01	6.822 (2810)
No. of chronic diseases	None	28.6%	9.2%	< 0.01	192.632 (2)
	One	31.4%	26.5%		
	Two or more	39.9%	64.3%		
Impairment in IADL	One or more	7.7%	30.3%	< 0.01	412.322 (1)
C-reactive protein	< 5 mg/L	83.0%	76.4%	< 0.01	39.531 (2)
	5−9 mg/L	9.3 %	10.6%		
	> 9 mg/L	7.7%	13.0%		
Lifestyle behaviors					
Leisure activity	Low	23.1%	43.5%	< 0.01	153.078 (2)
	Moderate	47.8%	42.7%		
	Intense	29.1%	13.8%		

Social network	Limited	27.7%	49.0%	< 0.01	94.778 (2)
	Moderate	35.2%	28.3%		
	Rich	37.1%	22.7%		
Smoking status	Never	44.2%	47.8%	0.139	3.943 (2)
	Former	41.6%	37.5%		
	Current	14.2%	14.7%		
Alcohol consumption	Never/occasional	23.7%	43.2%	< 0.01	145.489 (2)
	Light/moderate	66.9%	51.1%		
	Heavy	9.4%	5.8%		
Personality traits					
Extraversion	Low	26.2%	37.0%	< 0.01	40.765 (2)
	Moderate	40.1%	41.6%		
	High	33.7%	21.4%		
Neuroticism	Low	41.6%	35.4%	< 0.01	29.651 (2)
	Moderate	32.1%	26.6%		
	High	26.3%	38.0%		
Openness	Low	30.6%	45.6%	< 0.01	53.833 (2)
	Moderate	29.9%	29.1%		
	High	39.5%	25.3%		

Abbreviations: SD, standard deviation; BMI, body mass index; IADL, instrumental activities of daily living; df, degree of freedom

Missing values: 153 for leisure activity, 89 for C-reactive protein, 41 for body mass index, 14 for smoking status, 6 for alcohol consumption, 3 for social network, and 2 for IADL

Univariate analyses were performed with Chi-square test for categorical variables and Student's t-test for continuous variables

Table 2 Hazard ratios (HRs) of mortality with 95% confidence intervals (CIs) by personality traits over 11 years of follow-up

	Model 1			Model 2		
Personality traits	HR of mortality	95% CI	z (p-value)	HR of mortality	95% CI	z (p-value)
Extraversion						
One unit increase	0.86	0.79−0.95	-3.14 (<0.01)	0.88	0.80−0.97	-2.64 (<0.01)
Moderate vs. low	0.87	0.71−1.06	-1.40 (0.162)	0.86	0.67−1.09	-1.29 (0.196)
High vs. low	0.70	0.55−0.89	-2.93 (<0.01)	0.71	0.56−0.90	-2.77 (<0.01)
Neuroticism						
One unit increase	1.10	1.01−1.20	2.21 (0.02)	1.07	0.98−1.17	1.51 (0.131)
Moderate vs. low	0.85	0.68−1.07	-1.39 (0.165)	0.81	0.65−1.03	-1.73 (0.083)
High vs. low	1.16	0.94−1.44	1.42 (0.155)	1.08	0.87−1.34	0.74 (0.462)
Openness						
One unit increase	0.95	0.87−1.05	-0.94 (0.346)	0.97	0.88−1.07	-0.58 (0.559)
Moderate vs. low	0.94	0.78−1.16	-0.57 (0.569)	0.97	0.79−1.20	-0.24 (0.807)
High vs. low	1.05	0.84−1.30	0.43 (0.664)	1.11	0.89−1.39	0.97 (0.334)

Model 1: personality traits are examined separately; adjustment for sex, age, and education

Model 2: personality traits are mutually adjusted; additional adjustment for sex, age, and education

The Z test and p-values were calculated from the natural regression coefficients and standard errors

Table 3 Hazard ratios (HRs) with 95% confidence intervals (CIs) of mortality by combinations of personality traits after adjustment for sex, age, and education

Levels of personality traits			Number	%	HR of mortality	95% CI	z (p-value)
Extraversion	**Neuroticism**	**Openness**					
Low	High	Low	248	10.8	Reference		
Low	High	High	325	14.1	0.97	0.72−1.30	-0.20 (0.840)
Low	Low	Low	385	16.7	0.82	0.62−1.10	-1.34 (0.179)
Low	Low	High	640	27.9	0.74	0.56−0.98	-2.11 (0.035)
High	High	Low	30	1.3	0.35	0.14−0.88	-2.24 (0.025)
High	High	High	72	3.1	0.81	0.48−1.35	-0.82 (0.414)
High	Low	Low	132	5.7	0.55	0.35−0.87	-2.53 (0.011)
High	Low	High	466	20.3	0.72	0.53−0.99	-2.01 (0.044)

High levels: the upper tertile of extraversion and neuroticism and upper two tertiles of openness

Low levels: the lower 2 tertiles of extraversion and neuroticism and lower tertile of openness

The Z test and p-values were calculated from the natural regression coefficients and standard errors