Does personality explain social inequalities in mortality? The French GAZEL cohort study

Running head: Personality and social inequalities in mortality

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ABSTRACT

Background: The "indirect-selection" hypothesis proposes that some quality of the individual, a personality characteristic or intelligence, leads to both socioeconomic position (SEP) and health. We aim to quantify the contribution of personality measures to the associations between SEP and mortality.

Methods: 14 445 participants of the GAZEL cohort, aged 39-54 years in 1993 and followed-up over 12.7 years, completed the Bortner-Type-A-scale, the Buss-Durkee-Hostility-Inventory, and the Grossarth-Maticek and Eysenck-Personality-Stress-Inventory. Indicators of SEP, such as father's social class, education, occupational grade and income, were assessed at baseline. Relative indices of inequality in Cox regression models were used to estimate associations.

Results: In age-adjusted-analyses, risk of death was inversely associated with SEP among men and women. Among men, the attenuation in this association depended on the measures of SEP and was 28-29% for "neurotic-hostility", 13-22% for "anti-social" and 13-16% for "CHD-prone" personality. In women, the attenuation was evident only for type-A-behaviour, by 11%. After controlling simultaneously for all personality factors that predicted mortality, associations between SEP and mortality were attenuated in men: by 34% for education, 29% for occupational position and 28% for income; but were only attenuated by 11% for income in women. For cardiovascular mortality, the corresponding percentages of reduction were 42%, 31% and 44% after adjustment for "CHD-prone" personality in men.

Conclusions: Personality measures explained some of the mortality gradients observed for measures of adult socioeconomic position in men, but had little explanatory power in women. Whether personality represents a predictor or an outcome of social circumstances needs further research.

Keywords: GAZEL; mortality; personality; social inequalities

KEY MESSAGES

The "indirect-selection" hypothesis proposes that some quality of the individual, a personality characteristic or intelligence, may explain part of the social inequalities in health.

However, few studies have examined the contribution of personality factors to social inequalities in health.

Our results show personality factors to explain some of the all-cause and cardiovascular mortality gradients observed for three measures of adult socioeconomic position in men, but had little explanatory power in women.

A considerable proportion of the association between socioeconomic position indicators and mortality remained unexplained by personality factors.

INTRODUCTION

Socioeconomic inequalities in morbidity and mortality have been widely documented(**1-3**). The Black Report identified four explanations for social inequalities: artefact, selection, materialist, and cultural/behavioural (**4**). Artefact as an explanation has received little support, leading research efforts to be directed at the three other explanations. The material and behavioural explanations (**5**) have been shown to explain only part of the social gradient in health (**6,** 7). The "indirect selection hypothesis" proposes that some quality of the individual - a personality characteristic or intelligence - leads to both socioeconomic position (SEP) and health (**8**). Two sets of evidence support this hypothesis. First, personality attributes are associated with an increased risk of hypertension (**9, 10**), coronary heart disease (CHD) (**11, 12**), subclinical atherosclerosis (**13**), myocardial infarction (**14, 15**), and all-cause mortality (**11, 14**). Second, personality factors such as hostility have been found to be associated with lower socioeconomic status (occupation, income and education) among adult men and women (**16-20**). Furthermore, personality factors have also been shown to be associated with social mobility (**21**). Recent studies have examined the role of intelligence (**22, 23**) but the extent to which personality factors explain social inequalities in health remains little explored.

Personality is defined as the "distinctive and characteristic patterns of thought, emotion and behaviour that define an individual's personal style and influence his or her interaction with the environment" (**21**). Friedman and Rosenman's seminal work (**24**) in the late 1950s showing Type-A behaviour pattern (TABP) to be a risk factor for coronary heart disease (CHD) renewed interest in the relationship between personality and health. 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). The association between TABP and CHD has been replicated in many studies (**12, 25-27**).

To date, TABP and hostility, the 'toxic' component of TABP, have been by far the most extensively studied personality constructs in health research, but other conceptualisations have also been developed. The personality-disease theory proposed by Grossarth-Maticek and Eysenck (**28-31**) in the 1980s seems 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. However, empirical evidence to support the theory is still relatively limited, consisting mostly of the original studies by Grossarth-Maticek and Eysenck (**28, 31, 32**) and a few other studies (**33, 34**).

The association between SEP, personality and health remains little explored. We found only two smaller-scale studies that examined the role of personality in explaining educational differences in perceived general health (**35**) and risky health behaviours (**36**). In this study of a large cohort of French employees followed-up over a thirteen years (GAZEL cohort), we used three different personality models to quantify their contribution to the associations between SEP in childhood and adulthood and mortality from all causes and cardiovascular diseases.

MATERIALS & METHODS

The GAZEL cohort was established in 1989, on employees of France's national gas and electricity companies: Electricité de France (EDF) and Gaz de France (GDF) (GAZEL stands for "GAZ" and "ELectricité"). Further details of this study can be found elsewhere (**37**). At baseline, 20 624 (15 010 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 about GAZEL participants. Occupational and personal data are updated through human resources department files (**38**).

Socioeconomic position

SEP indicators including educational level (primary, secondary, and tertiary) and occupation grade (unskilled workers, skilled workers, and managers) were obtained from employer's human resources files in 1989. Income (<1 600€, 1 600€ to 2 592€, and >2 592€) and father's social class (low, intermediate, and high), derived using the occupational classification by the French National Institute for Statistics and Economic Studies, INSEE, were reported by participants in the 1989 GAZEL cohort annual questionnaire.

Personality

The personality test battery was first validated on a sub-sample of the GAZEL study (**39**) and was then administered between 1st February and 31st July 1993. It was composed of the following scales:

The Bortner Rating Scale (Cronbach's α=0.56) for behaviour type (type A/type B) consists of 14 items (**40**) 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 score suggests 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% (**24, 41, 42**).

The Buss-Durkee Hostility Inventory (BDHI): The BDHI is a standardized measure of general aggression and hostility (**43**), composed of 66 items with "true-false" answers (**44**) that make up seven subscales: assault, verbal aggression, indirect hostility, irritability, negativism, resentment, and suspicion. A validation study (**39**) identified two overarching factors, involving an "emotional" component and a "motor" component, roughly corresponding to the affective and behavioural dimensions. Subsequent studies (**44, 45**) have also derived a similar 2-factor solution, described as "reactive hostility" formed by the first four sub-scales and "neurotic" hostility"

formed by the last two sub-scales, respectively. Cronbach's α was 0.67 for "reactive hostility" and 0.71 for "neurotic hostility".

The Grossarth-Maticek and Eysenck Personality-Stress Inventory (PSI): This inventory 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. (**29**) Five of the personality scales are measured by 10 items each and one (healthy type) is measured by 20 items. As suggested by Grossarth-Maticek and Eysenck, a total score is computed on each personality type for each participant (**46**) . Evidence to support the validity of this inventory, described below, is mixed (**47-49**).

"Cancer-prone" or Type 1 personality (Cronbach's α=0.54) refers to individuals who show harmony seeking 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; (**29**).

"CHD-prone" or Type 2 personality (Cronbach's α=0.60) 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 (**50**). 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(**29**).

"Ambivalent" or Type 3 personality (Cronbach's α=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 (**29**)

"Healthy" or Type 4 personality (Cronbach's α=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 (**29**)

"Rational" or Type 5 personality (Cronbach's α =0.62) is thought to be prone to depressive disorders and possibly cancer (**29**). 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" or Type 6 personality (Cronbach's α=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 (**29**).

Mortality

Mortality data on all participants are obtained from EDF-GDF. We used all-cause mortality data from 1st August 1993 to 5th October 2006. Cardiovascular disease (CVD) deaths (I00-I99), recorded by the French national cause-of-death registry, were available only till 31st December 2003 and coded using the International classification of diseases, 10th Revision (**51**).

Covariates

Data on age and sex were obtained from employer's human resources files. Depressive symptoms were assessed in 1993 using the validated French version of the Center for Epidemiologic Studies Depression Scale (CES-D) (**39**).

Statistical analysis

Differences in personality scores as a function of SEP indicators were assessed using one way-ANOVA, with a linear trend fitted across hierarchical variables. The intercorrelations between personality factors were calculated using Pearson correlation. We first calculated a relative index of inequality (RII) (**52**) to examine the association between personality measures

and mortality (RII). The RII is a regression-based measure that summarises the association between two variables (**52**). It is computed by ranking each personality measure on a scale from the lowest, which is 0, to the highest, which is 1. Each participant is given a score on the scale equal to the cumulative midpoint of the number of participants who had the each same personality score. For the purposes of interpretation, the RII should be regarded as the relative risk of mortality among individuals with the highest personality score relative to those with the lowest personality score. An advantage of using the RII is that it is estimated using data on all individuals and is weighted to account for the distribution of the personality scores. Here the RII was fitted using Cox regression adjusted for age and CES-D to take into account the influence of mood variations on personality measures. A RII of 2, for example, indicates a doubling of the risk of mortality for individuals with the highest personality score compared to those with the lowest score.

We modelled associations between the indicators of SEP and mortality using the RII in Cox regression. Linearity in the association between SEP indicators and mortality was checked using ANOVA test for linearity. This assumption was satisfied for all indicators ($p \leq 0.002$). We assumed that if personality explains or partially explains SEP differences in mortality then the association between SEP and mortality should disappear or be attenuated after statistical control for personality. Thus, in a first step, each personality measure was introduced in the age-adjusted model as a continuous variable, its contribution being quantified by the percentage of reduction in RII $[RII_{\text{age adjusted}} - RII_{\text{age and personality adjusted}}]/[RII_{\text{age adjusted}} - 1]^{*}100$. In a second step, personality measures that were associated with mortality outcomes were simultaneously entered in a model already including age in order to quantify the cumulative percentage reduction in the RII. Despite small number of deaths in women, all analyses were performed separately for men and women due to gender differences in the association between SEP and mortality. Analyses for CVD mortality as an outcome were conducted only for men as only two women died from CVD during the follow-up.

This study was approved by the French Data Protection Authority (Commission Nationale Informatique et Liberté (CNIL)).

RESULTS

Sample selection is described in Figure 1. Mean age in 1993 was 49.0 years for men and 46.2 years for women. During a mean follow-up of 12.7 years subsequent to the completion of the personality questionnaires, there were 932 deaths from all causes and 115 deaths of these were from cardiovascular diseases. At best, the analysis is based on 603 all-cause deaths and 74 cardiovascular deaths. Missing data are essentially due to non-response on the personality questionnaire. These data were more likely to be missing among particpants with low father's social class (p=0.02), lower education (p<0.001), employment grade and income (p<0.001). Missing data were not influenced by sex (p=0.701) and age (p=0.922).

Table 1 shows the associations between SEP indicators and personality scores in men. In general terms, out of the four SEP indicators it was father's social class that was least associated with personality measures. "Rational" personality type showed no association with the measures of SEP. Table 2 shows the same associations in women. Even though there was more of an association between father's social class and personality; overall the association between SEP and personality was less consistent in women. Table 3 shows that the bivariate correlations between personality measures in men and women were similar, low or moderate overall with the highest correlation coefficient being r=0.63.

The associations between the measures of personality and mortality outcomes in age- and CES-D adjusted models in men and women are presented in Table 4. Among men, "neurotic hostility" (RII = 2.22; 95 % CI: 1.59-3.11), "CHD-prone" (RII= 1.42; 95 % CI: 1.01-2.01), "ambivalent" (RII= 1.37; 95 % CI: 1.00-1.88), and "anti-social" (RII= 1.68; 95 % CI: 1.22-2.31) personality types were associated with all cause mortality. In women, unexpectedly, Type-A

behaviour pattern (RII= 0.40; 95 % CI: 0.19-0.84) and "CHD-prone" (RII= 0.31; 95 % CI: 0.13-0.72) were inversely and "healthy" personality type was positively associated (RII= 2.27; 95 % CI: 1.00-5.13) with all-cause mortality. Analysis on CVD mortality, in men alone, shows an association with "CHD-prone" personality (RII= 2.81; 95 % CI: 1.13-7.03).

Table 5 shows the associations between indicators of SEP and mortality in men. Father's social class was not associated with mortality (RII=0.98; 95% CI 0.68-1.40), leading us not to analyse this association any further. Education (RII=1.85; 95% CI 1.27-2.70), occupational grade (RII=2.52; 95% CI 1.79-3.55) and income (RII=2.19; 95% CI 1.57-3.00) were inversely associated with mortality. Adjustment for personality measures was carried out only if these measures were themselves associated with mortality (see Table 4). The most important attenuation in the association between SEP and mortality was observed for neurotic hostility (28-29%), "CHD-prone" (13-16%) and "anti-social" (12-22%) personality types. Adjustment for "ambivalent" personality type attenuated associations only by 3-5%. Simultaneous adjustment for all these four personality measures reduced the association between SEP and mortality by 34% for education, 29% for occupational grade and 28% for income.

In men, only occupational grade was clearly and inversely related to CVD mortality. Education level and income were also inversely related to this mortality outcome, but with wide confidence intervals (table 5). Adjustment for "CHD-prone" personality type reduced the association between SEP and CVD mortality by 42% for education, 31% for occupational grade, and 44% for income.

In women, there was no evidence of a consistent association of education (RII=1.48; 95% CI 0.56-3.89) or occupational position (RII=2.11; 95% CI 0.78-5.69) with mortality. Thus, the analysis to examine the role of personality in explaining social inequalities in mortality were pursued for father's social class (RII=3.58; 95% CI=1.51-8.53) and income (RII=2.97; 95% CI=1.30 to 6.82) which were inversely associated with mortality (table 6). Controlling for type-A behaviour reduced the RIIs for father's social class and income by 3-11%. In contrast, controlling

for CHD-prone personality type increased the association by 10% for father's social class and by 11% for income. Adjustment for "healthy" personality type increased the association between father's social class and mortality by 4%. Adjusting for all three personality measures increased the association by 6 % for father's social class and by 2 % for income.

DISCUSSION

We quantified the contribution of personality measures to the association between different indicators of SEP and mortality in a large cohort of French employees followed-up over a 13-year period. First, there was a social gradient in mortality among men for the measures of education, occupational position and income; and among women for father's social class and income. Second, based on hazard ratio reductions after adjustments, personality partly explained some of these associations, although the exact proportion explained varied depending mainly on the dimension of personality adjusted for, gender and somewhat on the indicator of SEP under consideration. Third, controlling for all personality predictors considerably attenuated the association between SEP and all-cause mortality in men, i.e., 34% for education, 29% for occupational position and 28% for income. The corresponding percentages of reduction for CVD mortality in men were 42%, 31% and 44%. For all-cause mortality in women, the attenuation was 11% at best. In both genders, strong associations with mortality remained for all measures of SEP after simultaneous adjustment for all the personality measures.

To our knowledge, this is the first prospective cohort study that has examined effects of personality on social inequalities in mortality using various personality measures and indicators of SEP from different stages of the lifecourse. To test the robustness of our findings, we repeated the analyses excluding deaths (all-cause) that occurred in the first five years of follow-up. These analyses provided very similar results as those for all-cause mortality presented in Table 5 for men. Our findings are in agreement with smaller-scale studies that examined the role of personality in explaining educational differences in perceived general health (**35**) and risky health

behaviours (**36**). In those studies, adjustment for hostility reduced educational differences in perceived general health and adjustments for type A behaviour components, such as impatience and lack of hard driving, attenuated educational gradients in smoking. The average percentage of attenuation in these associations was higher in men (from 24% to 28%) than women (from 11% to 16%), consistent with our results for the social gradient in mortality.

There were clear gender differences in the results of our study. First, the associations between SEP and personality are less consistent among women; even though father's social class appears more important. The different personality measures are associated with each other in a similar manner in men and women even though their associations with mortality are quite different in the two sexes. Type-A behaviour and CHD-prone personality are protective for mortality among women whereas "healthy" personality type is a risk factor. The mortality rate among women in this cohort is lower than among men, partly because women in our study are somewhat younger than men (women aged 35-50 years versus 40-50 years for men) and because of the generally longer life expectancy in women (**53**). Nevertheless, these results are intriguing, particularly as the gender differences in the association between personality and mortality in our analysis was strengthened after adjustment for depressive symptoms. This was particularly true for the "healthy" personality type (table 4) which was inversely correlated with depressive symptoms in both men and women. However, the change in the association between "healthy" personality type and mortality when adding depressive symptoms to the age-adjusted model was considerable in women only, suggesting gender-differentiated associations between personality, mental health and mortality.

The association between the measures of socioeconomic position and mortality also differed in the two sexes. Among men, father's social class whereas in women education and own occupational position was not associated with mortality. Thus, comparisons between men and women on the attenuation effects associated with personality measures can only be made for the measure of income and clearly personality explains less of the association between SEP and

mortality in women. No firm conclusions can be drawn from these analyses as there are few deaths among women. Nevertheless, these results suggest that the association between SEP, personality and health is different in men and women.

In this study, personality was measured in adulthood, making it difficult to ascertain the causal nature of the association between personality and SEP. In line with the "indirect selection" hypothesis, a Finnish study found that components of type A behaviour in childhood, such as high impatience and low hard-driving, predicted drift to a lower educational level, which in turn was associated with smoking (**54**). The authors of that study suggested that "personality earlier in life may affect adulthood health behaviours through its impact on adult social circumstances" (**36**). Other studies have shown associations between personality and career success and job satisfaction (**55, 56**). However, the relationship between personality and SEP may be bi-directional. Although personality is often seen as a relatively stable individual attribute, it is likely that socioeconomic circumstances also affect personality, both in childhood and adulthood (**57**). It has been shown in previous studies (**58, 59**) that psychological attributes, including personality, are partially rooted in environmental conditions in childhood, (learning) experiences, and rearing styles and that the development of hostility could be explained by factors such as parental behaviour that is overly strict, critical and demanding of conformity.

It is also plausible that adult circumstances, such as work-related stressors act as possible contributors to the development or promotion of personality traits, such as hostility. The parental behaviour pattern described above (i.e., overly strict, critical and demanding of conformity) is more common in low SEP households, and may be viewed as a reflection of the parents' occupational and other life experiences, which are characterized by job-strain for example (**17**). Given the evidence on job strain as a risk factor for CHD (**60, 61**), psychological distress (**62**), and depression (**63, 64**), it would be of great public health importance to get insight into the direction of causality in the association between SEP and personality.

Interpretation of these findings should be considered within the context of the study objectives and 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 (**65, 66**), for example the internal consistency of some scores of the Grossarth-Maticek and Eysenck personality was lower than the accepted cut-off of 0.70. Imprecision in the measurement of personality types may contribute to underestimation of both their predictive power and role in socioeconomic differences in mortality. Second, while this study included various measures of personality, it did not cover recent personality constructs, including the big five factors of personality (**57**). However, the advantage of using older measures is that there is sufficient follow-up to allow mortality analysis. The problem with using current measures is that the mortality analysis will necessarily be on high risk population (already sick for instance) to allow enough events for analysis. Thus, the longitudinal analysis using mortality outcomes necessarily has a time lag with the current literature. Nevertheless, our analysis is useful in identifying aspects of personality that are linked both to mortality and SEP indicators and will contribute to improve understanding of the considerable variability in morbidity and mortality between individuals and subgroups. A further caveat relates to the fact that the GAZEL cohort is not representative of the general population. The EDF-GDF employees have security of employment and certain categories of the population (agricultural workers, self-employed, foreigners) are not represented. However, it is important to note that the social gradient in mortality in EDF-GDF is similar to that in the French general population (**67**). Although occupational records ensure the completeness of mortality data, at least 35% of mortality cases were not included in the study, mainly due to non-response on the personality measures. Missing data were more likely to be associated with lower SEP, suggesting that the social gradient in mortality may be underestimated in the present study. Finally, due to the small number of deaths (n=75), findings among women may suffer from lack of power in the analyses.

In conclusion, these results show the importance of personality traits in explaining part of the social gradient in mortality, particularly in men, and encourage further research on the developmental origins of personality traits and the processes by which these traits influence diverse life outcomes, i.e. whether personality is a predictor of SEP or an outcome of social circumstances

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FIGURE 1. Flow chart of sample selection.

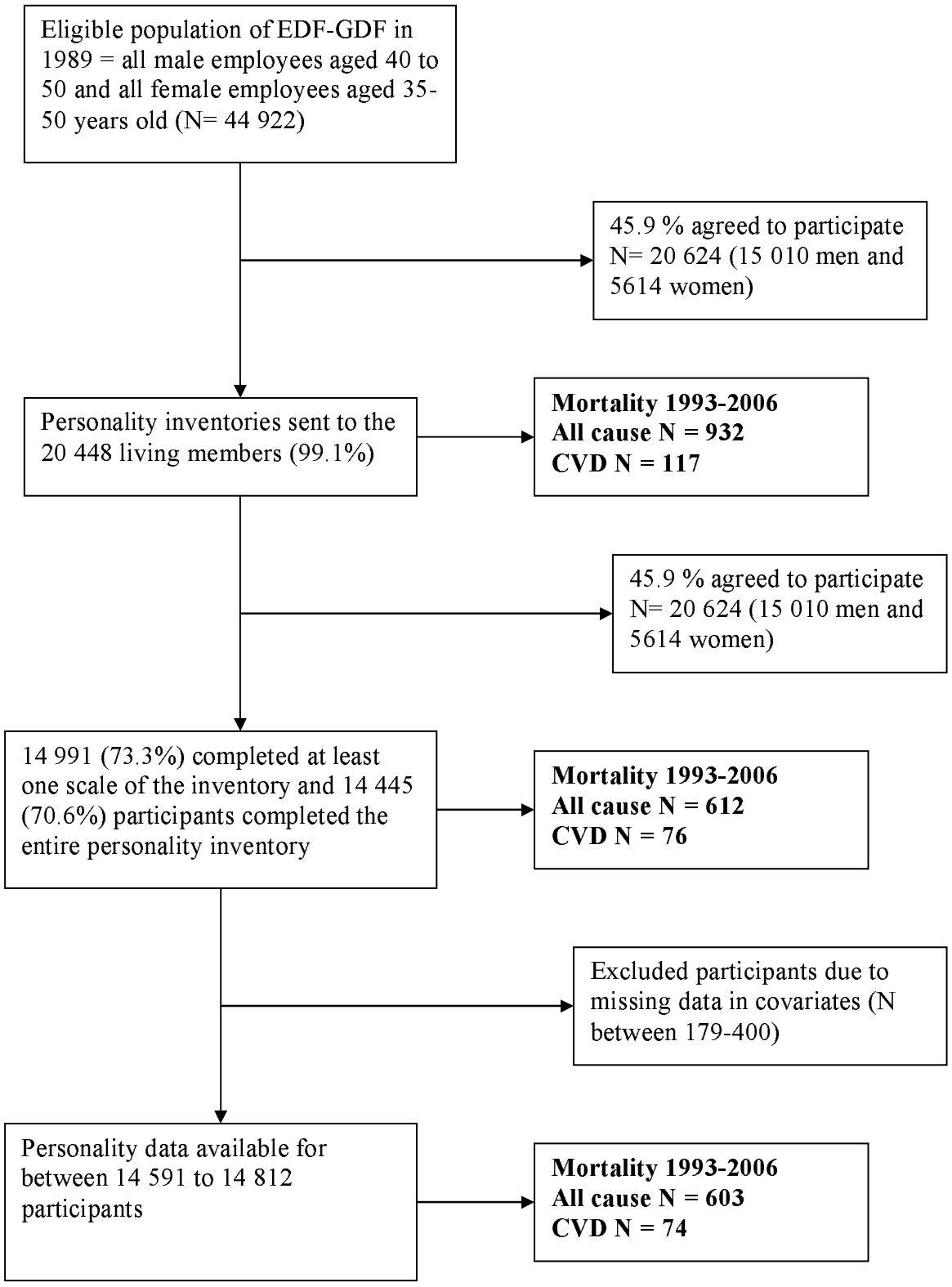

TABLE 1. Personality as a function of socioeconomic position in men

		Bortner*	BDHI*		Grossarth-Maticek & Eysenck PSI*					
	N**	Type-A pattern M (SD)	Neurotic hostility M (SD)	Reactive hostility M (SD)	Cancer prone (Type1) M (SD)	CHD prone (Type 2) M (SD)	Ambivalent (Type 3) M (SD)	Healthy (Type 4) M (SD)	Rational (Type 5) M (SD)	Anti-social (Type 6) M (SD)
Father's social class	10806									
High	82	53.9 (6.9)	6.7 (3.7)	20.3 (7.7)	4.1 (1.9)	3.3 (2.7)	2.2 (1.7)	6.8 (1.8)	6.3 (2.2)	2.0 (1.6)
Intermediate	5629	52.9 (7.5)	6.3 (3.5)	20.0 (7.2)	3.7 (2.0)	3.0 (2.5)	2.2 (1.7)	7.1 (1.6)	6.3 (2.0)	2.1 (1.7)
Low	5095	52.5 (7.8)	6.6 (3.6)	20.5 (7.1)	3.7 (2.1)	3.2 (2.5)	2.2 (1.8)	7.0 (1.7)	6.3 (1.9)	2.2 (1.8)
p value		0.006	<0.001	<0.001	0.600	<0.001	0.772	<0.001	0.474	0.001
Education level	10704									
Primary	2370	51.4 (7.9)	7.5 (3.8)	20.8 (7.6)	4.0 (2.2)	3.7 (2.6)	2.4 (1.9)	7.0 (1.6)	6.4 (1.8)	2.7 (1.9)
Secondary	5060	52.4 (7.7)	6.7 (3.5)	20.4 (7.2)	3.7 (2.1)	3.3 (2.5)	2.2 (1.8)	7.1 (1.5)	6.3 (1.9)	2.3 (1.8)
Higher secondary & tertiary	3274	53.6 (7.4)	5.7 (3.3)	19.8 (7.2)	3.6 (2.1)	2.6 (2.4)	2.1 (1.7)	7.2 (1.6)	6.3 (2.1)	1.8 (1.6)
p for trend		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.177	<0.001
Occupational grade	10985									
Unskilled workers	1304	50.8 (7.8)	7.7 (3.7)	21.0 (7.5)	3.9 (2.1)	4.0 (2.1)	2.5 (1.9)	6.8 (1.5)	6.2 (1.9)	2.7 (1.9)
Skilled workers	6062	52.3 (7.7)	6.8 (3.5)	20.4 (7.2)	3.7 (2.1)	3.7 (2.1)	2.2 (1.8)	7.0 (1.6)	6.3 (1.9)	2.3 (1.8)
Managers	3619	54.2 (6.7)	5.4 (3.1)	19.7 (7.0)	3.5 (2.0)	2.5 (2.0)	2.1 (1.6)	7.3 (1.6)	6.3 (2.1)	1.9 (1.6)
p for trend		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.149	<0.001
Income in €	10704									
< 1 600	2370	51.7 (7.7)	7.4 (3.7)	20.4 (7.4)	4.0 (2.1)	3.8 (2.6)	2.3 (1.8)	6.9 (1.6)	6.3 (1.9)	2.4 (1.8)
1 600-2 592	5060	52.5 (7.7)	6.6 (3.5)	20.2 (7.1)	3.7 (2.0)	3.2 (2.5)	2.2 (1.7)	7.1 (1.6)	6.3 (1.9)	2.2 (1.7)
>2 592	3274	53.9 (7.5)	5.6 (3.4)	20.1 (7.2)	3.5 (2.0)	2.5 (2.3)	2.2 (1.7)	7.2 (1.6)	6.3 (2.1)	1.9 (1.7)
p value		<0.001	<0.001	0.063	<0.001	<0.001	0.001	<0.001	0.289	<0.001

* M: Mean; SD: Standard Deviation

** N = Varies somewhat as a function of the personality measures.

TABLE 2. Personality as a function of socioeconomic position in women

		Bortner*	BDHI*		Grossarth-Maticek & Eysenck PSI*					
	N**	Type-A pattern M (SD)	Neurotic hostility M (SD)	Reactive hostility M (SD)	Cancer prone (Type1) M (SD)	CHD prone (Type 2) M (SD)	Ambivalent (Type 3) M (SD)	Healthy (Type 4) M (SD)	Rational (Type 5) M (SD)	Anti-social (Type 6) M (SD)
Father's social class	3873									
High	56	56.0 (7.3)	5.5 (2.9)	19.4 (6.2)	3.6 (2.1)	3.4 (2.7)	2.6 (1.8)	6.8 (1.9)	5.1 (1.9)	1.7 (1.8)
Intermediate	2096	54.4 (7.3)	6.8 (6.9)	20.5 (6.9)	3.9 (2.2)	3.8 (2.7)	2.5 (1.4)	6.7 (1.7)	5.6 (2.1)	2.0 (1.7)
Low	1721	54.3 (7.7)	7.2 (3.6)	20.7 (6.9)	4.1 (2.2)	4.2 (2.6)	2.6 (1.8)	6.5 (1.7)	5.6 (2.1)	2.2 (1.7)
p value		0.305	<0.001	0.235	0.018	<0.001	0.208	0.001	0.174	<0.001
Education level	3906									
Primary	254	53.7 (7.6)	7.7 (3.6)	20.5 (6.8)	4.6 (2.2)	4.6 (2.6)	2.5 (1.9)	6.3 (1.7)	5.8 (1.8)	2.4 (1.7)
Secondary	2640	53.2 (7.7)	7.2 (3.6)	20.4 (7.2)	3.7 (2.1)	3.3 (2.6)	2.3 (1.8)	6.9 (1.6)	5.6 (2.0)	2.2 (1.8)
Higher secondary & tertiary	1012	52.8 (7.7)	6.2 (3.4)	20.1 (7.1)	3.8 (2.1)	3.3 (2.6)	2.2 (1.7)	7.0 (1.6)	5.4 (2.2)	1.8 (1.6)
p for trend		0.0481	<0.001	0.331	<0.001	<0.001	0.202	<0.001	0.001	<0.001
Occupational grade	3990									
Unskilled workers	971	53.5 (7.8)	7.7 (3.7)	20.8 (7.2)	4.2 (2.3)	4.5 (2.7)	2.7 (1.8)	6.4 (1.7)	5.6 (2.0)	2.3 (1.9)
Skilled workers	2655	54.5 (7.5)	6.9 (3.5)	20.5 (6.9)	3.9 (2.2)	4.0 (2.6)	2.5 (1.8)	6.6 (1.7)	5.6 (2.1)	2.1 (1.7)
Managers	364	55.6 (6.7)	5.4 (3.1)	20.6 (6.6)	3.6 (2.2)	2.7 (2.2)	2.2 (1.5)	7.0 (1.7)	5.5 (2.3)	1.5 (1.7)
p for trend		<0.001	<0.001	0.293	<0.001	<0.001	<0.001	<0.001	0.815	<0.001
Income in €	3804									
< 1 600	791	53.2 (8.0)	7.4 (3.6)	20.3 (6.9)	4.1 (2.1)	4.2 (2.8)	2.6 (1.7)	6.7 (1.8)	5.5 (2.1)	2.2 (1.8)
1 600-2 592	1676	54.3 (7.4)	7.2 (3.5)	20.8 (6.9)	4.1 (2.2)	4.2 (2.6)	2.6 (1.8)	6.5 (1.8)	5.7 (2.1)	2.2 (1.8)
>2 592	1337	55.3 (7.4)	6.3 (3.4)	20.4 (6.9)	3.8 (2.2)	3.5 (2.6)	2.5 (1.7)	6.8 (2.1)	5.5 (2.1)	2.0 (1.7)
p value		<0.001	<0.001	0.995	0.008	<0.001	0.056	0.083	0.433	0.004

* M: Mean; SD: Standard Deviation

** N = Varies somewhat as a function of the personality measures.

TABLE 3. The correlations between personality measures in men (below the diagonal) and women (above the diagonal)

		1	2	3	4	5	6	7	8	9
Bortner Type-A behaviour	(1)	--	0.18**	0.35**	-0.12**	0.17**	0.13**	-0.16**	-0.06**	0.19**
BDHI: Neurotic hostility	(2)	0.13**	--	0.42**	0.33**	0.63**	0.32**	-0.43**	0.16**	0.41**
BDHI: Reactive hostility	(3)	0.34**	0.44**	--	-0.07**	0.34**	0.34**	-0.27**	-0.08**	0.45**
Cancer-prone-Type 1	(4)	-0.16**	0.28**	-0.06**	--	0.42**	0.17**	-0.39**	0.21**	0.11**
CHD-prone-Type 2	(5)	0.10**	0.61**	0.34**	0.40**	--	0.34**	-0.57**	0.09**	0.37**
Ambivalent-Type 3	(6)	0.12**	0.36**	0.34**	0.22**	0.35**	--	-0.20**	0.05**	0.51**
Healthy-Type 4	(7)	-0.10**	-0.38**	-0.24**	-0.37**	-0.53**	-0.22**	--	0.06**	-0.21**
Rational-Type 5	(8)	-0.06**	0.12**	-0.06**	0.20**	0.06**	0.06**	0.09**	--	0.03
Anti-social-Type 6	(9)	0.16**	0.42**	0.46**	0.11**	0.35**	0.50**	-0.16**	0.01	--

** $p < 0.001$ two-tailed

TABLE 4. Associations between personality measures and mortality among men and women adjusted for age and depressive symptoms.

	MEN		WOMEN	
	N events/N participants	RII (95% CI)	N events/N participants	RII (95% CI)
Mortality from all causes				
Bortner Type-A	514/10848	0.77 (0.57-1.04)	89/3946	0.40 (0.19-0.84)*
BDHI : Neurotic hostility	508/10727	2.22 (1.59-3.11)***	88/3918	1.15 (0.50-2.64)
BDHI : Reactive hostility	507/10729	1.00 (0.73-1.36)	88/3910	1.07 (0.50-2.29)
Cancer prone-Type 1	504/10715	1.11 (0.80-1.54)	87/3912	0.49 (0.23-1.03)
CHD-prone-Type 2	503/10700	1.42 (1.01-2.01)*	87/3891	0.31 (0.13-0.72)**
Ambivalent-Type 3	502/10711	1.37 (1.00-1.88)*	85/3896	1.30 (0.57-3.01)
Healthy-Type 4	504/10715	0.90 (0.63-1.28)	86/3895	2.27 (1.00-5.13)*
Rational-Type 5	501/10705	0.93 (0.68-1.27)	87/3899	1.34 (0.64-2.81)
Anti-social-Type 6	502/10737	1.68 (1.22-2.31)*	87/3911	0.71 (0.33-1.51)
Mortality form cardiovascular disease†				
Bortner Type-A	74/10408	0.62 (0.24-1.39)	-	-
BDHI : Neurotic hostility	73/10292	2.03 (0.84 -4.90)	-	-
BDHI : Reactive hostility	73/10293	0.63 (0.28 -1.42)	-	-
Cancer prone-Type 1	73/10310	1.09 (0.46-2.55)	-	-
CHD-prone-Type 2	73:10270	2.81 (1.13-7.03)*	-	-
Ambivalent-Type 3	73/10282	0.93(0.41-2.15)	-	-
Healthy-Type 4	73/10284	0.57 (0.23-1.43)	-	-
Rational-Type 5	73/10270	0.92 (0.41-2.07)	-	-
Anti-social-Type 6	73/10308	0.97 (0.42-2.21)	-	-

Note RII provides the relative risk of mortality outcomes in the highest personality score relative to the lowest personality score.
* P < 0.05, ** p<0.01, *** p< 0.001
†Restricted to men due to small number of CVD deaths (n=7) in women

TABLE 5. Role of personality in explaining the association between SEP indicators and mortality in men.

	Education			Occupational grade			Income		
	N events/ N participants	RII	95% CI	N events/ N participants	RII	95% CI	N events/ N participants	RII	95% CI
Adjusted for :	**All-cause mortality**								
Age (reference)	498/10681	1.85	(1.27-2.70)**	513/10836	2.52	(1.79-3.55)***	497/10560	2.19	(1.57-3.00)***
Age + BDHI-Neurotic hostility		1.60	(1.09-2.35)*		2.10	(1.48-3.00)***		1.85	(1.32-2.60)**
% change			**-29**			**-28**			**-29**
Age (reference)	493/10663	1.83	(1.25-2.68)**	507/10814	2.52	(1.79-3.55)***	491/10539	2.21	(1.58-3.10)***
Age + CHD-prone-Type 2		1.70	(1.16-2.50)**		2.30	(1.62-3.55)***		2.02	(1.43-2.84)***
% change			**-13**			**-15**			**-16**
Age (reference)	492/10179	1.83	(1.25-2.68)**	506/10821	2.52	(1.79-3.56)***	490/10546	2.19	(1.56-3.06)***
Age + Ambivalent-Type 3		1.80	(1.23-2.63)**		2.45	(1.73-3.45)**		2.16	(1.54-3.02)***
% change			**-4**			**-5**			**-3**
Age (reference)	492/10698	1.82	(1.24-2.66)**	506/10850	2.48	(1.76-3.49)***	490/10576	2.16	(1.54-3.02)***
Age + Anti-social-Type 6		1.64	(1.12-2.41)**		2.26	(1.60-3.21)***		2.02	(1.44-2.83)***
% change			**-22**			**-15**			**-12**
Age (reference)	490/10559	1.82	(1.24-2.65)**	504/10709	2.50	(1.77-3.52)***	488/10438	2.18	(1.56-3.05)***
Age + All personality measures		1.54	(1.04-2.26)*		2.07	(1.45-2.97)***		1.85	(1.31-2.62)***
% change			**-34**			**-29**			**-28**
	Cardiovascular disease mortality								
Age (reference)	70/10240	1.64	(0.60-4.40)	73/10380	2.59	(1.05-6.40)*	69/10117	1.97	(0.81-4.80)
Age + CHD-prone-Type 2		1.35	(0.49-3.72)		2.09	(0.83-5.29)		1.54	(0.62-3.83)
% change			**-42**			**-31**			**-44**

* p< 0.05, ** p<0.01, *** p< 0.00

Table 6. Role of personality in explaining the association between SEP indicators and mortality in women.

	Father's social class			Income		
	N events/ N participants	RII	95% CI	N events/ N participants	RII	95% CI
Adjusted for :	**All-cause mortality**					
Age (reference)	85/3873	3.58	(1.51-8.53)**	81/3804	2.97	(1.30 to 6.82)*
Age + Type-A behaviour pattern		3.51	(1.47-8.35)**		2.76	(1.20 to 6.35)*
% change			**-3**			**-11**
Age (reference)	83/3820	3.65	(1.52-8.78)**	79/3753	2.82	(1.26-6.32)*
Age + CHD-prone-Type 2		3.92	(1.62-9.46)**		3.02	(1.35-6.73)**
% change			**+10**			**+11**
Age (reference)	82/3824	3.51	(1.45-8.47)**	78/3755	2.66	(1.18-6.00)*
Age + Healthy-Type 4		3.62	(1.50-8.75)**		2.66	(1.18-5.99)*
% change			**+4**			**0**
Age (reference)	82/3792	3.48	(1.44-8.40)**	78/3725	2.67	(1.19-6.01)*
Age + All personality measures		3.63	(1.50-8.80)**		2.70	(1.19-6.09)*
% change			**+6**			**+2**

* p< 0.05, ** p<0.01, *** p< 0.001