American Journal of Epidemiology

Vol. 158, No. 12
Printed in U.S.A.
DOI: 10.1093/aje/kwg272

Sense of Coherence and Mortality in Men and Women in the EPIC-Norfolk United Kingdom Prospective Cohort Study

Paul Surtees[1], Nicholas Wainwright[1], Robert Luben[1], Kay-Tee Khaw[2], and Nicholas Day[1]

[1] Strangeways Research Laboratory, Institute of Public Health, University of Cambridge, Cambridge, United Kingdom.
[2] Clinical Gerontology Unit, University of Cambridge School of Clinical Medicine, Addenbrooke's Hospital, Cambridge, United Kingdom.

Received for publication April 8, 2003; accepted for publication June 18, 2003.

This study tested the hypothesis that a personality disposition defined by a strong sense of coherence is associated with a reduced risk of mortality. The authors prospectively examined, for ≤6 years, the relation between a strong sense of coherence and mortality due to all causes, cardiovascular disease, and cancer among 20,579 participants aged 41–80 years from the European Prospective Investigation into Cancer (EPIC)-Norfolk Study in the United Kingdom. Data were collected in 1996–2002. Participants were recruited by post from general practice age-sex registers and subsequently completed a postal assessment of their sense of coherence. During follow-up, 1,024 deaths were recorded. A strong sense of coherence was associated with a 30% reduction in mortality from all causes (rate ratio = 0.69, $p < 0.0001$), cardiovascular disease (rate ratio = 0.70, $p = 0.001$), and cancer (rate ratio = 0.74, $p = 0.003$), independent of age, sex, and prevalent chronic disease. These associations were consistent by sex, except that no association was observed for cancer mortality in women. The association for all-cause mortality remained after adjustment for cigarette smoking history, social class, body mass index, systolic blood pressure, cholesterol, hostility, and neuroticism (rate ratio = 0.76, $p = 0.002$). Results suggest that a strong sense of coherence may confer some resilience to the risk of chronic disease.

cardiovascular diseases; mortality; neoplasms; personality; prospective studies; psychology

Abbreviations: EPIC, European Prospective Investigation into Cancer; HLEQ, Health and Life Experiences Questionnaire; SOC, sense of coherence.

Understanding of whether the association between chronic disease and mortality risk is influenced by personality is limited and controversial (1–3). Although research has considered a diverse range of personality dispositions, including emotional distress (4), emotional control (5), neuroticism (6), and submissiveness (7), most studies have focused on the role of negative emotions in chronic disease, for example, reporting evidence of an association between measures of hostility (or an angry temperament) and incident physical disease and all-cause mortality (8, 9). In marked contrast to the pathogenic orientation concerned with negative emotions and health outcomes, a model proposed by Antonovsky (10) focuses on personality dispositions that promote health rather than contribute to disease causation; the model was formulated partly by studying survivors of the Holocaust and their subsequent adaptation to the experiences endured.

Sense of coherence (SOC) was defined by Antonovsky (10) as representing the salutogenic resources available to individuals. These resources, when strong, include the belief that what happens in their lives is rational, predictable, structured, and understandable (comprehensibility); that adequate and sufficient resources are perceived to be available to help resolve difficulties as they arise (manageability); and that the demands created by exposure to adversity are seen as challenges and are worthy of engagement (meaningfulness). SOC is hypothesized to be a stable personality disposition that serves as a major coping resource for preserving health. Empirical testing of Antonovsky's salutogenic model has been restricted almost entirely to cross-sectional research designs (11, 12), with no previous known test in relation to

Reprint requests to Dr. Paul Surtees, Strangeways Research Laboratory, Worts Causeway, Cambridge CB1 8RN, United Kingdom (e-mail: paul.surtees@srl.cam.ac.uk).

mortality. Findings based on prospective cohort studies of initially healthy populations are considered to provide the most appropriate observational research design for addressing questions concerned with the etiologic and prognostic importance of personality dispositions for chronic disease outcomes (13). We tested the hypothesis that a strong SOC is associated prospectively with a reduced risk of mortality in a large, community-dwelling population.

MATERIALS AND METHODS

Participants and measures

During 1993–1997, 30,414 men and women (then) aged 40–74 years and residing in Norfolk, United Kingdom, were recruited for the European Prospective Investigation into Cancer (EPIC)-Norfolk population study by using general practice age-sex registers (14, 15). As part of a baseline questionnaire survey, all participants were asked to provide details about their medical history, including whether a physician had ever confirmed to them a diagnosis of any of a range of conditions that included cancer, diabetes, heart attack, and stroke. Current and lifetime smoking behavior was also assessed. A health check was attended by 25,637 participants and included assessments of height, weight, blood pressure, and blood lipids (14). During 1996–2000, an assessment of social and psychological circumstances, based on the Health and Life Experiences Questionnaire (HLEQ) (16), was completed by 20,921 participants, representing a response rate of 73.2 percent of the total eligible EPIC-Norfolk sample (n = 28,582). The HLEQ instrument included a three-item SOC questionnaire developed in Sweden (17, 18) and designed to assess each of the component constructs (comprehensibility, manageability, and meaningfulness) by single questions (refer to the Appendix). Completed scores for the SOC scale were available for 20,579 (98.4 percent of all) EPIC-Norfolk HLEQ participants. Of the HLEQ sample, 18,248 persons had attended the health check.

Participant response choices were yes, usually (scored 0); yes, sometimes (scored 1); and no (scored 2). Following reverse scoring for comprehensibility, all items were summed to provide a total SOC scale score in the range of 0–6; a higher score represents a weaker SOC. As part of the HLEQ assessment, participants also completed a revised form of the Personality Deviance Scales (PDS-R) (19, 20) together with a measure of the personality trait neuroticism (21). The PDS-R consists of eight items that assess hostile thoughts and acts, scored in the range of 1–4 and summed (range, 8–32); a low scale score indicates increased hostility. The neuroticism scale (range, 0–12; a high score represents increased neuroticism) is considered a marker for susceptibility to depression (22, 23). Details of demographic factors and of either current or prior primary employment were obtained, enabling us to allocate participants by social class (according to Computer-Assisted Standard Occupational Coding (24)). Participants were flagged for mortality through the United Kingdom Office of National Statistics, with vital status established for the whole HLEQ cohort, and were classified initially according to the Ninth Revision of the *International Classification of Diseases* and subsequently the Tenth Revision. Death was considered due to cardiovascular disease if the underlying cause on the death certificate was Ninth Revision codes 401–448 or Tenth Revision codes I10–I79 and cancer if the underlying cause was either Ninth Revision codes 140–208 or Tenth Revision codes C00–C97.

Statistical analysis

The association between SOC as a binary variable based on a median split (strong: 0 or 1; weak: 2–6) and all-cause, cardiovascular, and cancer mortality was investigated through Poisson regression models, taking into account duration of follow-up (relative to time of HLEQ completion). In this paper, results are presented by sex as age-adjusted mortality rates per 1,000 person-years of follow-up and as rate ratios with progressive adjustments for age (in 5-year bands), prevalent physical disease, cigarette smoking history (current, former, never), and social class (I, II, III nonmanual, III manual, IV, and V), all as categorical variables. Where results are presented for men and women combined, additional adjustment was included for sex and age-sex interaction. Prevalent physical disease was defined to include cancer, stroke, diabetes mellitus, or previous myocardial infarction at EPIC-Norfolk baseline assessment. Subsequent analysis was restricted to all-cause mortality and was completed for men and women combined. Further adjustments were made for body mass index (weight in kilograms divided by height in meters squared), included as a categorical variable, and for systolic blood pressure (mmHg), serum total cholesterol (mmol/liter), hostility, and neuroticism, included as continuous variables. In addition, this paper presents adjusted associations between a strong SOC and all-cause mortality following exclusion of participants reporting prevalent physical disease at baseline and of all deaths occurring within 12 months of HLEQ completion, and separately within strata of age, smoking status, and social class. Adjusted survival rates for those with a strong and a weak SOC are presented by duration of follow-up (obtained from Cox regression), and adjusted rate ratios are given according to an increasing SOC score to evaluate existence of a dose-response relation.

RESULTS

Completed SOC scale scores were available for 20,579 (98.4 percent of all) EPIC-Norfolk HLEQ participants aged 41–80 years, including 8,974 men and 11,605 women. Of the sample, 41.9 percent reported a strong (score, 0 or 1) compared with a weak (score, 2–6) SOC. More men than women reported a strong SOC (47.6 percent vs. 37.4 percent, $p < 0.0001$). Table 1 shows variations in SOC by selected demographic and other factors and reveals that the percentage of participants reporting a strong SOC was greater for those aged 60–69 years and for former and never smokers and that there was a steep gradient according to social class, with just over twice as many participants in social class I versus social class V reporting a strong SOC. A strong SOC was powerfully associated with both decreased hostility and decreased neuroticism. Some evidence existed that SOC varied according to body mass index. No association was observed between SOC and prevalent physical disease, systolic blood pressure, or

TABLE 1. Percentage of Health and Life Experiences Questionnaire participants with a strong (score, 0 or 1) vs. a weak (score, 2–6) sense of coherence by selected demographic and other factors, EPIC-Norfolk Study, United Kingdom, 1996–2000

	No.	Men (n = 8,974)		Women (n = 11,605)		All (n = 20,579)	
		%	p value*	%	p value*	%	p value*
Age (years)			0.02		<0.001		<0.001
41–49	2,548	44.5		36.8		39.9	
50–59	6,865	46.8		38.1		41.7	
60–69	6,574	49.7		39.8		44.3	
70–80	4,591	47.4		33.3		39.8	
Prevalent disease			0.08		0.12		0.06
No	18,478	48.0		37.6		42.1	
Yes	2,101	45.1		35.3		40.0	
Cigarette smoking history			<0.001		0.002		<0.001
Current	2,224	41.8		33.1		37.0	
Former	8,467	48.3		37.4		43.7	
Never	9,723	48.6		38.4		41.6	
Social class			<0.001		<0.001		<0.001
I	1,002	56.4		56.0		56.3	
II	6,940	53.7		47.0		50.3	
III nonmanual	4,918	42.7		34.0		35.4	
III manual	2,794	42.1		39.3		41.3	
IV	1,813	36.8		28.0		31.2	
V	552	20.0		24.5		23.6	
Body mass index†			0.20		0.05		<0.001
<20	391	41.1		35.5		36.8	
20–24.99	6,872	48.5		39.6		42.9	
25–29.99	8,069	48.9		38.2		43.8	
≥30	2,622	46.0		36.0		39.8	
Quartile of systolic blood pressure (mmHg)			0.14		0.08		0.71
1 (<123)	4,486	49.6		40.1		43.2	
2 (123–133)	4,490	47.7		38.6		42.8	
3 (134–147)	4,401	46.6		37.8		42.1	
4 (>147)	4,575	49.7		36.7		43.0	
Quartile of cholesterol (mmol/liter)			0.19		0.37		0.68
1 (<5.4)	4,073	46.6		40.0		43.2	
2 (5.4–6.0)	4,132	48.1		39.4		43.6	
3 (6.1–6.8)	4,194	48.9		38.3		43.0	
4 (≥6.9)	4,411	50.2		37.8		42.3	
Quartile of hostility (score)			<0.001		<0.001		<0.001
1 (8–22)	4,698	37.7		26.4		32.3	
2 (23–24)	4,468	45.2		31.5		38.0	
3 (25–26)	5,014	51.1		40.4		45.0	
4 (27–32)	6,357	57.9		44.7		49.3	
Quartile of neuroticism (score)			<0.001		<0.001		<0.001
1 (0–1)	4,829	65.6		62.2		64.1	
2 (2–3)	4,489	53.4		49.4		51.3	
3 (4–6)	5,598	41.6		36.3		38.4	
4 (7–12)	5,559	22.1		16.9		18.7	

* For overall test of significance across all categories of each factor.
† Weight in kilograms divided by height in meters squared.

TABLE 2. Age- and sex-adjusted rates (per 1,000 person-years) of all-cause, cardiovascular, and cancer mortality for a strong (score, 0 or 1) vs. a weak (score, 2–6) sense of coherence, EPIC-Norfolk Study, United Kingdom, 1996–2002

	Sense of coherence					
	Men		Women		All	
	Weak	Strong	Weak	Strong	Weak	Strong
All-cause mortality						
No. of deaths (person-years)	384 (22,163)	231 (20,513)	286 (34,951)	123 (20,969)	670 (57,114)	354 (41,482)
Age-adjusted rate	11.8	7.6	5.0	3.8	7.7	5.3
Rate ratio	1	0.64	1	0.76	1	0.68
95% CI*		0.55, 0.76		0.62, 0.94		0.60, 0.78
Cardiovascular mortality						
No. of deaths (person-years)	146 (22,163)	101 (20,513)	100 (34,951)	32 (20,969)	246 (57,114)	133 (41,482)
Age-adjusted rate	4.0	3.0	1.2	0.7	2.2	1.5
Rate ratio	1	0.74	1	0.59	1	0.69
95% CI		0.57, 0.95		0.40, 0.88		0.56, 0.85
Cancer mortality						
No. of deaths (person-years)	155 (22,163)	88 (20,513)	127 (34,951)	71 (20,969)	282 (57,114)	159 (41,482)
Age-adjusted rate	5.9	3.6	2.8	2.7	4.1	3.0
Rate ratio	1	0.60	1	0.95	1	0.73
95% CI		0.46, 0.78		0.71, 1.27		0.60, 0.89

* CI, confidence interval.

cholesterol. At the end of October 2002, 1,024 deaths (615 in men and 409 in women) were observed in this sample in a follow-up period of up to 6 years (a total of 98,596 person-years; mean, 4.8 years). Of these deaths, 379 were from cardiovascular diseases and 441 from cancer.

Table 2 shows age-adjusted mortality rates for those participants who reported a strong compared with a weak SOC and reveals that, for men and women combined, a strong SOC was associated with a 30 percent reduction in all-cause, cardiovascular, and cancer mortality. These associations were consistent by sex, except that no association was observed for cancer mortality in women. Table 3 shows rate ratios for a strong as opposed to a weak SOC after adjustment, first for age and prevalent physical disease, and

TABLE 3. Association between a strong (score, 0 or 1) vs. a weak (score, 2–6) sense of coherence and all-cause, cardiovascular, and cancer mortality, after adjustment for age and prevalent disease (A); age, prevalent disease, and social class (B); and age, prevalent disease, social class, and cigarette smoking history (C), EPIC-Norfolk Study, United Kingdom, 1996–2002

	Men		Women		All	
	Rate ratio	95% CI*	Rate ratio	95% CI	Rate ratio	95% CI
All-cause mortality						
A	0.65	0.55, 0.77	0.77	0.63, 0.96	0.69	0.61, 0.79
B	0.73	0.61, 0.87	0.79	0.62, 1.01	0.75	0.65, 0.86
C	0.73	0.61, 0.87	0.81	0.64, 1.04	0.76	0.65, 0.87
Cardiovascular mortality						
A	0.75	0.58, 0.97	0.60	0.40, 0.89	0.70	0.57, 0.87
B	0.85	0.65, 1.12	0.54	0.34, 0.87	0.75	0.60, 0.95
C	0.87	0.66, 1.15	0.53	0.32, 0.86	0.76	0.60, 0.96
Cancer mortality						
A	0.61	0.47, 0.79	0.97	0.72, 1.30	0.74	0.61, 0.91
B	0.66	0.50, 0.89	1.07	0.77, 1.49	0.81	0.65, 1.01
C	0.66	0.49, 0.88	1.09	0.78, 1.52	0.81	0.65, 1.02

* CI, confidence interval.

TABLE 4. Associations, adjusted for age, sex, and prevalent disease, between a strong (score, 0 or 1) vs. a weak (score, 2–6) sense of coherence and all-cause mortality, within strata of age (in 10-year bands), cigarette smoking history, and social class, EPIC-Norfolk Study, United Kingdom, 1996–2002

	No. of deaths	Rate ratio	95% CI*
Age (years)			
40–49	9	0.42	0.09, 2.06
50–59	115	0.70	0.48, 1.03
60–69	324	0.67	0.53, 0.84
70–80	576	0.71	0.60, 0.85
Cigarette smoking history			
Current	164	0.61	0.44, 0.87
Former	535	0.67	0.56, 0.81
Never	309	0.80	0.64, 1.01
Social class			
High (I, II, III nonmanual)	549	0.78	0.65, 0.92
Low (III manual, IV, V)	286	0.65	0.50, 0.84

* CI, confidence interval.

second with further adjustment for social class and then cigarette smoking history. These results revealed only a modest attenuation in effect size, with significant associations indicating a 25 percent reduction in all-cause and cardiovascular mortality for those with a strong as opposed to a weak SOC. This magnitude of association corresponds to an attributable risk of 16 percent. An association between SOC and cancer mortality remained for men but not for women.

Further adjustment for body mass index, systolic blood pressure, cholesterol, hostility, and neuroticism (with these data available for a reduced sample of 16,668 of those participants who attended the health check, with 775 deaths) resulted in no further attenuation of the association between SOC and all-cause mortality (rate ratio = 0.76, 95 percent confidence interval: 0.64, 0.90). In addition, this association remained after exclusion of those participants reporting prevalent physical disease and of all deaths that occurred within 12 months of HLEQ completion (age-sex adjusted rate ratio = 0.68, 95 percent confidence interval: 0.58, 0.79).

Table 4 shows adjusted associations for all-cause mortality within strata of age, cigarette smoking history, and social class. Although the association was generally consistent across all strata, it appeared marginally stronger for those participants who were smokers (or former smokers) and for those in lower social classes. Figure 1 shows adjusted survival rates for all-cause mortality for a strong and a weak SOC and confirms that the association was consistent across the follow-up period (and importantly was not restricted to the first few years of follow-up). Figure 2 shows adjusted associations for all-cause mortality by an increasingly strong SOC (defined by a progressively lower scale score). This figure reveals a dose-response relation such that increasing strength of SOC is associated with decreasing mortality.

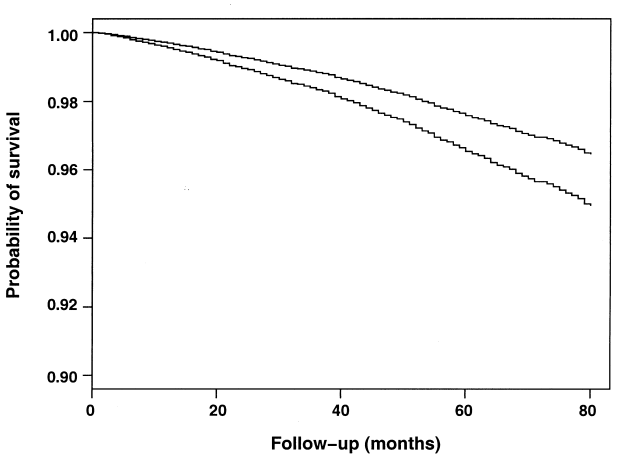

FIGURE 1. Probability of survival by number of months of follow-up for participants with a strong (top line) vs. a weak (bottom line) sense of coherence at baseline, after adjustment for age, sex, and prevalent disease, EPIC-Norfolk Study, United Kingdom, 1996–2002.

DISCUSSION

Our results support the hypothesis that a strong SOC is associated with a reduced risk of all-cause mortality. These findings were consistent by sex and were shown to be independent of social class, cigarette smoking history, body mass index, blood pressure, cholesterol, hostility, and neuroticism. A strong SOC was also found to be associated with reduced mortality from cardiovascular causes and with reduced cancer mortality in men but not women.

Large-scale, prospective cohort studies evaluating the effect of personality dispositions on the risk of chronic disease and mortality are rare, reflecting in part the challenge

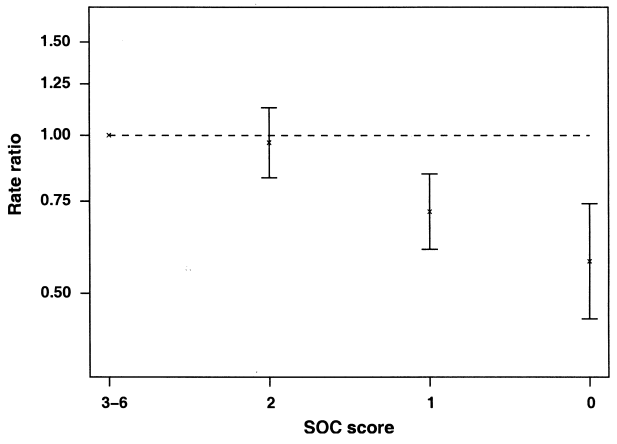

FIGURE 2. Rate ratios (with 95% confidence intervals) for all-cause mortality, adjusted for age, sex, and prevalent disease, by an increasingly strong sense of coherence (SOC) (defined by a decreasing score), EPIC-Norfolk Study, United Kingdom, 1996–2002.

of assessment as well as the need to limit participant burden. For example, despite decades of research in this field, a recent quantitative review (25) of prospective studies examining the role of hostility in coronary heart disease identified only six healthy cohort studies (with a combined population of ≈8,300 participants) that had been subsequently flagged for "hard" endpoints.

Therefore, data limitations ensure that formal prospective ascertainment of the association between personality dispositions and chronic disease outcomes remains clouded by extreme uncertainties. These limitations arise typically from combinations of study design factors that include inadequate statistical power to achieve objectives, restricted follow-up or incomplete endpoint ascertainment (providing reduced capacity to evaluate consistency of relations according to other factors of interest), and failing (or being unable) to adjust adequately for known relevant risk factors (e.g., cigarette smoking behavior), leading to residual confounding.

We are aware of only one prospective study (26) that examined whether a strong SOC had a salutogenic effect in terms of being associated with a reduced risk of chronic disease incidence. This study involved subgroups of employed male participants (aged 40–55 years) of the Helsinki Heart Study (a secondary analysis using data from a placebo-controlled, double-blind, primary prevention trial) and concluded that a strong (or intermediate) SOC promotes health, but only in white-collar workers. The study design, its restriction to coronary heart disease morbidity and to employed middle-aged men, and the 5-year interval between baseline clinical screening and psychosocial assessments limit opportunity for comparing findings with our own results. Other work (27), based on a random sample of the total Finnish population aged 15–64 years reassessed after an interval of 4 years, has shown strong SOC (defined according to a modified version of the original SOC-29 questionnaire) to be significantly associated with future subjective health, following adjustment for initial (subjective) health and other factors.

The EPIC-Norfolk HLEQ cohort size, our capacity to adjust for traditional mortality risk factors and for chronic disease prevalent at baseline, together with validated complete prospective ascertainment of deaths by cause provided a unique opportunity to test and confirm the core hypothesis that a strong SOC is associated with a reduced risk of all-cause mortality. This association was observed after adjustment for traditional mortality risk factors and was unaffected by exclusion of participants who had chronic disease at baseline and of deaths occurring during the first year immediately following personality assessment. In addition, the observed effect size was large, a 25 percent reduction in all-cause mortality (after adjustment for traditional mortality risk factors), and corresponded to an attributable risk of 16 percent. The association was consistent by sex, was consistent by time since follow-up, was shown to conform to a dose-response relation, and was observed within strata of age, cigarette smoking history, and social class. The association was observed for mortality from cardiovascular diseases and mortality from cancer in men (but not women). Given their consistency and strength, these results may contribute to the debate as to whether psychosocial factors have yet achieved the status of risk factors for chronic disease (28, 29).

Confirmation of our hypothesis that a strong SOC is associated with reduced mortality now requires further investigation to aid etiologic understanding of the relation. Included is establishing whether a strong SOC is associated with biologic, other lifestyle, or other social and psychological profiles that confer protection from chronic disease (and mortality). A recent study has suggested that participants reporting high SOC levels also report higher levels of self-esteem, greater control over their lives, greater optimism, and reduced negative affectivity (30). Confounding of current emotional state with SOC may therefore have implications for the interpretation of our findings, given evidence that a history of affective disturbance is suspected to have a role in chronic disease etiology and mortality (31, 32). However, in the current study, the association between SOC and mortality was not explicable in terms of either hostility or neuroticism. Future work will need to assess SOC in the context of other social and psychological factors for chronic disease and to consider the adverse effects of clustering of psychosocial factor exposures for chronic disease outcomes. This rationale builds on accumulating, but still very sparse evidence of clustering of psychosocial factors and of their combined effects, magnifying chronic disease risk beyond that of individual risk factor exposure—including impaired prognosis following cardiac events—and thus increasing the risk of incident disease and mortality (33).

Growing recognition of the need for an integrated model of human developmental physiology that can assist thinking about how ontogenetic changes may mediate social, psychological, and environmental effects (34) has started to affect social epidemiology. A scientific consensus has been developing that insights into predisease pathways may result from knowledge gained from simultaneous assessment of measures of physiologic risk across multiple systems. Central to this consensus is that allostatic systems (e.g., the hypothalamic-pituitary-adrenal axis) act adaptively to challenge in order to maintain homeostasis and health (35–37). A wide range of circumstances, including periods of sustained challenge, are considered sufficient to influence allostatic load, leading to an adverse impact on organ systems and initiating disease. System disruption may arise because of prolonged adverse exposures over the lifespan, experiencing chronic emotional states, prolonged social isolation (or prolonged exposure to critical social ties), practicing poor health behaviors, pathogenic personal dispositions, and living for extended periods in deprived environments. Preliminary results also suggest associations between allostatic load and measures of well-being, including environmental mastery, personal growth, and purpose in life (38). Therefore, investigation of the relation between SOC and allostatic load may provide insights into whether and how SOC influences biologic systems that mediate health and illness.

Participants in this study were asked to complete a simplified three-item SOC measure (17) evaluated in a representative sample of the Swedish population aged 25–75 years. Inclusion of this measure helped limit participant burden and study costs. SOC was operationalized by Antonovsky (10,

39) initially as a 29-item questionnaire rated on seven-point semantic differential scales (subsequently shortened to a 13-item version), with factor analysis resulting in a single-factor solution. The designers of the simplified SOC measure reported satisfactory test-retest reliability (over a relatively short interval), that the measure appeared valid (because analysis of the three component items suggested a single-factor solution representative of SOC), and that the relation between the simplified measure of SOC and other variables was similar to that reported for the measure operationalized by Antonovsky (39). Although no known study has thus far been undertaken that contrasts (either of) the original scales with the simplified SOC scale used in this study, we consider this lack relatively unimportant. As some have noted (11), other measures of SOC are required to advance understanding of this hypothesized generalized disposition and its relation to other constructs. We demonstrated strong predictive validity for the simplified SOC measure in relation to mortality. Its brevity will permit use in other large-scale prospective studies and consequently aid evaluation of the model proposed by Antonovsky (10) for a diverse range of health outcomes.

Future research will also need to advance understanding of the association between SOC and class and their combined effects on mortality. For example, in this cohort, the association was observed within strata of social class. Antonovsky (10) considered that SOC and social class would be related. He theorized that a strong SOC originating through favorable circumstances in early life would be preserved if relative advantages and opportunities were sustained into the third decade of life. It was expected that a positive class gradient in the prevalence of a strong SOC would differentially aid establishment of effective and adaptive strategies to cope with adverse experiences. Our results confirm this theorized class gradient; more than twice as many study participants in social class I versus class V reported a strong SOC.

Evaluation of the hypothesized role of SOC in moderating social adversity and the mediational model associating SOC (and other lifestyle behaviors, personal dispositions, affective disorder history, and social circumstances) with biologic disease mechanisms remains to be tested empirically (12). Research efforts to achieve greater understanding of the "disability paradox" (40) and very recent developments in the emerging psychological science of strength and resilience, focused on positive human traits such as courage, optimism, and future-mindedness (41), share a foundation with Antonovsky's ideas (10). To our knowledge, this paper is the first formal test of the hypothesis that a strong SOC is associated with reduced mortality and, while leaving many questions unanswered, may aid further work devoted to this intriguing area of study.

ACKNOWLEDGMENTS

The EPIC-Norfolk Study is supported by program grants from Cancer Research UK and the Medical Research Council (United Kingdom), with additional support from the Stroke Association, the British Heart Foundation, the Department of Health, the Food Standards Agency and the Wellcome Trust, and the Europe Against Cancer Programme of the Commission of the European Communities.

The authors thank the general practitioners who took part in this study and the staff associated with the research program.

REFERENCES

1. Pelosi AJ, Appleby L. Psychological influences on cancer and ischaemic heart disease. BMJ 1992;304:1295–8.
2. Dalton SO, Boesen EH, Ross L, et al. Mind and cancer: do psychological factors cause cancer? Eur J Cancer 2002;38:1313–23.
3. Lillberg K, Verkasalo PK, Kaprio J, et al. Personality characteristics and the risk of breast cancer: a prospective cohort study. Int J Cancer 2002;100:361–6.
4. Denollet J, Sys SU, Stroobant N, et al. Personality as independent predictor of long-term mortality in patients with coronary heart disease. Lancet 1996;347:417–21.
5. Tijhuis MA, Elshout JR, Feskens EJ, et al. Prospective investigation of emotional control and cancer risk in men (the Zutphen Elderly Study) (The Netherlands). Cancer Causes Control 2000;11:589–95.
6. Lillberg K, Verkasalo PK, Kaprio J, et al. A prospective study of life satisfaction, neuroticism and breast cancer risk (Finland). Cancer Causes Control 2002;13:191–8.
7. Whiteman MC, Deary IJ, Lee AJ, et al. Submissiveness and protection from coronary heart disease in the general population: Edinburgh Artery Study. Lancet 1997;350:541–5.
8. Barefoot JC, Larsen S, von der Lieth L, et al. Hostility, incidence of acute myocardial infarction, and mortality in a sample of older Danish men and women. Am J Epidemiol 1995;142:477–84.
9. Williams JE, Nieto FJ, Sanford CP, et al. Effects of an angry temperament on coronary heart disease risk: The Atherosclerosis Risk in Communities Study. Am J Epidemiol 2001;154:230–5.
10. Antonovsky A. Unraveling the mystery of health. San Francisco, CA: Jossey-Bass, 1987.
11. Geyer S. Some conceptual considerations on the sense of coherence. Soc Sci Med 1997;44:1771–9.
12. Ouellette SC, DiPlacido J. Personality's role in the protection and enhancement of health: where the research has been, where it is stuck, how it might move. In: Revenson TA, Singer JE, eds. Handbook of health psychology. Mahwah, NJ: Lawrence Erlbaum Associates, 2001:175–93.
13. Smith TW, Spiro A. Personality, health, and aging: prolegomenon for the next generation. J Res Personal 2002;36:363–94.
14. Day N, Oakes S, Luben R, et al. EPIC-Norfolk: study design and characteristics of the cohort. Br J Cancer 1999;80(suppl 1):95–103.
15. Khaw KT, Bingham S, Welch A, et al. Relation between plasma ascorbic acid and mortality in men and women in EPIC-Norfolk prospective study: a prospective population study. Lancet 2001;357:657–63.
16. Surtees PG, Wainwright NW, Brayne C. Psychosocial aetiology of chronic disease: a pragmatic approach to the assessment of lifetime affective morbidity in an EPIC component study. J Epidemiol Community Health 2000;54:114–22.
17. Lundberg O, Nyström Peck M. A simplified way of measuring sense of coherence: experiences from a population survey in

Sweden. Eur J Public Health 1995;5:56–9.
18. Lundberg O. Childhood conditions, sense of coherence, social class and adult ill health: exploring their theoretical and empirical relations. Soc Sci Med 1997;44:821–31.
19. Deary IJ, Bedford A, Fowkes FGR. The Personality Deviance Scales: their development, associations, factor structure and restructuring. Personal Individ Differ 1995;19:275–91.
20. Surtees PG, Wainwright NW, Khaw KT, et al. Inflammatory dispositions: a population-based study of the association between hostility and peripheral leukocyte counts. Personal Individ Differ 2003;35:1271–84.
21. Eysenck SB, Eysenck HJ, Barrett P. A revised version of the psychoticism scale. Personal Individ Differ 1985;6:21–9.
22. Hirschfeld RM, Klerman GL, Lavori P, et al. Premorbid personality assessments of 1st onset of major depression. Arch Gen Psychiatry 1989;46:345–50.
23. Duggan C, Sham P, Lee A, et al. Neuroticism: a vulnerability marker for depression evidence from a family study. J Affect Disord 1995;35:139–43.
24. Elias P, Halstead K, Prandy K. CASOC : Computer-Assisted Standard Occupational Coding. London, United Kingdom: HMSO, 1993.
25. Myrtek M. Meta-analyses of prospective studies on coronary heart disease, type A personality, and hostility. Int J Cardiol 2001;79:245–51.
26. Poppius E, Tenkanen L, Kalimo R, et al. The sense of coherence, occupation and the risk of coronary heart disease in the Helsinki Heart Study. Soc Sci Med 1999;49:109–20.
27. Suominen S, Helenius H, Blomberg H, et al. Sense of coherence as a predictor of subjective state of health—results of 4 years of follow-up of adults. J Psychosom Res 2001;50:77–86.
28. Beaglehole R, Magnus P. The search for new risk factors for coronary heart disease: occupational therapy for epidemiologists? Int J Epidemiol 2002;31:1117–22.
29. Marmot M. Commentary: occupational therapy or the major challenge? Int J Epidemiol 2002;31:1122–4.
30. Pallant JF, Lae L. Sense of coherence, well-being, coping and personality factors: further evaluation of the sense of coherence scale. Personal Individ Differ 2002;33:39–48.
31. Penninx BW, Geerlings SW, Deeg DJ, et al. Minor and major depression and the risk of death in older persons. Arch Gen Psychiatry 1999;56:889–95.
32. Rugulies R. Depression as a predictor for coronary heart disease—a review and meta-analysis. Am J Prev Med 2002;23:51–61.
33. Rozanski A, Blumenthal JA, Kaplan J. Impact of psychological factors on the pathogenesis of cardiovascular disease and implications for therapy. Circulation 1999;99:2192–217.
34. Worthman CM. Epidemiology of human development. In: Panter-Brick C, Worthman CM, eds. Hormones, health and behavior. Cambridge, United Kingdom: Cambridge University Press, 1999:47–104.
35. Seeman TE, Singer BH, Rowe JW, et al. Price of adaptation—allostatic load and its health consequences. Arch Intern Med 1997;157:2259–68.
36. McEwen BS, Seeman T. Protective and damaging effects of mediators of stress: elaborating and testing the concepts of allostasis and allostatic load. Ann N Y Acad Sci 1999;896:30–47.
37. Seeman TE, McEwen BS, Rowe JW, et al. Allostatic load as a marker of cumulative biological risk: MacArthur studies of successful aging. Proc Natl Acad Sci U S A 2001;98:4770–5.
38. Ryff CD, Singer B. From social structure to biology. Integrative science in pursuit of human health and well-being. In: Snyder CR, Lopez SJ, eds. Handbook of positive psychology. New York, NY: Oxford University Press, 2002:541–55.
39. Antonovsky A. The structure and properties of the Sense of Coherence Scale. Soc Sci Med 1993;36:725–33.
40. Albrecht GL, Devlieger PJ. The disability paradox: high quality of life against all odds. Soc Sci Med 1999;48:977–88.
41. Snyder CR, Lopez SJ, eds. Handbook of positive psychology. New York, NY: Oxford University Press, 2002.

APPENDIX

1. Do you usually feel that the things that happen to you in your daily life are hard to understand? (comprehensibility)
2. Do you usually see a solution to problems and difficulties that other people find hopeless? (manageability)
3. Do you usually feel that your daily life is a source of personal satisfaction? (meaningfulness)