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Neuroticism predicts all-cause mortality over 19-years: The moderating effects on functional status, and the angiotensin-converting enzyme

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ABSTRACT

Objective: To examine if the personality traits neuroticism, extraversion, and openness to experience are related to all-cause mortality in older adults over a follow-up period of 19 years.

Methods: Participants were a locally representative sample of 417 older adults ($M \pm SD = 84.55 \pm 8.62$ years). Statistical significance levels for hazard ratios were estimated having adjusted for age, sex, education, income, depressive illness, and personality traits.

Results: A significant effect was observed for neuroticism with each 1 SD increase in neuroticism associated with a 14% increased risk in all-cause mortality ($p = 0.031$: 95% CI, 1.01–1.28). Following the trichotomization of neuroticism, the hazard for those > 1 SD above the mean was significantly greater than the average range (HR = 1.59; $p = 0.001$; 95% CI, 1.19–2.11). Examination of potential mechanisms revealed that neuroticism significantly moderated the effects of functional status ($HR_{interation} = 1.09$; $p = 0.018$; 95% CI = 1.02–1.17), and the angiotensin-converting enzyme (ACE; $HR_{interation} = 0.88$; $p = 0.031$; 95% CI = 0.79–0.99) on mortality. As such, for each 1 SD increase in neuroticism, the effect rate on all-cause mortality increased by 9% for functional status, and decreased by 12% for ACE.

Conclusions: Findings suggest that neuroticism is associated with all-cause mortality in older age. Specifically, persons higher in neuroticism are at a distinctly greater risk of all-cause mortality. Both functional status, and the angiotensin-converting enzyme provide two potential mechanisms of effect in the association between neuroticism and mortality.

1. Introduction

Accumulating research over recent decades has linked personality traits – "dimensions of individual differences in tendencies to show consistent thoughts, feelings, and actions" [1] – to a number of wide-ranging outcomes. Conventionally, personality traits are assumed to derive from a biological basis, albeit influenced by environmental factors [2]. For this reason, traits occur throughout non-human species [3], with species closer to humans (such as chimpanzees) seen to exhibit personality traits similar to humans [4]. Essentially, personality traits are naturally selected and serve as mechanisms which have evolved to solve adaptive problems [5]. Correspondingly, varying intensities of a particular personality trait can be expected to be adaptive in varying contexts [6]. In short, personality traits are not only likely to be markers of pertinent physiological characteristics, they are likely to influence health-relevant behaviours and attitudes over long periods of time.

Accordingly, the idea that personality traits can predict patterns of mortality in humans has received considerable research attention. For example, several studies have reported a positive association between neuroticism (a trait-level tendency to experience negative emotions and display emotional instability) and risk of premature mortality [7–17]. However, a number of other studies have also reported either no association [18–22] or negative associations [23,24]. Likewise, openness to experience (a trait-level receptiveness to varied events combined with intellectual curiosity) has been associated with protective health effects [18,25–28], although a number of studies have failed to corroborate this conclusion [8,16,22,23,29]. A similar situation arises with extraversion (trait-level sociability and sensation-seeking), where some studies have shown a link to longevity [7,13,16,17] but others have reported no significant association [8,11,14,21,23]. The inconsistent pattern of these findings may result from a number of factors. For example, many studies have focused on narrow subgroups of the population (e.g., [12,16,28]), and so may have limited generalisability.

Examining data from the original Berlin Aging Study (BASE), Maier and Smith [30] investigated psychological predictors of mortality over

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Table 1
Baseline sample characteristics.

	Complete sample (N = 417)		Males (n = 224)		Females (n = 193)	
	M/n	SD/%	M/n	SD/%	M/n	SD/%
Age (years)	84.55	8.62	85.00	8.46	84.03	8.80
Marital status						
Married	130	31.2	117	52.2	13	6.7
Widowed	228	54.7	94	42.0	134	69.4
Divorced	26	6.2	7	3.1	19	9.8
Single	33	7.9	6	2.7	27	14
Education						
Elementary school, No Apprenticeship	113	27.1	40	17.9	73	37.8
Elementary school, apprenticeship	206	49.4	113	50.4	93	48.2
Secondary school certificate, apprenticeship	98	23.5	71	31.7	27	14
Income (Deutsche Mark)[a]	1997.61	1133.03	2186.75	1336.54	1778.10	785.20
Depressive illness						
No depressive disorder	241	57.8	156	69.6	85	44
Questionable depressive disorder	148	35.5	54	24.1	94	48.7
Depressive disorder	28	6.7	14	6.3	14	7.3
Functional status	4.48	1.22	4.53	1.13	4.42	1.32
ACE (U/l)[a,b]	34.69	15.48	34.74	15.85	34.63	15.08
Neuroticism[a]	2.33	0.76	2.18	0.72	2.51	0.78
Extraversion[a]	3.35	0.59	3.34	0.61	3.37	0.56
Openness to experience[a]	3.07	0.58	3.03	0.53	3.11	0.63

[a] Represents raw values prior to conversion to standard deviation units for analysis.
[b] Sample size for this sample, including both male, and female subsamples (N = 399; n = 215; n = 184) respectively.

a 6-year period. As a peripheral hypothesis, the authors examined if neuroticism, extraversion, or openness to experience predicted mortality [30]. They reported significant unadjusted effects for each personality trait but found that effects were no longer significant following adjustment for demographic variables [30]. The study may have been limited due to the relatively brief follow-up period, which may be insufficient to reveal the relevant trajectories. Within proportional hazards analysis, power is determined by the number of events under examination (e.g., [31]). Studies examining brief follow-up periods are not without precedent in the wider literature (e.g. [8,18,24]).

The overall aim of the present study was to examine if neuroticism, extraversion, and openness to experience are associated with long-term mortality in older adults from the BASE. In doing so, we examined mortality rates over the complete 19-year follow-up period available within the project. We also sought to examine mechanisms which may account for the potential association between personality and all-cause mortality. This study focused on two potential mechanisms, namely functional status, and the angiotensin-converting enzyme (ACE). Functional status is of crucial importance in older adults, and its decline represents associated health deterioration that has been widely reported as of relevance to all-cause mortality [32–34]. ACE is implicated in a wide range of health outcomes such as kidney disease [35], liver disease [36], and most notably cardiovascular disease [37]. The targeting of ACE with interventions in the elderly have been well reported as having significant effects on mortality [38]. As such, this study also sought to determine if both functional status, and ACE could provide possible mechanisms of effect in the association between personality and mortality.

2. Methods

The BASE is an inter- and multidisciplinary investigation of older adults [39,40]. Within the core study (1990–1993), a sample of 516 individuals were examined in 14 sessions in which information pertaining to geriatric, psychiatric, medical, psychological, sociological, and economic circumstances, inter alia, was gathered. After 1993, BASE was continued as a longitudinal examination. Importantly, BASE participants were recruited using an obligatory population registry for the city of Berlin, thus allowing the researchers to maximize sample heterogeneity and local representativeness [41]. Analysis of 22 comparison variables revealed the BASE sample possessed the intended sample heterogeneity, and that the collated data holds high generalizability [41]. This sample of 516 individuals represented 27% of the verified parent sample of 1908 obtained from the city registry. Examination of sample selectivity revealed no strong evidence for selectivity effects regarding individual heterogeneity and intervariable covariation [42].

A consensus conference was organized in order to provide an accurate determination relating to diagnostic criteria pertaining to disease and diagnosable pathological states for each participant. In order to sort all participants into relevant categories, all data (e.g., interview, medical examination, blood pressure, Doppler ultrasound, resting electrocardiography [ECG], serum, plasma, flow cytometry, lymphocyte stimulation, urinalyses, major histocompatibility types) were compiled, with psychiatrists and internists then classifying participants within each diagnostic category [43].

2.1. Participants

A sample of 516 male and female participants took part in BASE. Participants were drawn at random from the Berlin city registry office, with participants stratified into 12 age-by-gender groups (70–74 years, 75–79 years, 80–84 years, 85–89 years, 90–94 years, and 95+ years; [32,33]). Those who cancelled their registration with Berlin City or moved from the city were removed from the study (n = 20). Those whose information pertaining to income (n = 66), and education (n = 13) which were missing were not included within the present study. The final sample comprised of 417 participants who ranged in age from 70 to 103 years (see Table 1).

2.2. Measures

2.2.1. Mortality

Mortality status for participants and the date of death for deceased participants were obtained from the State Registry Office in Berlin City, and are included in the full BASE dataset. Mortality status was defined as the number of days between the initial contact at baseline (between 1990 and 1993) and the date of death. For those who were not deceased, the date represented the number of days between the initial contact at baseline and latest data update from the State Registry Office. The final available update regarding mortality status was made in July