Five Factor Model Personality Traits and All-Cause Mortality in the Edinburgh Artery Study Cohort

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Objective: To examine whether personality traits are related to all-cause mortality in a general adult population in Scotland. **Methods:** The Edinburgh Artery Study began in 1987 to 1988 by recruiting 1592 men and women aged 55 to 74 years to be followed-up for atherosclerotic diseases. The NEO Five-Factor Inventory (NEO-FFI) was completed by 1035 surviving participants in 1995 to 1996. Deaths from all causes were examined in relation to personality traits and social and physical risk factors for mortality. **Results:** During follow-up, 242 (37.1%) men and 165 (24.6%) women died. For the whole sample, there was a 28% lower rate of all-cause mortality for each 1 SD increase in NEO-FFI openness (95% CI, 0.61–0.84) and a 18% lower rate of all-cause mortality for each 1 SD increase in NEO-FFI conscientiousness (95% CI, 0.70–0.97). In men, the risk of all-cause mortality was 0.63 (95% CI, 0.5–10.78) for a 1 SD increase in openness and 0.75 (95% CI, 0.61–0.91) for a 1 SD increase in conscientiousness. In women, none of the personality domains were significantly associated with all-cause mortality. Well fitting structural equation models in men ($n = 652$) showed that the relationships between conscientiousness and openness and all-cause mortality were not substantially explained by smoking, or other variables in the models. **Conclusion:** High conscientiousness and openness may be protective against all-cause mortality in men. Further investigations are needed on the mechanisms of these associations, and the influence of personality traits on specific causes of death. **Key words:** personality, Five-Factor Model, all-cause mortality, cohort.

BMI = body mass index; **SBP** = systolic blood pressure; **NEO-FFI** = NEO Five-Factor Inventory.

INTRODUCTION

The influence of personality on physical health and mortality attracts much interest but has few well-replicated findings (1–20). There is growing consensus that the traits used as health predictors should include those from the best-validated personality scales. The Five Factor Theory of personality has been suggested as a reference framework for investigations of the relationship between personality and health outcomes (4,13). The Five-Factor Model comprises five, culturally robust, basic, broad personality traits: neuroticism (e.g., anxiety, angry-hostility, and depression), extraversion (e.g., warm, assertive, positive emotions), openness to experience (e.g., fantasy, esthetics, and feelings), agreeableness (e.g., altruism, trust, and compliance) and conscientiousness (e.g., self-discipline, order, and achievement striving) (21–24).

To date, the majority of studies on personality and health have focused on the broad traits of extraversion and neuroticism. One early study by Almada et al. (5), did not find evidence for an association between neuroticism, assessed using the Minnesota Multiphasic Personality Inventory (MMPI), and mortality in a sample of 1871 middle-aged men who were followed up for 25 years, but a significant association was found between MMPI-defined cynicism (low agreeableness) and mortality. Subsequent studies which have assessed personality using scales developed by Eysenck and colleagues have produced mixed results. Huppert and Whittington (6) followed up 6096 adults aged 18 to 99 years of age and found no association between the Eysenck Personality Inventory scales of neuroticism and extraversion and all-cause mortality over 7 years. Another study by Korten et al. (7) assessed personality using the short form of the Eysenck Personality Questionnaire-Revised. In that study, 897 older adults aged 70 years and above were followed up for approximately 4 years and no relationship was found between extraversion and mortality; however, neuroticism was a protective factor.

A positive relationship between neuroticism and mortality was shown in two subsequent studies. Murberg et al. (8) found that neuroticism, measured using the Eysenck Personality Questionnaire, was a significant risk factor for mortality in a 2-year follow-up of 119 older patients with congestive heart failure. Support for an association between neuroticism, assessed using the Eysenck Personality Inventory, and mortality was also found by Shipley et al. (9), in the Health and Lifestyle Survey, a nationwide survey of adults aged over 18 years who have been followed up for mortality for 21 years. The results of the Health and Lifestyle Survey showed that neuroticism was a risk factor for death from all causes and cardiovascular disease. The same associations were also found when the sample was split into younger and older participants.

Although studies are few, there is evidence that some traits from the Five Factor Model are associated with mortality. Maier and Smith (10) conducted one of the first of these studies, using their own abbreviated and unvalidated version of the NEO Five-Factor Inventory (NEO-FFI) to assess associations between personality and mortality in old age among 514 individuals aged between 70 and 103 years. High neuroticism was a significant risk factor for mortality although high extraversion and openness were protective factors over 5 years of follow-up. However, after adjustment for age these associations were attenuated and no longer significant.

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The longest follow-up for personality predictors of mortality is provided by Friedman et al. (11). The Terman Life-Cycle study is a 60-year follow-up study of a sample of 1178 highly gifted children. The results showed that children scoring higher on "social dependability," which is moderately associated with the personality trait conscientiousness (25), were more likely to live to age 70 than those who scored lower on social dependability in childhood (11). Furthermore, the association between social dependability and all-cause mortality was found to be stronger in men than in women (11). There was some indication that "permanency of mood," an indicator of low neuroticism, was protective against mortality in men (11). "Cheerfulness," an indicator of agreeableness, was inversely associated with survival up to age 70 in men and women, but "sociability," an indicator of extraversion, was not associated with survival (11). A follow-up of the original sample revealed that the protective effect of social dependability on mortality was not primarily due to accident avoidance and could not be explained fully by healthy lifestyle choices such as abstinence from alcohol and smoking (12).

Christensen et al. (13) reported that among a clinical sample of patients with chronic renal insufficiency, those who obtained lower scores on NEO-FFI conscientiousness had a 36.4% increased mortality rate over 4 years of follow-up. High neuroticism was also a risk factor for mortality; it was associated with a 37.5% increased risk of mortality over 4 years (13). These findings have been replicated by Wilson et al. (14) in a study of 883 Catholic clergy members (mean age 75 at baseline) taking part in the Religious Orders Study. Over an average of 5 years of follow-up, neuroticism was found to be a risk factor for mortality although conscientiousness and extraversion were protective (14).

In another study, Wilson et al. (15) administered the abbreviated versions of the NEO-FFI neuroticism and extraversion scales to a community sample of 6158 adults aged 65 years or older. After 6 years of follow-up, neuroticism was found to be a risk factor for mortality and extraversion was a protective factor. Similar findings have been reported in the Georgia Centenarian Study (16) which obtained NEO-PI-R personality self-ratings and proxy informant ratings from a population based sample of 285 centenarians (98 years and older). Centenarians overall had lower levels of neuroticism and higher levels of extraversion, competence, and trust (16).

A recent study of a sample of 1076 older, frail participants (aged 65–100) found that the NEO-FFI personality traits of conscientiousness and agreeableness were significant protective factors against all-cause mortality and that there was a similar trend for neuroticism (17). Facet level analysis of the Revised NEO Personality Inventory (NEO-PI-R) revealed that the impulsiveness, straightforwardness, and self-discipline facets of neuroticism, agreeableness and conscientiousness, respectively, were protective against all-cause mortality over 3 years of follow-up (17). The largest effects were found for the self-discipline facet of conscientiousness; people with high self-discipline scores were less than half as likely to die during the 3-year follow-up period than people with low or average scores (17). These authors suggested that people with high levels of self-discipline may be less likely to engage in health damaging behaviors.

Overall, the Five Factor Model personality trait which most consistently predicts mortality is conscientiousness. The personality trait which has received the least attention in personality and health research is openness to experience, with the majority of studies reporting no association between openness and mortality (13,14,17) and one which reported that two of the NEO PI facets of openness (openness to feelings and openness to actions) were associated with decreased risk of cardiac mortality and all-cause mortality (18). In reviewing the evidence for the remaining personality traits, the evidence for associations between agreeableness, neuroticism, and all-cause mortality is inconsistent, while the association between extraversion and mortality is weak or non existent. There may be several reasons why previous studies have resulted in inconsistent findings. First, there are relatively few studies that have investigated the relationships between personality and mortality using the well-validated traits of the Five Factor Model. The use of these personality traits is advantageous in studies of health, because it leads to findings that are comparable across different studies (4). Second, many previous studies have used relatively short follow-up periods (7,8,17) included only frail or elderly participants (13,15,16), or relied on very specific samples of the population (13,18).

The present study is the first to examine the associations between the traits of the Five Factor Model and all-cause mortality in a general population sample based in the UK. It comprises almost 10 years of prospective follow-up, considerably longer than most previous studies. The study was conducted in a community sample of older men and women (aged 63–82 years) residing in Edinburgh. Previous research suggests that one pathway from personality to mortality may be health behaviors such as smoking (19,20). For example, a recent meta-analysis by Bogg and Roberts (20) found that conscientiousness was negatively associated with health damaging behaviors such as smoking. However, the associations between other personality traits such as neuroticism and agreeableness and health behaviors were inconsistent (20). Furthermore, a study by Hagger-Johnson and Whiteman (26) tested the associations between conscientiousness facets and health behaviors using a latent variable modeling approach, which demonstrated a direct pathway between the self-discipline facet of conscientiousness and health behaviors ($\beta = 0.27$). It is therefore important to consider potential physiological and/or behavioral mechanisms in investigations of personality and the risk of mortality. In our study, we specifically aimed to: a) test whether the Five Factor Model's personality traits are associated with all-cause mortality in a representative general population sample of older adults, and b) identify behavioral and physiological markers that may account for variance in the link between personality and all-cause mortality.

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METHODS

Participants

Participants were from the Edinburgh Artery Study (EAS), a longitudinal cohort study designed to investigate the epidemiology of peripheral arterial disease and its risk factors in the general population. Full details of the study population and recruitment have been described elsewhere (27). The EAS began in 1987 to 1988 as a cross sectional study of 1592 participants (809 men, 783 women) selected by age-stratified random sampling from the age-sex registers of 10 general practices serving a wide range of socio-economic and geographic areas across Edinburgh. The target population comprised Edinburgh residents aged 55 to 74 years. It was estimated that a sample size of at least 1500 was necessary to conduct a subsequent follow-up study with adequate power to detect differences in the incidence of vascular events due to baseline characteristics (27,28). To produce at least 1500 participants, 272 subjects were randomly sampled from each practice: 34 males and females from each of four 5-year age bands (55–59, 60–64, 65–69, and 70–74). General Practitioners reviewed lists of their patients selected for the study and excluded those unfit to participate due to illness, those who had moved away from the practice, or those who had died. These exclusions were replaced by other randomly sampled patients.

Participants attended a medical examination and were asked to complete a questionnaire at baseline. The baseline response rate was 65% and there was no substantial socio-economic bias in representativeness of the sample. As reported elsewhere, the social class distribution of responders was similar to that of the Edinburgh population in the 1981 census except that responders contained fewer social classes IV and V (13% compared with 19%) (27). Response rates were also lower in practices serving more deprived areas and there was a slight underrepresentation of women aged 70 to 74 years and men aged 55 to 59 years (27). A second medical examination and data collection took place in 1993; and in an interim study in 1995 to 1996 personality data were gathered. The study was approved by the Lothian Health Board Ethics Committee, and informed consent was obtained from each participant.

Medical Examination

The baseline medical examination took place in 1987 to 1988 and 1156 (72.6%) of the original sample attended a second examination 5 years later in 1993 (28). The data from the second examination were used in the present study to provide recent physical and lifestyle information. At the second examination, each participant's height and weight was recorded from which body mass index (BMI) (kg/m^2) was calculated. Systolic and diastolic (phase V) blood pressures were measured in the right arm using a Hawksley random zero sphygmomanometer. An electrocardiogram was recorded for each participant. Two observers later coded the electrocardiograms for ischemic conditions using the Minnesota code (29). A consultant cardiologist made the final decision if there was a discrepancy between coders. At both examinations, participants completed a questionnaire that included personal characteristics, occupation, smoking history, and self-reported medical history. Social class was coded (I–V) using the Registrar General's Classification (1980) (30). Self-reported smoking history was recorded and the information for each subject was converted into pack years by calculating the number of 20-cigarette packs smoked per day and then multiplying by the number of years the person had been a smoker. In between examinations, participants were sent brief annual questionnaires regarding new medical diagnoses, and data on hospital admissions and deaths were obtained from the Information and Statistics Division of the Scottish Executive and the National Health Service Central Register.

Personality Measurement

An interim data collection took place between October 1995 and April 1996, when 1295 (81.3%) surviving members of the EAS cohort were sent the NEO-FFI (21) by post. This was approximately 1 year after their second medical examination. Two hundred and seventy (17%) of the original sample had died before this interim follow-up and a further 27 (1.7%) people had dropped out of the study because they were unable or no longer wished to take part. In total, 1035 people returned the questionnaire. This was a 79.9% response rate. The personality questionnaire was included along with the usual brief annual questionnaire on medical diagnoses. If no reply was obtained after 6 weeks, a reminder letter was sent. Ethical approval was granted by Lothian Health and Medicine and Clinical Oncology Ethics Sub-Committee to administer the personality questionnaires.

The NEO Five-Factor Inventory (NEO-FFI)

The NEO-FFI is a 60 item version of the 240 item Revised NEO Personality Inventory (NEO-PI-R) and measures five personality domains (21). Each domain is measured by 12 items. The five domains are: neuroticism (N) which includes anxiety, angry hostility, depression, self-consciousness, impulsivity, and vulnerability; extraversion (E) which includes warmth, gregariousness, assertiveness, activity, excitement-seeking, and positive emotion; openness (O) which includes fantasy, aesthetics, feelings, actions, ideas and values; agreeableness (A) which includes altruism, trust, compliance, tender-mindedness, straightforwardness, and modesty; and conscientiousness (C) which includes self-discipline, competence, order, dutifulness, achievement striving, and deliberation.

All-Cause Mortality

The present study provides approximately 10 years of follow-up of the participants for mortality from the time of the personality assessment in Autumn 1995 until the last recorded death in March 2005.

Deaths were identified in the following ways: a) A card was attached to the participant's general practitioner medical records at the start of the study, to be returned if the participant died or changed address. All cardiovascular deaths notified by the GP were followed up by reviewing hospital or post mortem notes; other causes of death were verified from the death certificate; b) Notification of date and cause of death was identified by flagging each participant at the UK National Health Service Central Registry, which ensured that death certificates were automatically forwarded to the EAS office.

In the UK it is a legal requirement that any death is registered shortly after the death has occurred. All deaths that are registered are entered into the UK National Health Service Central Registry. Therefore, it can be assumed that the accuracy of ascertaining deaths within the sample was close to 100% and the misidentification rate would be negligible. Additionally, as a safeguard, routine data on hospital admissions and deaths were requested from the NHS and from general practitioners involved in the study.

Data Analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) Version 13.0 (SPSS, Inc, Chicago, IL).

Analyses were conducted for the whole sample, and men and women separately. To investigate whether the effects of personality traits on all-cause mortality differed between men and women, sex-specific associations were tested in a full model to identify interaction effects. All further analyses were carried out separately in men and women because there were statistically significant interactions among sex, personality, and all-cause mortality. That is, there was an interaction between conscientiousness and sex on all-cause mortality, where higher conscientiousness predicted lower mortality in men but not women. Mean (SD) levels of the NEO-FFI scale scores were calculated. Smoking (pack years) was square-root transformed for analyses because of the skewed distribution of the data. Cox proportional hazards regression models were generated to determine the relative rates of mortality according to differences in personality trait scores. All-cause mortality was the dependent variable in all of the models.

Cox proportional hazards modeling is based on the proportionality assumption, which is violated when the relative risk of the outcome does not change in the same manner for equivalent changes in the levels of a risk factor (17). To test for possible violations of proportionality we created a new variable equal to $T*Var$ where T is the time from the second baseline assessment and Var is the personality variable of interest in each model. This new variable was entered into each model. In all models, $T*Var$ was nonsignificant indicating that proportionality assumptions were met.

Although cardiovascular end-points were recorded, these results are not presented here because there were too few deaths from myocardial infarction,

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stroke and other cardiac-related deaths to warrant exploration of cause-specific deaths.

A model of the associations between NEO-FFI conscientiousness, age, social class, smoking (pack years), BMI, systolic blood pressure (SBP), and mortality was examined in men (n = 652) using the EQS structural equation modeling program (31). A second model was tested to examine the associations between NEO-FFI openness and the aforementioned covariates using the same procedure. Social class and mortality were categorical variables. The method of estimation was Maximum Likelihood. The method allows a number of interrelated variables to be specified in a hypothetical framework and tested for their goodness of fit to the data. Chi square, residual covariance, and fit indices were used to indicate the goodness-of-fit of the model to the data.

RESULTS

One thousand and thirty-five participants returned the personality questionnaires. Full personality data were obtained from 753 people, and full personality and physical data were obtained from 655 people. A total of 667 participants who were alive at the second medical examination in 1992 had missing personality or physical data. A comparison of individuals with complete data and those with missing data revealed that those who had complete data were significantly younger (68.9, SD = 5.4 versus 70.6, SD = 5.9, $p < .001$), more likely to have a higher socioeconomic status ($\chi^2 = 97.6$, $df = 5$, $p < .001$), a lower BMI (26.1, SD = 4.2 versus 26.7, SD = 4.6, $p < .03$), lower SBP (144.9, SD = 22.8 versus 152.1, SD = 25.1, $p < .001$), were less likely to have a history of cardiovascular events ($\chi^2 = 31.0$, $df = 1$, $p < .001$), and reported fewer pack-years of smoking (14.0, SD = 19.3 versus 18.2, 22.4, $p < .001$) than those who did not have complete data. Participants with complete data also reported significantly higher levels of agreeableness (32.8, SD = 5.2 versus 31.9, SD = 4.8, $p = .03$) and conscientiousness (33.5, SD = 5.8 versus 32.4, SD = 5.5, $p = .02$) than those with missing data. The fact that there were systematic differences between those participants included and those excluded due to missingness, on multiple measures including personality traits, indicates that data were not missing at random and suggested that multiple imputation should be performed to avoid introducing sample bias (32). Therefore, the following analyses are based on multiple imputed data from a sample of 1322 individuals who were alive at the time of the personality assessment in 1995 to 1996. Data were also analyzed separately for individuals with complete data on personality and risk factors (N = 656) and the results were very similar (not shown). These results are available on request from the authors.

During follow-up between 1995 and 2005, a higher number of men (242/652; 37.1%) than women (165/670; 24.6%) died ($p < .001$).

Table 1 shows the personality characteristics of the sample at the second clinical examination. Women had significantly higher mean (SD) levels of neuroticism (20.9, SD = 8.0 versus 17.4, SD = 7.2, $p < .001$) and agreeableness (33.6, SD = 4.6 versus 31.3, SD = 5.2, $p < .001$) than men. Extraversion, openness, and conscientiousness scores were similar in women and men.

The means and standard deviations of NEO-FFI personality traits according to all-cause mortality are shown in Table 2, for the whole sample and for men and women separately. For the whole sample, people who died during follow-up had significantly lower openness scores (23.0, SD = 5.4 versus 24.7, SD = 5.8, $p = .002$) and lower conscientiousness scores (32.4, SD = 5.8 versus 33.4, SD = 5.7, $p = .03$) than people

TABLE 1. Characteristics of the Sample at the Second Examination

	All N = 1322	Men N = 652	Women N = 670	p^a
NEO-FFI				
Neuroticism	19.1 ± 7.8	17.4 ± 7.2	20.9 ± 8.0	<.001
Extraversion	25.0 ± 5.4	25.0 ± 5.3	25.1 ± 5.5	.74
Openness	24.2 ± 5.8	23.8 ± 5.9	24.7 ± 5.6	.06
Agreeableness	32.5 ± 5.0	31.3 ± 5.2	33.6 ± 4.6	<.001
Conscientiousness	33.1 ± 5.7	33.1 ± 5.7	33.2 ± 5.7	.45
Risk factors				
Age	69.5 ± 5.6	69.7 ± 5.4	69.4 ± 5.7	.31
Social class				
I	164 (12.4)	90 (13.8)	74 (11.0)	
II	461 (34.9)	243 (37.3)	218 (32.5)	
IIIN	231 (17.5)	83 (12.7)	148 (22.1)	
IIIM	333 (25.2)	172 (26.4)	161 (24.0)	
IV	94 (7.1)	47 (7.2)	47 (7.0)	
V	39 (3.0)	17 (2.6)	22 (3.3)	<.001
Smoking[b]	15.4 ± 20.5	20.5 ± 23.2	10.7 ± 16.4	<.001
Systolic blood pressure	147.2 ± 23.7	145.1 ± 22.5	149.2 ± 24.7	.01
Body mass index	26.3 ± 4.3	26.1 ± 3.5	26.5 ± 4.9	.23
Number of deaths	407 (30.8)	242 (37.1)	165 (24.6)	<.001

Figures in the table are means ± SD or N (%).

[a] T-tests were used to test for differences for continuous variables, Chi-square was used to test for differences for discrete variables.

[b] Smoking was measured in pack years.

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TABLE 2. Unadjusted Means (and Standard Deviations) for Each of the NEO-FFI Scales According to All-Cause Mortality

	All-Cause Mortality								
	All			Men			Women		
	Dead $N = 407$	Alive $N = 915$	p	Dead $N = 242$	Alive $N = 415$	p	Dead $N = 165$	Alive $N = 500$	p
Neuroticism	19.5 (7.5)	18.9 (7.8)	.30	18.6 (7.3)	16.7 (7.0)	.03	20.8 (7.7)	20.9 (8.0)	.90
Extraversion	24.4 (5.5)	25.2 (5.4)	.08	24.4 (5.2)	25.2 (5.3)	.20	24.4 (5.9)	25.3 (5.4)	.20
Openness	23.0 (5.4)	24.7 (5.8)	.002	22.4 (5.2)	24.5 (6.0)	<.001	23.9 (5.4)	25.0 (5.6)	.13
Agreeableness	32.1 (5.0)	32.6 (5.0)	.20	31.1 (5.2)	31.5 (5.1)	.50	33.7 (4.2)	33.7 (4.7)	.74
Conscientiousness	32.4 (5.8)	33.4 (5.7)	.03	31.7 (5.6)	33.7 (5.7)	.001	33.5 (5.9)	33.2 (5.7)	.52

TABLE 3. Hazard Ratios (95% Confidence Intervals) of a one SD Increase in the NEO-FFI Traits on the Risk of All-Cause Mortality

	All ($N = 1322$)		Men ($N = 652$)		Women ($N = 670$)	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
NEO-FFI						
Neuroticism	0.89 (0.76–1.05)	0.94 (0.79–1.11)	1.12 (0.91–1.37)	1.16 (0.93–1.45)	0.85 (0.64–1.15)	0.88 (0.67–1.16)
Extraversion	0.95 (0.80–1.13)	0.97 (0.82–1.16)	1.12 (0.90–1.39)	1.12 (0.89–1.40)	0.77 (0.58–1.03)	0.81 (0.62–1.06)
Openness	0.72 (0.61–0.84)**	0.80 (0.67–0.95)**	0.63 (0.51–0.78)***	0.72 (0.58–0.90)**	0.87 (0.67–1.13)	0.92 (0.71–1.21)
Agreeableness	0.97 (0.83–1.13)	0.99 (0.84–1.16)	1.06 (0.87–1.30)	1.02 (0.83–1.25)	1.02 (0.78–1.34)	1.02 (0.78–1.35)
Conscientiousness	0.82 (0.70–0.97)*	0.86 (0.73–1.01)	0.74 (0.61–0.90)**	0.75 (0.61–0.91)**	1.08 (0.80–1.44)	1.21 (0.90–1.63)
Risk factors						
Age	—	1.12 (1.09–1.16)***	—	1.12 (1.07–1.17)***	—	1.15 (1.10–1.21)***
Social class	—	1.13 (0.99–1.30)	—	1.13 (0.96–1.34)	—	1.09 (0.87–1.38)
Smoking (pack years)	—	1.60 (1.27–2.01)***	—	1.21 (0.90–1.65)	—	1.96 (1.34–2.86)***
Systolic blood pressure	—	1.00 (0.99–1.01)	—	1.01 (1.00–1.02)	—	1.00 (0.98–1.01)
Body mass index	—	0.98 (0.94–1.02)	—	1.00 (0.95–1.06)	—	0.97 (0.92–1.02)

Model 1 adjusted for NEO-FFI traits.
Model 2 adjusted for NEO-FFI traits, age, social class, smoking (pack years), systolic blood pressure, and body mass index.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

who survived. There were no significant differences in neuroticism, extraversion, and agreeableness scores among people who died and people who survived.

When the unadjusted means were examined for men and women separately, compared with men who were alive at follow-up, men who had died from any cause had higher mean levels of neuroticism (18.6, SD = 7.3 versus 16.7, SD = 7.0, $p = .03$), and lower mean levels of openness (22.4, SD = 5.2 versus 24.5, SD = 6.0, $p < .001$) and conscientiousness (31.7, SD = 5.6 versus 33.7, SD = 5.7, $p = .001$). There were no significant differences in mean personality trait scores between the women who died and those women who survived during follow-up.

Cox Regression Analyses

Cox proportional hazards regression models were used to investigate which of the personality traits and other covariates made an independent contribution to all-cause mortality during the follow-up period. Descriptive data (Table 1) revealed that men had higher pack years of smoking than women ($p < .001$). A higher proportion of men than women were in the highest social classes (I and II) ($p < .001$). On average, women had higher SBP than men ($p < .01$). There were no significant differences between men and women in age or BMI.

To investigate whether the effects of personality traits on mortality differ between men and women, individual models were tested to examine interaction effects between sex and each personality domain, after adjusting for the other personality domains. There was a significant interaction between sex and conscientiousness on all-cause mortality (HR 0.73, 95% CI, 0.53–0.99). High conscientiousness was associated with a reduced risk of all-cause mortality in men, but not in women. There was no significant interaction between sex and any of the remaining personality traits. Table 3 shows the relative risks (95% confidence intervals) of a 1 SD increase in the NEO-FFI personality traits on the risk of all-cause mortality for the whole sample, and for men and women separately.

Cox regression models were used initially to identify which variables were associated with all-cause mortality when all of the personality traits were entered simultaneously (Model 1; Table 3). Personality traits were entered simultaneously be-

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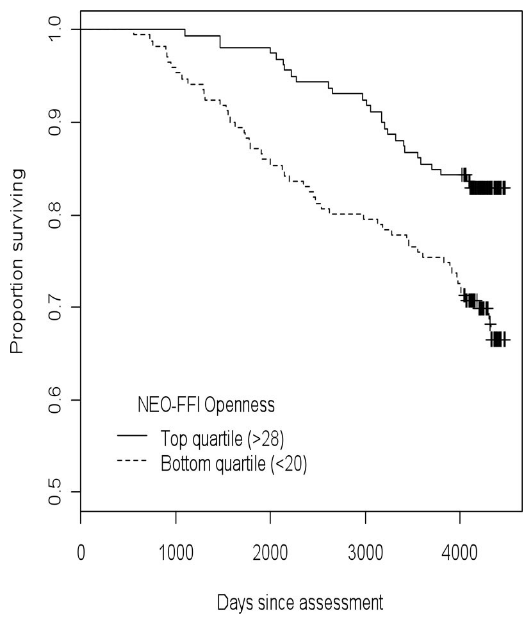

Figure 1. Kaplan-Meier curve showing the proportion of survivors with scores in the top and bottom quartiles of the NEO-FFI openness domain over approximately 10 years of follow-up.

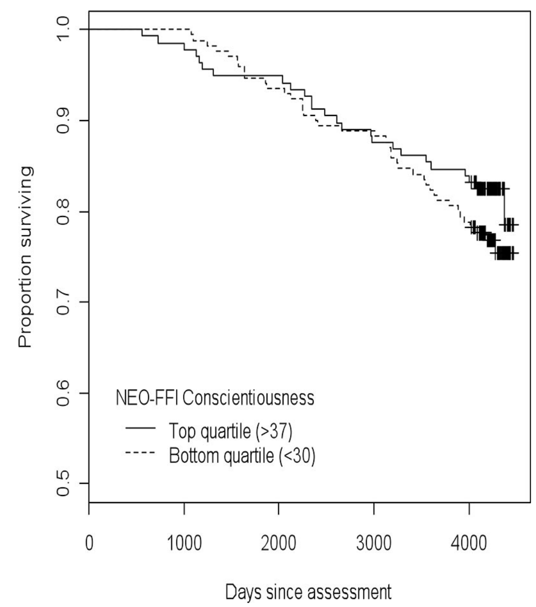

Figure 2. Kaplan-Meier curve showing the proportion of survivors with scores in the top and bottom quartiles of the NEO-FFI conscientiousness domain over approximately 10 years of follow-up.

cause there were intercorrelations between the Five Factor Model domains ($r = 0.08$ to -0.34, all $p < .05$), with the exception of openness and agreeableness, and openness and neuroticism, which did not correlate significantly with each other. A second model (Model 2; Table 3) was then used to identify personality traits that accounted for significant amounts of variance in mortality risk after further adjustment for potential confounding variables (age, social class, smoking consumption (pack years), SBP, and BMI). The results for the whole sample revealed that in Model 1, when personality traits were entered simultaneously, there was a 28% lower rate of all-cause mortality for each 1 SD increase in NEO-FFI openness (HR 0.72, 95% CI, 0.61–0.84) and a 18% lower rate of all-cause mortality for each 1 SD increase in NEO-FFI conscientiousness (HR 0.82, 95% CI, 0.70–0.97) (Figures 1 and 2). After additional adjustment for age, social class, smoking, blood pressure, and BMI (Model 2; Table 3), the association between openness and all-cause mortality was slightly attenuated, but remained significant (HR 0.80, 95% CI, 0.67–0.95). The association between conscientiousness and all-cause mortality was attenuated and became nonsignificant after adjusting for risk factors (HR 0.86, 95% CI, 0.73–1.01). Age and smoking were significant independent predictors of mortality in the fully adjusted model (Model 2; Table 3).

Men

In Model 1 (Table 3), when all personality traits were entered simultaneously, lower NEO-FFI openness and conscientiousness were significantly associated with a higher rate of all-cause mortality in men (Figures 3 and 4). There was a 37% lower rate of all-cause mortality for each 1 SD increase in openness scores (HR 0.63, 95% CI, 0.51–0.78) and a 26% lower relative rate of all-cause mortality for each 1 SD increase in conscientiousness scores (HR 0.74, 95% CI, 0.61–0.90). After additional adjustment for age, social class, BMI, SBP, and smoking the association between openness and all-cause mortality and conscientiousness and all-cause mortality remained significant; there remained a 28% reduced relative rate of all-cause mortality for each 1 SD increase in openness, and a 25% reduced relative rate of all-cause mortality for each 1 SD increase in conscientiousness (Model 2; Table 3). Age was a significant independent predictor of all-cause mortality in the fully adjusted model (Model 2; Table 3).

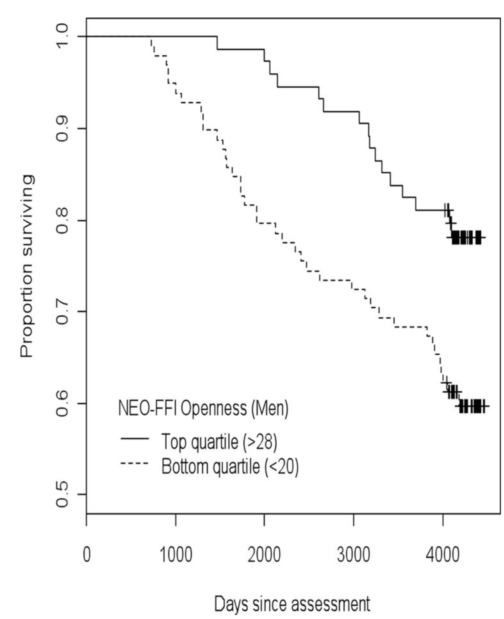

Figure 3. Kaplan-Meier curve showing the proportion of male survivors with scores in the top and bottom quartiles of the NEO-FFI openness domain over approximately 10 years of follow-up.

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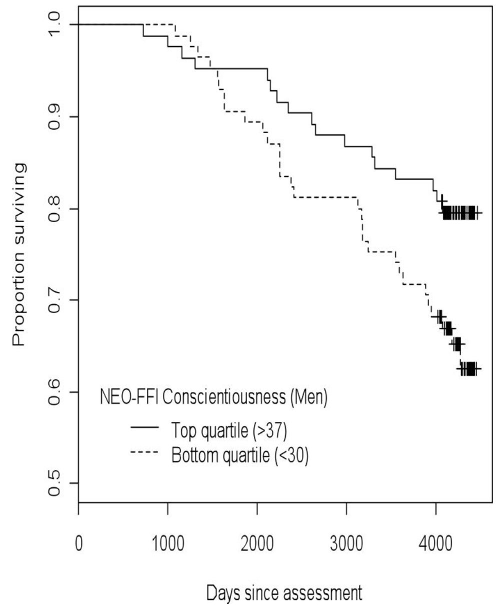

Figure 4. Kaplan-Meier curve showing the proportion of male survivors with scores in the top and bottom quartiles of the NEO-FFI conscientiousness domain over approximately 10 years of follow-up.

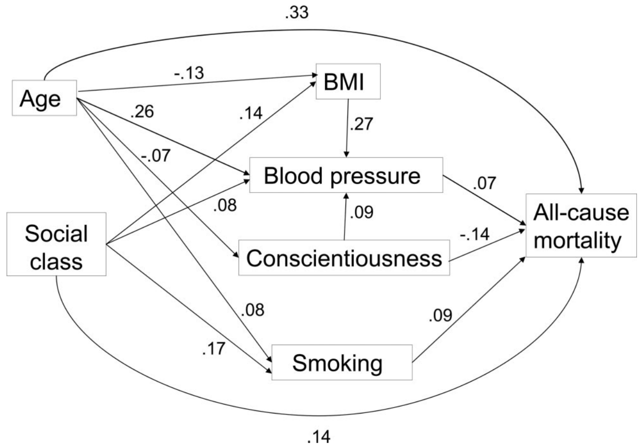

Figure 5. Structural equation model to show the relationships between NEO-FFI conscientiousness and other risk factors on all-cause mortality in men (N = 652). All of the parameters were statistically significant. Coefficients placed beside arrows may be squared to give the percentage of variance shared by adjacent variables.

Women

None of the NEO-FFI personality traits were significantly associated with all-cause mortality in women. However, older age and a greater number of pack years of smoking were associated with an increased risk of all-cause mortality in women (Model 2; Table 3).

Path Analysis

Structural equation modeling was used to perform path analyses to investigate whether health behaviors and physiological markers of risk accounted for variance in the relationship between conscientiousness and openness and all-cause mortality in men. A separate path analysis was performed for each personality factor. Structural equation modeling provides parameter weights that indicate the strength of association among variables in the model. When specifying the model to be tested it was hypothesized that: i) age, social class, blood pressure, and smoking are directly associated with all-cause mortality; ii) there is a direct association between age and blood pressure; iii) social class influences health behaviors (e.g., smoking) and physiological markers of risk; iv) BMI is directly associated with blood pressure; and v) conscientiousness and openness are directly associated with blood pressure and all-cause mortality.

Conscientiousness and All-Cause Mortality

The structural equation model for 652 men with complete data are displayed in Figure 5. The arrows represent the hypothesized directions of influence. The values placed next to the arrows are the parameter weights estimated by the model fitting procedures. The Wald test was used to indicate nonsignificant parameters that should be dropped from the model and the Lagrange multiplier suggested pathways that could be added to improve the goodness of fit. Chi square, residual covariance, and fit indices were used to indicate goodness-of-fit of the model to the data. All of the parameters in the model were significant. The model had a reasonable fit to the data. The χ^2 value for the model was 14.3 (df = 7), p = .05. The average of the off-diagonal absolute standardized residuals was 0.013; values of less than 0.04 typically indicate good fit. These tests indicate that the residual covariance among the variables was low after the model's paths were taken into account. Three further indices reflect how well the model fits the variables' covariance matrix, where a good fit is indicated by values equal to or greater than 0.9 in each. For the present model, the normed Bentler-Bonnett, the non-normed Bentler-Bonnet, and the comparative fit indices were: 0.98, 0.96, and 0.99, respectively, indicating that the model had an acceptable fit.

The model (Figure 5) shows that conscientiousness was a direct predictor of all-cause mortality: men who had higher conscientiousness scores were less likely to die during the 10-year follow-up period than men with lower conscientiousness scores. Smoking and BMI did not account for variance in the link between conscientiousness and mortality. However, there was a small positive association between conscientiousness and blood pressure, and between blood pressure and mortality. Other variables with significant direct effects on all-cause mortality were older age, smoking, and higher blood pressure. The network of pathways also suggests there were potential intervening variables (Figure 5). For instance, it was expected that blood pressure would have an intermediate position between age and all-cause mortality, and between social class and all-cause mortality. These specified pathways were consistent with the data. This suggests that blood pressure may partly account for variance in these associations. The Lagrange multiplier indicated that three further pathways could be added to improve the fit of the model. The first pathway was between age and conscientiousness suggesting that conscientiousness is inversely correlated with age. A

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second pathway was indicated between social class and pack-years of smoking; people with a poorer socioeconomic status smoked more heavily and for a longer duration, and a further pathway was indicated between social class and mortality suggesting that individuals with a poorer socioeconomic status were more likely to have died during follow-up.

Openness and All-Cause Mortality

The model displayed in Figure 5 was fitted to the openness and all-cause mortality data. The Wald test and the Lagrange multiplier tests were used to indicate pathways which might be changed to indicate a better fitting model. The Lagrange multiplier suggested that four additional paths could be added to improve the overall fit of the model. The first path was between age and openness, the second path was between age and pack-years of smoking suggesting that older people smoked more than younger people, the third path was between social class and BMI, and the fourth path was between social class and mortality. The Wald Test suggested that the pathway between social class and SBP should be removed. The model is shown in Figure 6. The χ^2 value for the model was 16.33 (df = 9), p = .06. The average of the off-diagonal absolute standardized residuals was 0.034. The normed Bentler-Bonnett, the nonnormed Bentler-Bonnet, and the comparative fit indices were: 0.92, 0.90, and 0.99, respectively, indicating that the model had an acceptable fit.

The model (Figure 6) replicates several of the pathways shown in Figure 5. Older age, higher blood pressure, social class, and smoking had direct effects on all-cause mortality. The intermediate position of smoking between social class and mortality, and the intermediate position of BMI between age and blood pressure were also replicated. As expected, lower social class was a direct predictor of openness, as was younger age. Openness was shown to be a direct predictor of all-cause mortality: men who had higher openness scores were less likely to die during the 10-year follow-up period than men with lower openness scores. There was a negative relationship between openness and blood pressure; the link between openness and mortality was partly explained by blood pressure.

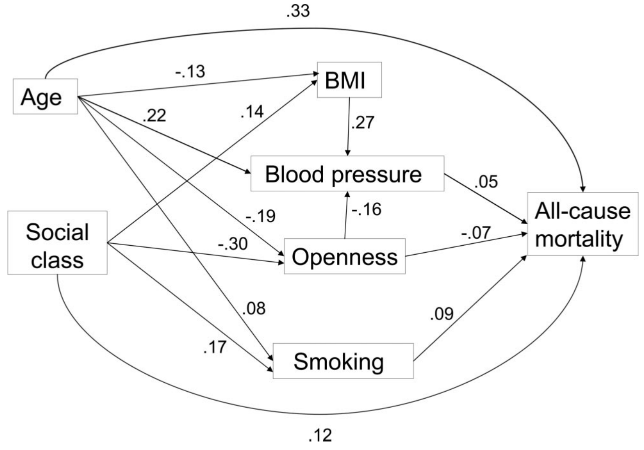

Figure 6. Structural equation model to show the relationships between NEO-FFI openness and other risk factors on all-cause mortality in men (N = 652). All of the parameters were statistically significant. Coefficients placed beside arrows may be squared to give the percentage of variance shared by adjacent variables.

DISCUSSION

The present study examined the influence of NEO-FFI personality traits on all-cause mortality over approximately 10 years of prospective follow-up of the EAS cohort. High NEO-FFI conscientiousness and openness conferred protection against premature mortality in this sample. For the whole sample, the influence of openness on mortality remained after adjustment for other covariates including age, social class, smoking, blood pressure, and BMI. When the results were analyzed for men and women separately, in men the associations between openness and mortality, and conscientiousness and mortality, remained after adjustment for covariates. However, in women none of the personality traits were significantly associated with all-cause mortality.

To our knowledge, this is the first study in the UK to observe an association between conscientiousness and all-cause mortality in a general community-based population sample. The Terman study group found that children scoring high on social dependability were more likely to live to age 70 than children who had lower scores on social dependability (12). The Terman study, however, consisted of only gifted children who were relatively homogeneous on dimensions of intelligence, race and social class. This meant that the results were not representative of the US sample of adults as a whole and perhaps not generalizable to the general population. In a recent study, high NEO-PI-R conscientiousness was a strong significant predictor of all-cause mortality over 5 years of follow-up among a sample of older Medicare patients in the US (17). The present study has replicated these findings in a younger, previously healthy, community based sample of Scottish men who have been followed up for approximately 10 years.

Identifying the mechanisms that underlie the association between conscientiousness and all-cause mortality is an important direction for future research. The conscientiousness-mortality link provides support for the hypothesis that some personality dispositions promote good health. In the present study, blood pressure accounted for variance in the association between conscientiousness and mortality. Conscientiousness might have promoted the testing and monitoring of blood pressure in this sample.

Friedman (19) refers to personality influences on health choices over time as "health trajectories." Examination of such trajectories in other studies has shown that the Five Factor Model personality trait of neuroticism, together with hostility, leads to damaging health behaviors such as heavy smoking or alcohol consumption (33,34). In this study, we did not find evidence that the personality-health link was significantly influenced by behavioral choices, such as smoking. This was possibly due to a survivor effect in this group. The personality assessment took place 5 years into the study when the participants were aged between 60 and 79 years. It is possible that the smokers who are most susceptible to the

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health damaging effects of smoking will have already died. As a result, the present sample may include a higher number of "healthy smokers" who are not representative of smokers in the general population. A review of cross-sectional and longitudinal studies has found support for the concept of the healthy smoker as an individual whose lungs are relatively resistant to the effects of smoking (35). The effects of smoking in this study may also be underestimated due to the unreliability of self-reports, but this explanation is less likely because in the EAS self-reported smoking correlated moderately with serum thiocyanate concentrations (36). A recent study by Zil-a-Rubab and Rahman (37) found significantly higher mean serum thiocyanate concentrations among self-reported smokers than passive and never smokers. Serum thiocyanate concentration had 91% sensitivity, 80% specificity, and 84% accuracy at $\geq$60 uml/L for smokers (37). In the EAS, 80.9% of current smokers had serum thiocyanate concentrations $>$60 uml/L, as did 12.6% of ex-smokers and 7.7% of never smokers.

As proposed by Friedman et al. (11), one possible explanation for the association between conscientiousness and mortality is that highly conscientious people are different in health-relevant ways other than their drinking and smoking habits. We have added blood pressure as another possible factor here. Conscientious individuals may be more likely to monitor their health and make sure that they get their blood pressure checked regularly. Conscientious people may also be more able to cope with stressful life events or more likely to maintain stable marriages and other social support networks which relate to their health. Indeed, from an interactionist perspective, the interrelationships between personality traits and situations have an impact on the expression of behavior. One of the drawbacks of the present study is that situational factors such as stressful life events, coping abilities, and other contextual factors such as the amount of social support available were not accounted for. These situational factors may have important interactions with personality traits, or account for their associations with health outcomes. Alternatively, genetic factors or early social processes may act as antecedents in the association between personality and health. Although the mechanism of the association between conscientiousness and all-cause mortality remains unclear, the evidence is continuing to grow that conscientiousness may be a personality trait that not only helps people order their daily tasks, but also helps protect them from ill-health or even death.

The present study found that high NEO-FFI openness was protective against all-cause mortality over 10 years in men. This finding is inconsistent with previous studies which found that openness domain scores did not predict all-cause mortality (13,14,17,18). However, these studies were made up of frail or elderly individuals (14,17) and specific samples, such as those suffering from chronic renal insufficiency (13) or cardiac disease (18). These individuals are unlikely to be representative of the general population. Therefore, the association between openness and all-cause mortality needs replicating in a general population sample. Openness has been related to cognitive ability in a previous study (38). Cognitive ability is known to be a predictor of longevity (39–41) independent of a person's social position (40). Social class has been related to cognitive ability (39,42) and mortality (39). In the EAS, NEO-FFI openness and social class were moderately correlated with each other (Spearman's $rho = -0.31$). Furthermore, social class predicted all-cause mortality (HR 1.19; 95% CI, 1.05–1.34) (results not shown), and the association between openness and all-cause mortality was slightly attenuated after controlling for social class and other covariates. One possible explanation is that NEO-FFI openness is significantly associated with cognitive ability (38), and social class was acting as a partial surrogate for that here. For example, results from a longitudinal study by Gow et al. (43) showed that early life ability (at age 11) was significantly related to the personality factors of IPIP-emotional stability (low neuroticism) and IPIP-intellect and imagination (similar to openness) measured in later adulthood ($r = 0.11$ and 0.32, respectively). A similar pattern was found for later ability (at age 79), but after adjustment for early ability the association between age 79 ability and IPIP-intellect was no longer significant (43). These findings suggest that IQ and intellect-imagination (openness) may be related through lifelong intelligence. In path analysis (Figure 6), the relationship between openness and all-cause mortality was partially accounted for by SBP. The relationship between openness and blood pressure adds to previous literature which has shown a relationship between cognitive ability and blood pressure (44), and provides further support for the suggestion that openness may be acting as a proxy marker for intelligence in this sample.

Studies which have examined the relationship between neuroticism and all-cause mortality have produced mixed results. Some previous studies found no association between neuroticism and mortality (5,6,14). However, other studies have found evidence that neuroticism is a risk factor for mortality (8,9,13). One study showed a protective effect of neuroticism against mortality (7). In the present study, men who died during follow-up had significantly higher mean levels of NEO-FFI neuroticism than men who survived ($p = .03$). However, this association was not found in women, nor did it persist after time to follow-up and other risk factors were taken into account. There may be several reasons for these mixed results. It is possible that some facets of neuroticism are more strongly related to mortality than others. For example, the NEO-PI-R facet of impulsiveness has been shown to be protective against all-cause mortality (17) whereas measures of anxiety, suppressed anger, and depressive symptoms, which are similar to the NEO-PI neuroticism facets of anxiety, angry hostility and depression, were related to increased risk of mortality (45).

There was no significant relationship between extraversion and mortality in this sample. This finding is largely consistent with previous research, although a protective effect of extraversion has been reported by Wilson et al. (15). In addition, we did not find evidence of a significant relationship between agreeableness and mortality in the present sample. There is

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increasing evidence in the literature to suggest that agreeableness is protective against cardiovascular disease (46,47), but there are mixed findings regarding the relationship between agreeableness and all-cause mortality. One study found evidence of a small positive association (5) while others have reported no association (13,14).

One reason why associations between personality traits and mortality are not well replicated may be due to variability in the nature and extent of covariate coverage in different studies. This is a potential weakness of the present study. Here we included biomedical covariates that were measured at the second baseline examination which took place before the personality assessment. As a result, we were not able to adjust for other "classic" risk factors, such as cholesterol level, which are known to influence mortality. In future research, it would also be interesting to assess the impact of situational factors (e.g., stressors) that may interact with personality predictors, obscure their effects, or account for their associations with health outcomes. As with all longitudinal studies, attrition of the sample across the various stages of data collection can lead to sources of bias in the sample and underestimation of the magnitude of observed associations. In this investigation it is possible that personality influenced attrition at the different stages of data collection, which may have led to some bias in the sample. However, personality data were collected relatively early in the study, 5 years after the initial baseline, making it less likely that personality seriously influenced attrition.

In future investigations it is important to discover why the associations between NEO-FFI personality traits and all-cause mortality were present in men but not in women. This sex difference could be due to the age of the sample. Future work should explore the pattern of associations between personality and all-cause mortality across age in men and women to explore this further. Another possibility could be that there were fewer deaths among women ($n = 165$) than men ($n = 242$) in the present study which reduced the power to detect a significant effect. However, we were able to discount this explanation by comparing the effect sizes (Cohen's d) of the personality effects in men and women. For openness, the effect sizes were: 0.37 for men and 0.19 for women. For conscientiousness, the effect sizes were: 0.35 for men and −0.05 for women. Therefore, the smaller number of deaths among women does not account for the null results, and it may be that the patterns in men and women are different. An alternative explanation is that although women vary in personality traits they may show less variation in health behaviors such as smoking, alcohol consumption and exercise, hence preventing personality traits such as low conscientiousness from taking full effect on their health (12). In the present study, however, the association between conscientiousness and all-cause mortality in men was direct, and not affected by smoking or other variables measured here. In future studies, it would be interesting to know whether other health-related behaviors such as alcohol consumption, exercise, or a person's diet are involved in the link between personality and mortality. If found this may have implications for behavioral interventions to improve health and perhaps longevity.

CONCLUSIONS

The present study provides new longitudinal information about the effects of personality traits on mortality in a nearly representative sample of older adults from a general UK population using the well-validated NEO-FFI. High conscientiousness and openness were protective against the risk of all-cause mortality in men. Our findings replicate similar results from quite different study populations. Although the precise mechanisms of the associations are not fully understood, the accumulating evidence suggests that personality traits may be important additional risk factors for mortality. This study adds to previous research by demonstrating a link between personality traits and all-cause mortality in a previously healthy sample of the general Scottish population who have been followed up for almost 10 years.

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