Does personality predict mortality? Results from the GAZEL French prospective cohort study.

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Abstract

Background

Majority of studies on personality and physical health have focused on one or two isolated personality traits. We aim to test the independent association of 10 personality traits, from three major conceptual models, with all-cause and cause-specific mortality in the French GAZEL cohort.

Methods

A total of 14,445 participants, aged 39–54 in 1993, completed the personality questionnaires composed of the Bortner Type-A scale, the Buss-Durkee-Hostility-Inventory (for total, neurotic and reactive hostility), and the Grossarth-Maticek-Eysenck-Personality-Stress-Inventory that assesses six personality types (cancer-prone, coronary heart disease (CHD)-prone, ambivalent, healthy, rational, anti-social). The association between personality traits and mortality, during a mean follow-up of 12.7 years, was assessed using the Relative Index of Inequality (RII) in Cox regression.

Results

In models adjusted for age, sex, marital status and education, all-cause and causespecific mortality were predicted by "total hostility", its "neurotic hostility" component as well as by "CHD-prone", "ambivalent" "antisocial", and "healthy" personality types. After mutually adjusting personality traits for each other, only high "neurotic hostility" remained a robust predictor of excess mortality from all causes (RII=2.62; 95% CI=1.68–4.09) and external causes (RII=3.24; 95% CI=1.03–10.18). "CHD-prone" (RII=2.23; 95% CI=0.72– 6.95) and "anti-social" (RII=2.13; 95% CI 0.61–6.58) personality types were associated with cardiovascular mortality and with mortality from external causes, respectively, but confidence intervals were wider. Adjustment for potential behavioural mediators had only a modest effect on these associations.

Conclusions

Neurotic hostility, CHD-prone personality and antisocial personality were all predictive of mortality outcomes. Further research is required to determine the precise mechanisms that contribute to these associations.

MESH Keywords Adult ; Antisocial Personality Disorder ; Cause of Death ; Coronary Disease ; mortality ; psychology ; Female ; Follow-Up Studies ; Hostility ; Humans ; Male ; Middle Aged ; Neoplasms ; mortality ; psychology ; Personality ; Personality Inventory ; Proportional Hazards Models ; Prospective Studies ; Risk Factors ; Type A Personality

Author Keywords GAZEL cohort study ; mortality ; personality

Key messages

Previous research is dominated by studies on only specific aspects of personality in relation to cardiovascular outcomes and mortality, on high risk elderly samples and has yielded inconsistent findings.

After adjustment for basic socio-demographic factors, a range of personality measures were associated with all-cause and cause-specific mortality. In mutually adjusted model “neurotic hostility” clearly predicted all cause and external causes mortality. “CHD-prone” and “anti-social ” personality types were also associated with CVD and external causes mortality, social” respectively.

Behavioural factors did little to explain the association between personality and mortality, making further research on other mechanisms an important next step.

INTRODUCTION

The term personality encompasses a multitude of ideas, with a recent view being that “personality is a dynamic organisation, inside the person, of psychophysical systems that create a person’s characteristic patterns of behaviour, thoughts, and feelings” (1). While the hypothesis that personality influences physical health is centuries old, an important stimulus for large-scale research was the seminal work by Friedman and Rosenman in the late 1950s (2). They found cardiovascular diseases, the leading cause of mortality in Western countries, to be more common among time-pressured, competitive, aggressive and hostile persons: individuals with what they labelled Type-A behaviour pattern (TABP). Prospective investigations in the 1970s, such as the Western Collaborative Group studies (3, 4) and the Framingham Heart study (5), provided further support for TABP as a predictor of coronary heart disease (CHD).

Subsequent failure to replicate these findings in the 1980s (6–8) focused interest on hostility as the “toxic” component of TABP. Hostile individuals were found to have increased risk of health problems in studies of hypertension (9–11), CHD (4, 12, 13), subclinical atherosclerosis (14), myocardial infarction (15, 16), and all-cause mortality (12, 15). However, null findings have also been reported (17) and two recent systematic quantitative reviews (18, 19) have concluded that there is no consistent evidence showing hostility to be a risk factor for cardiovascular disease or all-cause mortality.

TABP and hostility have been by far the most extensively studied personality constructs in health research, but a number of other conceptualisations have also been developed. The personality-disease theory proposed by Grossarth-Maticek and Eysenck (20–23) in the 1980s is important as it aims to cover a more comprehensive set of health outcomes than TABP and hostility. The theory proposes six personality types, i.e. cancer-prone, CHD prone, ambivalent, healthy, rational and antisocial, that are each hypothesised to predict a particular disease or long-term health outcome. To date, however, empirical evidence to support the theory is still relatively limited, consisting of the original studies by Grossarth-Maticek and Eysenck (20, 23, 24) and a few other studies (25, 26).

There is a need for further research on personality and physical health. A major limitation in most examinations of this association is that they focus only on one or two personality traits without examining the role of other traits. Despite different labels, personality constructs from various conceptual models may overlap in their content. Thus, it remains unclear if some personality traits are independent predictors of health while others are redundant. For example, hostility and CHD-prone personality type are both assumed to be associated with cardiovascular disease risk, but to our knowledge, no previous studies have determined whether they are uniquely associated with cardiovascular disease. Such information would be important in refining more parsimonious models of personality and health (27).

In this study from the GAZEL cohort, we examine several personality constructs, including TABP obtained from the Bortner scale, three measures of hostility from the Buss-Durkee Inventory (BDHI) and the six personality types assessed by the Grossarth-Maticek and Eysenck Personality Stress Inventory (PSI), to test the association between personality and subsequent mortality from all causes and specific causes during a follow-up of nearly thirteen years.

MATERIALS & METHODS

The GAZEL cohort study was established in 1989 and details of this study are available elsewhere (28). In brief, the target population was employees of France’s national gas and electricity companies: Electricité de France (EDF) and Gaz de France (GDF). At baseline, 20 625 (15 011 men and 5 614 women), aged 35–50, gave consent to participate in this study. The study design consists of an annual questionnaire used to collect data on health, lifestyle, individual, familial, social and occupational factors and life events. Various sources within EDF-GDF provide additional data on GAZEL participants.

Personality

The personality test battery used in this study, except for the Type-A scale, was previously validated on 408 randomly selected participants of the GAZEL study (29) and was then administered to all participants from 1st February to 31st July 1993. It was composed of the following scales.

The Bortner Type A Rating Scale Scale

The Bortner Rating Scale for behaviour type (type A/type B) consists of 14 items (30) each comprising 2 statements with a 6-point : Likert scale in between the 2 statements. Examples include "never late" on one end of the scale and "casual about appointments" on the other end of the scale. High scores indicate Type-A behaviour. This scale was translated and validated for the French population against the Friedman and Rosenman structured interview for assessing Type-A, agreement observed 71.5% (2, 31, 32).

The Buss-Durkee Hostility Inventory (BDHI) BDHI)

The BDHI is a measure of general aggression and hostility, composed of 66 items with "true-false" answers (33). It has seven subscales: assault, verbal aggression, indirect hostility, irritability, negativism, resentment, and suspicion. The sum of all the sub-scales leads to a "total hostility" (Cronbach's alpha coefficient (α) = 0.80). Factor analyses of the subscales in the original study (33) and the validation study (29) identified two overarching factors, involving an "emotional" component and a "motor" component, roughly corresponding to the affective and behavioural dimensions. Subsequent studies (33, 34) have also derived a similar 2-factor solution, described as "Neurotic" hostility" formed by the first four sub-scales and "Reactive hostility" formed by the last two sub-scales, respectively. The reliability coefficients to assess internal consistency of the scales were: Cronbach's alpha =0.67 for "Reactive hostility" and 0.71 for "Neurotic hostility".

The Grossarth-Maticek and Eysenck PSI types

This Grossarth-Maticek and Eysenck PSI assesses six personality types with different physical and/or psychological health liabilities. The inventory is made up of 70-items which have true-false as responses. (21) Five of the personality scales are measured by 10 items each and one (healthy type) is measured by 20 items. The six personality types are described below:

"Cancer-prone" personality or Type 1 (Cronbach's **=0.54)** refers to individuals who seek harmony and a lack of autonomy in relationships. These individuals have a tendency to suppress their emotions and be unassertive; these characteristics are thought to lead to the development of chronic perceived stress, and depressive and helpless tendencies, chronic hormonal elevations (cortisol), immunosuppression, and possible cancer development; (20, 21).

"CHD-prone" personality or Type 2 (Cronbach's **=0.79)** refers to individuals who also show a lack of autonomy, but are helplessly dependent in relationships. They experience anger, aggression, and arousal when faced with relational problems (20). These characteristics are thought to lead to the development of cardiovascular problems (elevated blood pressure, heart rate, and cholesterol), atherosclerosis, and coronary heart disease and related cardiovascular diseases (21).

"Ambivalent" personality or Type 3 (Cronbach's **=0.60)** refers to individuals who constantly shift from typical Type 1 to typical Type 2 reactions. These individuals vacillate between feelings of helplessness and anger when faced with relational problems (35). This type is hypothesised to be relatively resistant to physical illness because the Type 1 and Type 2 counteract one another (21)

"Healthy" personality or Type 4 (Cronbach's **=0.73)** refers to individuals who exhibit autonomy and consider it to be important for their wellbeing and happiness. They are able to self-regulate their behaviour and are hypothesised to have a disposition towards being healthy as they avoid the stress reactions commonly experienced by Type 1 and Type 2 individuals (21)

"Rational" personality or Type 5 (Cronbach's **=0.62)** is thought to be prone to depressive disorders and possibly cancer (21). While Type 5 individuals share the feature of emotional suppression with Type 1 individuals, they are different in their non-emotional and rational tendencies.

"Anti-social" personality or Type 6 (Cronbach's **=0.57)** refers to individuals who exhibit psychopathic, impulsive, rebellious and hostile behaviours. These individuals are considered to have dispositions towards criminal behaviour and drug addiction (21).

Mortality

Vital status data on all participants are obtained annually from EDF-GDF itself as it pays out retirement benefits. All-cause mortality data were available from 1st January 1989 to 5th October 2006. Causes of death were recorded (Cardio vascular disease (CVD): I00–I99; cancer:

C00-D48; external causes: V01-Y98) by the French national cause-of-death registry from 1st January 1989 to 31st December 2003 and coded using the International classification of diseases, 10th Revision (36).

Covariates

Socio-demographic characteristics including age, sex, marital status (single, married, divorced, widowed), and educational level (primary, lower secondary, higher secondary and tertiary) were obtained from employer's human resources files. Behavioural factors in 1993 were self-reported. Alcohol consumption, as drinks per week, was categorized as non drinkers, occasional drinkers (1–13 for men, 1–6 for women), moderate drinkers (14–27 for men, 7–20 for women), or heavy drinkers (≥28 for men, ≥21 for women). Smoking in the same period was categorized as non smoker and as smoker of 1–10, 11–20, or ≥21 cigarettes per day. Body mass index (BMI) in 1990 was calculated by dividing weight in kilograms by height in meters squared and categorised as <20, 20–24.9, 25–29.9, or ≥30 kg/m^2.

Statistical analysis

Differences in personality scores as a function of sociodemographic characteristics and behavioural factors were assessed using one way-ANOVA, with a linear trend fitted across the hierarchical variables. Differences in mortality were assessed using a chi-square test.

The associations between personality measures and mortality, both all cause and cause-specific, were modelled using the Relative Index of Inequality (RII) (37). The RII is a regression-based measure that summarises the association between two variables (37). It is computed by ranking the personality score on a scale from the lowest, which is 0, to the highest, which is 1. Each personality score covers a range on this scale that is proportional to the number of participants who had that score and is given a value on the scale corresponding to the cumulative midpoint of its range. The RII resembles relative risk in that it compares the mortality at the extremes of the personality score but it is estimated using the data on all personality scores and is weighted to account for the distribution of the personality scores. Here the RII was fitted using Cox regression. An RII of 2 indicates a doubling of the risk of mortality for individuals at the extremes of the personality score. The Cox regression was first adjusted for age and sex (model 1) and then additionally for educational level and marital status (model 2). Personality traits that were associated with mortality in model 1 were entered simultaneously into a model containing the socio-demographic variables (model 3). Finally, personality measures that remained predictors of mortality outcomes, even if imprecisely estimated, were selected for further analysis in order to explore the role of potential behavioural mediators. Missing values from these behavioural factors reduced slightly the sample size. We modelled age- and sex-adjusted associations for each personality predictor before and after controlling for the behavioural factors and calculated the percentage change in RII.

Despite the nearly 13-year follow-up the analysis was underpowered to allow sex specific analysis. Thus, as previously suggested (13), interactions between each personality item with sex in relation to mortality were checked, leading to sex-specific analyses only when the p value for the interaction (< 0.05) suggested clearly different associations in men and women.

RESULTS

In 1993, the personality inventory was mailed to the 20 448 living members of the GAZEL cohort. A total of 14 445 (70.6%) participants completed the entire personality inventory and 14 991 (73.3%) completed at least one scale of the inventory. In comparison, the corresponding proportion for the annual general GAZEL questionnaire was 78% in 1993. Compared to non-respondents, respondents were more likely to be male, educated ($p<0.001$), older ($p=0.003$), married or cohabitating ($p<0.002$), non-smokers ($p=0.001$) and to have lower all-cause mortality ($p<0.001$).

Average age in 1993 was 49 years for men and 46.2 years for women. During a mean follow-up of 12.7 years (till 5th October, 2006) subsequent to the completion of the personality questionnaires, 932 participants had died (85% in men). Of the 932 deaths there were 612 (65.7 %) for which at least one personality scale had been completed in 1993. The principal cause of death was available only for deaths that occurred between 1993 and 31st December 2003; 117 participants (94.0% in men) died from CVD, 315 (82.5% in men) died from cancer and 77 (83.1% in men) died from external causes including accidents and suicides. The distribution of mortality and the personality traits is presented in Table 1.

Personality and all-cause mortality

Table 2 shows the associations between personality measures and all-cause mortality. Type-A behaviour was found to be inversely related to all-cause mortality in age and sex adjusted models but subsequent adjustment for educational level and marital status attenuated this association (RII=0.80; 95% confidence interval (CI): 0.60–1.06). Model 1, adjusted for sex and age, shows that the highest scoring individuals on “total hostility” derived from the BDHI had a 1.47 times (95% CI: 1.10–1.95) higher risk of death compared to those scoring the lowest. Out

of the two BDHI "neurotic" and "reactive" hostility subscales, it is only the "neurotic" hostility component that had an association with all-cause mortality (RII = 2.20; 95% CI: 1.65–2.93). Of the six personality types derived from the Grossarth-Maticek and Eysenck PSI, "CHD-prone" personality was associated with mortality, but only in men (RII= 1.53; 95% CI: 1.12–2.10). The two other personality types that were associated with all-cause mortality in model 2 were "ambivalent" (RII= 1.44; 95% CI: 1.08–1.92) and "anti-social" personalities (RII= 1.57; 95% CI: 1.17–2.10). However, in the final mutually adjusted model (model 3), only "neurotic hostility" remained associated with all cause mortality (RII= 2.62; 95% CI: 1.68–4.09).

Personality and CVD mortality (table 3)

Of the hostility measures, only the "neurotic" hostility subscale was associated with CVD mortality (RII = 2.32; 95% CI: 1.02–5.27) in model 2. Two of the six personality types derived from the Grossarth-Maticek and Eysenck PSI showed an association with CVD mortality in model 2. "CHD prone" (RII = 3.11; 95% CI: 1.34–7.19) personality was associated with a higher risk of CVD mortality and the "healthy" personality type was associated with a protective effect (RII =0.42; 95% CI: 0.18–0.98). In the final model (model 3), all associations were attenuated even though there remained a large, though imprecisely estimated, association between "CHD-prone" personality and CVD mortality (RII = 2.23; 95% CI: 0.72–6.95).

Personality and mortality from cancer (table 4)

There were no evidence of an association between personality measures and mortality from cancer. For example, adjusted RII for " cancer-prone" personality type was 0.86; 95% CI: 0.53–1.41.

Personality and mortality from external causes (table 5)

After adjustment for socio-demographic characteristics, "neurotic" hostility (RII = 3.67; 95% CI: 1.31–10.22) and "anti-social" personality type (RII = 3.40; 95% CI: 1.19–9.69) were both associated with a greater risk of death from external causes. In the final mutually adjusted model (model 3), only neurotic hostility remained clearly associated with death from external causes (RII = 3.24; 95% CI: 1.03–10.18). " Anti-social" personality type remained strongly associated with this type of death, but with a wider confidence interval (RII = 2.14; 95% CI: 0.69–6.58).

Role of behavioural factors (table 6)

Personality measures that were associated with mortality outcomes in the analyses so far were examined further for the role played by behavioural factors. These analyses are on slightly smaller numbers due to missing data on behavioural factors and the results show that, the association between "neurotic hostility" and all-cause mortality (RII = 2.16; 95% CI: 1.60–2.91) was reduced by 12.1% when adjustment was made for behavioural factors. The association between "CHD-prone" personality type and CVD mortality (RII = 3.18; 95% CI: 1.33–7.58) was reduced by 6%. Finally, the association of "neurotic hostility" (RII = 3.88; 95% CI: 1.34–11.27) and "anti-social" personality type (RII = 2.98; 95 % CI: 1.00–8.89) with mortality from external causes was also not much attenuated after adjustment for behavioural factors.

DISCUSSION

We sought to determine the association between various personality measures and mortality from all causes and from three leading causes of death in a large cohort of French employees followed for over 12 years. Three different personality models were tested: the Bortner Type A behaviour pattern, the Buss-Durkee Hostility Inventory, and the Grossarth-Maticek and Eysenck six personality types. After adjustment for demographic characteristics, a number of personality measures were associated with all-cause and cause-specific mortality. However, after mutually adjusting personality traits for each other, only "neurotic hostility" remained associated with all cause mortality and mortality from external causes. There was also some evidence suggesting associations between "CHD-prone" personality and cardiovascular mortality and between "anti-social" personality and mortality from external causes. These associations were only marginally changed after further adjustment for smoking, alcohol consumption and BMI.

There are relatively few previous studies on the association between personality and mortality, and many of them are conducted on older participants (38–40) or high-risk populations (38, 41–43). It is possible that age-related decline in health among older individuals and serious disease may affect both personality ratings and mortality and therefore induce confounding or reverse causality. In our study, this is unlikely to be a major problem as personality was assessed when individuals were relatively young and we focussed on a working population which is likely to contain a lower proportion of ill individuals compared to the general population. The present study is unique in simultaneously

studying the associations of multiple personality models with all-cause and cause-specific mortality. The finding that only few of the observed associations between personality and mortality remained in mutually adjusted models suggests that there is a substantial empirical overlap in the content of the various personality constructs considered in this study.

In order to test whether behavioural mechanisms underlie the associations between personality and mortality (15), we adjusted the analyses for the effects of smoking, alcohol consumption and BMI. The marginal reduction in mortality risks after this adjustment (12% at best) suggests that the effects of personality on mortality were not primarily mediated through behavioural factors examined in this study. This stands in contrast with the Kuopio Ischemic Heart Disease Risk factor (KIHD) Study (15) which concluded that behavioural risk factor were important mediating factors in the associations between cynical hostility and mortality and myocardial infarction. In that study, the percentage reduction in the association with mortality from cardiovascular causes was estimated to be around 32% after adjustment for behavioural factors. The smaller contribution of behavioural factors to the associations of "neurotic hostility", "CHD-prone" personality and "antisocial" personality with mortality in our study could be related to the fact that there was little evidence of an association between these personality factors and smoking and BMI (table 1). Imprecision in measurement of behavioural factors is a potential source of bias here. For example, the lack of difference in all cause mortality between participants with different BMI was unexpected. However, the difference with the KIHD study could also be due to differing cultural norms on health behaviours.

The association of "neurotic hostility" with all-cause mortality could reflect its association with other categories of mortality, such as external causes and marginally, CVD mortality. Persons with an angry and resentful interpersonal style are likely to experience a more taxing environment involving a greater number of stressful life events, such as job-related, financial and interpersonal stressors, than non-hostile individuals. These and other stressors may put them at excess risk for adverse health outcomes (44). A study on the GAZEL cohort has shown low level of social integration to be associated with an increased risk of mortality from external causes (45). Stressful life events, in this cohort, were also associated with 4 times more risk of serious road traffic crashes (46).

Our results show both "neurotic hostility" and "CHD-prone" personality to be strongly associated with CVD mortality when modelled separately. However, when they were simultaneously entered in the same model, the effect of "neurotic hostility" largely disappeared (79% reduction), suggesting a strong and unique predictive power of the "CHD-prone" personality for CVD mortality. According to Grossarth-Maticek and Eysenck's conceptualisation "CHD-prone" individuals were more likely to experience anger, aggression, and arousal when faced with relational problems (20). These characteristics may induce pathophysiological changes which may increase the risk of cardiac morbidity and mortality, including autonomic nervous system dysfunction (e.g., elevated heart rate, low heart rate variability) or accelerated progression of atherosclerosis. We were not able to test this psychophysiological reactivity model as biological factors were not measured in the GAZEL cohort.

Finally, we found "anti-social" (type 6) personality to be associated with mortality from external causes. This association is highly plausible as anti-social individuals by their psychopathic, impulsive, rebellious and hostile behaviours (20) may be more likely to have low social support, higher interpersonal distress and more stressful life events. They are also considered to have dispositions towards criminal behaviour and drug addiction (20), which may contribute to mortality from external causes. Both suicidal ideation and attempts have been found to be positively associated with alcohol and drug problems, depression, low social and family supports (47, 48).

Limitations

Interpretation of these findings should be considered within the context of the study objectives, the measures of personality used. First, all comparisons in the predictive strength between personality traits should be interpreted with caution, as the operationalization of these concepts may not be equally successful in every case. Secondly, our study did not cover all personality traits, including several aspects of the big five factors of personality (49) or optimism and pessimism (1). Third, a further caveat relates to the fact that although GAZEL is not a high risk population, it is also not representative of the general population as it does not include unemployed individuals.

Public health relevance

There is a general consensus on the relative stability of personality in adulthood (50), requiring some reflection on the public health rationale for examining the association between personality and health. Our view on the matter is that research in this domain has the potential to contribute to more effective public health interventions by providing detailed information on the mediating and modifying factors in the relationship between personality and health. Health educational programs may incorporate personality issues with the purpose of encouraging individuals to recognize the effects of certain traits and related-emotions that could put them at risk for health problems. For example, anger in patients with a history of hypertension or angina is known to contribute to new cardiac events (51) and advice on alternative methods for dealing with impatience, frustration, and anger could be provided to cardiac patients at risk. Thus, the emphasis in prevention strategies is not

on an individual's personality, but on the important processes through which personality is associated with health risk. In order to develop informed prevention strategies, further research is required to identify underlying mechanisms, particularly those that are modifiable, to explain the association between personality and objective health outcomes.

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Footnotes:

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TABLE 1

Means (M) and standard deviations (SD) of personality scores and distribution of all-cause mortality by covariates

	Status at follow-up		Bortner*	BDHI*			Grossarth-Maticek & Eysenck PSI*					
	Alive N (%)	Dead N (%)	Type-A pattern	Total hostility	Neurotic hostility	Reactive hostility	Cancer prone (Type 1)	CHD prone (Type 2)	Ambivalent (Type 3)	Healthy (Type 4)	Rational (Type 5)	Anti-s (Type
Sex												
Male	10 471 (95.3)	522 (4.7)	52.7 (7.7)	28.9 (9.9)	6.5 (3.5)	20.2 (7.2)	3.7 (2.0)	3.1 (2.5)	2.2(1.7)	7.1 (1.6)	6.3 (1.9)	2.2 (1.7
Female	3 908 (97.7)	90 (2.3)	54.4 (7.5)	30.0 (9.6)	6.9(3.5)	20.6 (6.9)	4.0 (2.2)	4.0 (2.7)	2.6 (1.8)	6.6 (1.7)	5.6 (2.1)	2.1 (1.7
p value	<0.0001		<0.0001	<0.0001	<0.0001	0.010	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.101
Age												
35–39	1 232 (98.4)	20 (1.6)	55.0 (7.3)	30.7 (9.8)	6.9 (3.6)	21.3 (6.9)	3.7 (2.2)	3.8 (2.7)	2.6 (1.8)	6.6 (1.7)	5.4 (2.1)	2.1 (1.7
40–44	6 554 (96.5)	235 (3.5)	53.2 (7.7)	29.3 (9.9)	6.7 (3.6)	20.4 (7.2)	3.7(2.1)	3.3 (2.6)	2.3 (1.8)	6.9 (1.6)	6.1 (2.0)	2.2 (1.8
45–50	6 593 (94.9)	357 (5.1)	52.8 (7.7)	28.9 (9.7)	6.5 (3.5)	20.1 (7.1)	3.8 (2.1)	3.3 (2.6)	2.2 (1.7)	7.0 (1.6)	6.2 (2.0)	2.1 (1.7
p for trend	<0.0001		<0.0001	<0.0001	<0.0001	<.0001	0.013	<0.0001	<0.0001	<0.0001	<0.0001	0.276
Educational level												
Primary	775 (93.6)	53 (6.4)	52.1 (7.8)	30.6 (10.3)	7.6(3.7)	20.7 (7.3)	4.1 (2.1)	4.0 (2.7)	2.5 (1.9)	6.8 (1.7)	6.2 (1.8)	2.7 (1.8
Lower secondary	9 327 (95.9)	398(4.1)	53.0 (7.7)	29.5 (9.8)	6.8 (3.5)	20.4(7.1)	3.8 (2.1)	3.5 (2.6)	2.3 (1.8)	6.9 (1.6)	6.1 (2.0)	2.3 (1.7
Higher secondary & tertiary	4 044 (96.7)	140 (3.3)	53.9 (7.4)	28.1 (9.6)	5.8 (3.4)	20.0(7.1)	3.6 (2.1)	2.8 (2.4)	2.2 (1.7)	7.1 (1.7)	6.1 (2.2)	1.8 (1.6
p for trend	<0.0001		<0.0001	<0.0001	<0.0001	0.001	<0.0001	<0.0001	<0.0001	<0.0001	0.038	<0.000
Marital Status												
Married/cohabitant	12 866 (96.2)	511 (3.8)	53.3 (7.6)	29.2 (9.8)	6.5 (3.5)	20.4 (7.1)	3.7 (2.1)	3.3 (2.6)	2.3 (1.7)	7.0 (1.6)	6.1 (2.0)	2.1 (1.7
Single/divorced/widowed	1 499 (93.9)	98 (6.1)	52.3 (8.0)	29.4 (9.9)	7.2 (3.7)	19.8 (7.1)	4.1 (2.3)	3.8 (2.7)	2.6(1.8)	6.8 (1.8)	5.9 (2.1)	2.1 (1.7
p value	<0.0001		<0.0001	0.330	<0.0001	0.004	<0.0001	<0.0001	<0.0001	<0.0001	0.001	0.806
Smoking (cigarettes/day)												
Non smoker	11284 (96.7)	383 (3.3)	53.2 (7.6)	29.0 (9.8)	6.5 (3.5)	20.1 (7.1)	3.8 (2.1)	3.3 (2.6)	2.3 (1.7)	7.0 (1.6)	6.1 (2.0)	2.1 (1.7
1–10	1 227 (96.0)	51 (4.0)	52.8(8.1)	30.0 (9.8)	6.5 (3.5)	21.0(7.1)	3.7 (2.0)	3.3 (2.6)	2.4 (1.8)	7.0 (1.6)	6.2 (1.9)	2.3 (1.8
11–20	1 081 (91.5)	101 (8.5)	52.5 (8.0)	30.1 (9.7)	6.8 (3.5)	21.0(7.1)	3.9 (2.0)	3.3 (2.5)	2.3 (1.8)	7.0 (1.6)	6.1 (2.0)	2.2 (1.8
>20	377 (86.5)	59 (13.5)	54.1 (8.1)	31.4(10.5)	7.2 (3.8)	21.8 (7.6)	3.9 (2.0)	3.6 (2.7)	2.5 (1.8)	6.8 (1.9)	6.1 (2.1)	2.3 (1.8
p for trend	<0.0001		0.251	<0.0001	<0.0001	<0.0001	0.481	0.394	0.042	0.829	0.726	0.003

Alcohol consumption												
Non drinkers	1 699 (94.9)	91 (5.1)	53.3 (7.9)	29.1 (10.3)	7.0 (3.6)	19.8 (7.4)	3.9 (2.1)	3.7(2.7)	2.3 (1.7)	6.8 (1.7)	6.0 (2.0)	2.1 (1.8
Occasional drinkers	9 325 (96.5)	337 (3.5)	53.2 (7.6)	28.8 (9.6)	6.4 (3.5)	20.1 (7.0)	3.7 (3.5)	3.2 (2.5)	2.2 (1.7)	7.0 (1.6)	6.1 (2.0)	2.1 (1.7
Moderate drinkers	2 737 (94.5)	159 (5.5)	52.7 (7.7)	30.3 (10.0)	6.9 (3.6)	21.1 (7.3)	3.8 (2.1)	3.5 (2.6)	2.4 (1.9)	6.9 (1.6)	6.1 (2.0)	2.3 (1.8
Heavy drinkers	252 (96.8)	8 (3.1)	53.1 (7.9)	30.6 (10.8)	7.0 (3.7)	21.3 (7.8)	3.5 (1.9)	3.4 (2.5)	2.2 (1.7)	6.9 (1.6)	6.0 (2.0)	2.3 (1.9
p for trend	0.227		0.005	<0.0001	0.093	<0.0001	0.083	0.601	0.023	0.317	0.081	<0.000
BMI												
0–19.9	505 (96.4)	19(3.6)	53.0(8.1)	28.9 (10.2)	6.5 (3.5)	20.2 (7.3)	3.6 (2.0)	3.3 (2.6)	2.2 (1.7)	7.0 (1.6)	6.0 (2.1)	2.1 (1.7
20–24.9	5 605 (96.0)	232 (4.0)	53.1 (7.6)	29.1 (9.8)	6.6 (3.5)	20.3 (7.1)	3.8 (2.1)	3.3 (2.6)	2.3 (1.7)	7.0 (1.6)	6.1 (2.0)	2.2 (1.7
25–29.9	5 817 (96.0)	240 (4.0)	53.3 (7.7)	29.3 (9.8)	6.6 (3.5)	20.4 (3.5)	3.8 (2.1)	3.3 (2.6)	2.3 (1.8)	7.0 (1.6)	6.2 (2.0)	2.1 (1.7
>30	1 434 (95.8)	63 (4.2)	53.2 (7.8)	29.4(10.3)	6.7 (3.6)	20.4 (7.4)	3.7 (2.1)	3.5 (2.7)	2.3 (1.8)	6.1 (1.7)	6.1 (2.0)	2.1 (1.8
p for trend	0.654		0.279	0.262	0.389	0.430	0.699	0.063	0.717	0.201	0.440	0.927

* Means (SD)

TABLE 2

Association between personality measures and all-cause mortality, 1993–2006- Cox regression.

		RII (95% CI) for all-cause mortality		
Personality measures		**Model 1†**	**Model 2‡**	**Model 3§**
N event/N total ††				
Bortner rating scale				
Type-A behaviour pattern	591/14 737	0.73 (0.55–0.97)*	0.80 (0.60–1.06)	
Buss-Durkee hostility Inventory				
Total hostility	574/14 451	1.47 (1.10–1.95)**	1.43 (1.08–1.80)**	0.72 (0.47–1.11)
Neurotic hostility	582/14 552	2.20 (1.65–2.93)***	2.01 (1.50–2.68)***	2.62 (1.68–4.09)***
Reactive hostility	581/14 546	1.15 (0.87–1.52)	1.17 (0.88–1.55)	
Grossarth-Maticek and Eysenck's Personality-Stress Inventory				
Cancer-prone-Type 1	574/14 572	1.16 (0.87–1.55)	1.08 (0.81–1.44)	
CHD-prone Type 2‡‡	576/14 513	1.42 (1.06–1.89)*	1.31 (0.98–1.75)	0.75 (0.52–1.08)
Ambivalent-Type 3	572/14 525	1.52 (1.14–2.03)**	1.44 (1.08–1.92)**	1.14 (0.81–1.61)
Healthy-Type 4	576/14 530	0.77 (0.58–1.04)	0.81 (0.60–1.08)	
Rational-Type 5	574/14 526	0.98 (0.74–1.32)	0.97 (0.72–1.29)	
Anti social-Type 6	575/14 568	1.65 (1.23–2.20)***	1.57 (1.17–2.10)**	1.28 (0.89–1.84)

* p≤ 0.05,

** p≤ 0.01,

*** p≤ 0.001

† Model 1= RII adjusted for age and sex.

‡ Model 2= Model 1 + additionally adjusted for educational level, and marital status.

§ Model 3=Model 2 + additionally mutually adjusted for personality measures predicting mortality in Model 2

†† N events in table differ with each personality and models 1 and 2 are complete case analysis.

‡‡ There is sex difference in the association between "CHD-prone" personality and all-cause mortality: Model 2, RII = 1.53 (1.12–2.10) for men and RII =0.49 (0.23–1.06) for women).

TABLE 3

Association between personality measures and cardiovascular disease (CVD) 1993–2003-Cox regression.

		RII (95% CI) for mortality from CVD		
Personality measures		**Model 1†**	**Model 2‡**	**Model 3§**
N event/N total ††				
Bortner rating scale				
Type-A behaviour pattern	73/14 219	0.70 (0.31–1.57)	0.76 (0.34–1.69)	
Buss-Durkee hostility Inventory				
Total hostility	72/13 948	1.10 (0.49–2.43)	1.06 (0.48–2.36)	
Neurotic hostility	72/14 042	2.56 (1.13–5.77)*	2.32 (1.02–5.27)*	1.28 (0.46–3.53)
Reactive hostility	72/14 037	0.77 (0.35–1.76)	0.78 (0.35–1.74)	
Grossarth-Maticek and Eysenck's Personality-Stress Inventory				
Cancer-prone-Type 1	72/14 070	1.34 (0.59–3.06)	1.23 (0.54–2.81)	
CHD-prone -Type 2	72/14 009	3.36 (1.47–7.69)**	3.11 (1.34–7.19)**	2.23 (0.72–6.95)
Ambivalent- Type 3	72/14 025	1.01 (0.45–2.29)	0.95 (0.42–2.16)	
Healthy-Type 4	72/14 026	0.40 (0.18–0.93)*	0.42 (0.18–0.98)*	0.72 (0.27–1.90)
Rational- Type 5	72/14 024	0.94 (0.41–2.14)	0.92 (0.40–2.09)	
Anti social-Type 6	72/14 065	1.04 (0.46–2.37)	0.97 (0.42–2.23)	

* $p \leq 0.05$,

** $p \leq 0.01$,

*** $p \leq 0.001$

† Model 1= RII adjusted for age and sex.

‡ Model 2= Model 1 + additionally adjusted for educational level, and marital status.

§ Model 3=Model 2 + additionally mutually adjusted for personality measures predicting mortality in Model 2

†† N events in table differ with each personality and models 1 and 2 are complete case analysis.

TABLE 4

Association between personality measures and mortality from cancer, 1993–2003-Cox regression.

	RII (95% CI) for mortality from cancer		
Personality measures		**Model 1†**	**Model 2‡**
N event/N total §			
Bortner rating scale			
Type-A behaviour pattern	202/14 663	0.59 (0.36–0.95)*	0.63 (0.39–1.03)
Buss-Durkee hostility Inventory			
Total hostility	200/14 378	0.95 (0.59–1.53)	0.92 (0.57–1.48)
Neurotic hostility	202/14 480	1.32 (0.81–2.13)	1.20 (0.73–1.95)
Reactive hostility	201/14 473	0.93 (0.58–1.50)	0.94 (0.58–1.51)
Grossarth-Maticek and Eysenck's Personality-Stress Typology			
Cancer-prone- Type 1	199/14 500	0.92 (0.56–1.50)	0.86 (0.53–1.41)
CHD prone -Type 2	199/14 440	0.79 (0.48–1.30)	0.72 (0.44–1.18)
Ambivalent-Type 3	196/14 453	1.21 (0.74–2.01)	1.17 (0.72–1.93)
Healthy-Type 4	199/14 458	1.28 (0.78–2.11)	1.34 (0.82–2.21)
Rational-Type 5	199/14 454	1.07 (0.65–1.76)	1.06 (0.64–1.74)
Anti social- Type 6	200/14 496	1.03 (0.63–1.68)	0.96 (0.58–1.57)

* $p \leq 0.05$,

** $p \leq 0.01$,

*** $p \leq 0.001$

† Model 1= RII adjusted for age and sex.

‡ Model 2= Model 1 + additionally adjusted for educational level, and marital status.

§ N events in table differ with each personality and models 1 and 2 are complete case analysis.

TABLE 5

Association between personality measures and mortality from external causes (accidents and suicides), 1993–2003-Cox regression

		RII (95% CI) for mortality from external causes		
Personality measures		**Model 1†**	**Model 2‡**	**Model 3§**
N event/N total ††				
Bortner rating scale				
Type- A behaviour pattern	50/14 196	0.81 (0.31–2.12)	0.88 (0.33–2.32)	
Buss-Durkee hostility Inventory				
Total hostility	46/13 922	2.76 (0.99–7.69)	2.65 (0.95–7.42)	
Neurotic hostility	49/14 019	3.97 (1.44–10.94)**	3.67 (1.31–10.22)**	3.24 (1.03–10.18)*
Reactive hostility	49/14 014	1.65 (0.62–4.39)	1.63 (0.61–4.32)	
Grossarth-Maticek and Eysenck's Personality-Stress Inventory				
Cancer-prone-Type 1	47/14 045	1.04 (0.38–2.85)	1.00 (0.37–2.75)	
CHD-prone-Type 2	47/13 984	0.97 (0.35–2.68)	0.92 (0.33–2.52)	
Ambivalent-Type 3	46/13 999	2.33 (0.83–6.53)	2.13 (0.76–5.95)	
Healthy-Type 4	46/14 000	0.50 (0.17–1.42)	0.50 (0.18–1.40)	
Rational-Type 5	47/13 999	1.18 (0.43–3.25)	1.18 (0.43–3.25)	
Anti social-Type 6	47/14 040	3.48 (1.23–9.85)**	3.40 (1.19–9.69)**	2.13 (0.69–6.58)

* p ≤ 0.05,

** p ≤ 0.01,

*** p ≤ 0.001

† Model 1= RII adjusted for age and sex.

‡ Model 2= Model 1 + additionally adjusted for educational level, and marital status.

§ Model 3=Model 2 + additionally mutually adjusted for personality measures predicting mortality in Model 2

†† N events in table differ with each personality and models 1 and 2 are complete case analysis.

TABLE 6

Role of behavioural factors in the associations between personality and mortality outcomes- Cox regression

	RII (95% CI) for mortality outcomes			
	N event/N total	**Adjusted for age and sex**	**Adjusted for age, sex, smoking, drinking and BMI**	**% of reductio**
All cause mortality				
Neurotic hostility	529/13 354	2.16 (1.60–2.91)***	2.02 (1.49–2.72)***	− 12.1%
CVD mortality				
CHD-prone-Type 2	65/12 855	3.18 (1.33–7.58)**	3.05 (1.28–7.30)**	−6.0%
Mortality from external				
Neurotic hostility	44/12 869	3.88 (1.34–11.27)**	3.72 (1.29–10.79)**	−5.5%
Anti social-Type 6	42/12 843	2.98 (1.00–8.89)*	3.14 (1.04–9.45)*	+8.1%

* $p \leq 0.05$,

** $p \leq 0.01$,

*** $p \leq 0.001$

† N events in table differ with each personality and estimators are on complete case analyses.