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Hostility and Increased Risk of Mortality and Acute Myocardial Infarction: The Mediating Role of Behavioral Risk Factors

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Cynical hostility has been associated with increased cardiovascular morbidity and mortality; yet few studies have investigated this relation in population-based samples, and little is known about underlying mechanisms. This study examined the association between hostility, measured by the eight-item Cynical Distrust Scale, and risk for all-cause and cardiovascular mortality and incident myocardial infarction. Subjects were 2,125 men, ages 42–60 years, from the Kuopio Ischemic Heart Disease Risk Factor Study, a longitudinal study of unestablished and traditional risk factors for ischemic heart disease, mortality, and other outcomes. There were 177 deaths (73 cardiovascular) in 9 years of follow-up. Men with hostility scores in the top quartile were at more than twice the risk of all-cause mortality (relative hazards (RH) 2.30, 95% confidence interval (CI) 1.47-3.59) and cardiovascular mortality (RH 2.70, 95% CI 1.27–5.76), relative to men with scores in the lowest quartile. Among 1,599 men without previous myocardial infarction or angina, high scorers also had an increased risk of myocardial infarction (RH 2.18, 95% CI 1.01–4.70). Biologic and socioeconomic risk factors, social support, and prevalent diseases had minimal impact on these associations, whereas adjustments for the behavioral risk factors of smoking, alcohol consumption, physical activity, and body mass index substantially weakened the relations. Simultaneous risk factor adjustment eliminated the observed associations. Results show that high levels of hostility are associated with increased risk of all-cause and cause-specific mortality and incident myocardial infarction and that these effects are mediated primarily through behavioral risk factors. *Am J Epidemiol* 1997;146:142–52.

behavior; cardiovascular diseases; hostility; mortality; myocardial infarction; risk factors

Historically, anger, hostility, and aggressive qualities have been implicated often as predisposing factors in coronary heart disease and hypertension (1–3). More recently, attempts to isolate the important or "toxic" component of the broadly defined Type A behavior pattern, previously accepted as a risk factor for coronary heart disease (4), have focused on hostility (5, 6). Several studies have found that hostility, assessed by various measures, is associated with increased risk of cardiovascular morbidity and mortality and/or all-cause mortality (5–10). However, not all studies have identified a positive relation (11–13), and surprisingly few studies have looked at the relation between hostility and mortality and morbidity in population-based samples (e.g., (9)).

Several mechanisms or pathways have been suggested by which hostility may affect health adversely. Scores from the Cook-Medley Hostility Scale (14), a commonly used measure of cynicism, are inversely related to socioeconomic status, as indexed by occupation, income, and education (15, 16), indicating that hostility may operate through the well-documented effects of low social class on health (17–19). Similarly, hostile individuals may have a psychosocial profile that makes them more vulnerable to disease. High scores on the Cook-Medley Hostility Scale have been associated with high levels of interpersonal conflict, low levels of social support, more negative life events, and more frequent and severe daily hassles (15, 16, 20–23). The health behavior model suggests that people who are hostile may be at greater risk for disease

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Abbreviations: BMI, body mass index; CI, confidence interval; KIHD, Kuopio Ischemic Heart Disease Risk Factor Study; RH, relative hazards.

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because of poor health habits (24). Several studies have documented an association between high Cook-Medley Hostility Scale scores and greater alcohol and tobacco use, less leisure-time activity, greater caloric intake, and higher body mass index (BMI) (10, 25–27). Exaggerated sympathoadrenal arousal or activation may be another mechanism by which hostility contributes to cardiovascular and other diseases. Research has shown that hostile individuals, who tend to experience more frequent and intense episodes of anger, show heightened cardiovascular and/or neuroendocrine responses to behavioral and psychological stressors, particularly under conditions of interpersonal challenge (20, 28–32). Other biologic factors, such as blood pressure or lipid levels, both of which have been related to hostility and the related construct of suppressed anger (33–36), also may play a role in the adverse effects of hostility on health. Each of these proposed mechanisms requires further empirical testing.

The present study tested the hypothesis that high levels of cynical distrust are associated with increased risk of all-cause and cardiovascular mortality in a population-based sample of more than 2,100 men from eastern Finland. We also investigated the association between hostility and noncardiovascular mortality and examined the relation between hostility and incident myocardial infarction in a subset of participants who had no history of myocardial infarction or angina. This report is from the Kuopio Ischemic Heart Disease Risk Factor (KIHD) Study, which was designed to examine a variety of psychosocial characteristics as putative risk factors for ischemic heart disease, mortality, and other outcomes (37). The KIHD study enabled us to examine the influence of socioeconomic, psychosocial, and behavioral risk factors as well as health status on the relation between cynical hostility and mortality and myocardial infarction in an attempt to better understand some of the contributory mechanisms or pathways.

MATERIALS AND METHODS

Study population

The KIHD study is a population-based study of previously unestablished as well as traditional risk factors for carotid atherosclerosis and ischemic heart disease among middle-aged men from the Kuopio region in eastern Finland, an area with high coronary morbidity and mortality rates (38). The total sample of KIHD participants consists of 2,682 men who were recruited in two cohorts. The first cohort included 1,166 54-year-old men (83.3 percent) from a possible eligible sample of 1,399 who were enrolled in the study between March 1984 and August 1986. The second cohort included 1,516 42-, 48-, 54-, and 60-year-old men (82.6 percent) from an eligible group of 1,836 who were enrolled in the study between August 1986 and December 1989. There were no systematic differences between the two cohorts with respect to baseline demographic or subject characteristics other than the age distribution; thus, data from the two cohorts were combined for analysis. The present analyses were based on 2,125 men for whom we had complete data on the measure of cynicism, covariates, and disease history variables.

Cynical Distrust Scale

Cynical hostility was measured by the eight-item Cynical Distrust Scale (39) that was factor-analytically derived from the Cook-Medley Hostility Scale (14). Cronbach's α for the Cynical Distrust Scale is 0.81, indicating good internal consistency. Previous research with the Cynical Distrust Scale has shown it to be a reliable, valid, and more specific measure of cynicism and distrust than the 50-item Cook-Medley Hostility Scale (39, 40). Moreover, the Cynical Distrust Scale significantly predicted 2-year progression of carotid atherosclerosis in a subsample of KIHD participants (41). Items on the Cynical Distrust Scale include the following:

- I think most people would lie to get ahead.
- Most people inwardly dislike putting themselves out to help other people.
- Most people make friends because friends are likely to be useful to them.
- It is safer to trust nobody.
- No one cares much what happens to you.
- Most people are honest chiefly through fear of being caught.
- I commonly wonder what hidden reasons another person may have for doing something nice to me.
- Most people will use somewhat unfair means to gain profit or an advantage rather than lose it.

Response options were altered from the original true-false format of the Cook-Medley Hostility Scale to a four-point Likert Scale as follows: 0 = completely agree, 1 = somewhat agree, 2 = somewhat disagree, and 3 = completely disagree. This format allowed for greater variance and a nearly normal distribution of scores. Items were reverse scored and summed to obtain a Cynical Distrust Scale score, which had a range of 0–24. Cynical Distrust Scale scores increased with age ($p = 0.005$).

Outcomes

Mortality. All-cause mortality was ascertained by linkage to the national death registry. All deaths that occurred in the cohort between study entry (March 1984 to December 1989) and December 31, 1995, were included. Deaths coded with codes 390–459 from the *International Classification of Diseases*, Ninth Revision, were included in the analyses of cardiovascular deaths. All other deaths were included in the analyses of noncardiovascular deaths. Average follow-up time was 9.0 years (range 6.0–11.8 years). A total of 177 deaths, 73 of which were cardiovascular, occurred during the follow-up period.

Myocardial infarctions. Myocardial infarctions were ascertained through the FINMONICA register for the area (42). Information on incidence of myocardial infarction was available through December 31, 1992, during which time there were 60 first myocardial infarctions. Analyses of the myocardial infarction data excluded 526 men with a history of angina or a previously diagnosed myocardial infarction.

Baseline covariates

Biologic factors. Biologic risk factors included resting systolic blood pressure, measured with a random zero sphygmomanometer (Hawksley, London, United Kingdom) and calculated as the average of four readings, two readings taken at minutes 10 and 15 of a 15-minute supine rest and two readings taken at minutes 5 and 10 of a 10-minute seated rest; and high and low density lipoprotein cholesterol, separated from fresh plasma using ultracentrifugation and precipitation and measured enzymatically (CHOD-PAP cholesterol method, Boehringer Mannheim, Mannheim, Germany).

Behavioral factors. Behavioral covariates included alcohol consumption, assessed by a questionnaire on drinking behavior over the previous 12 months and by a 4-day dietary record; cigarette smoking, assessed by self-report of never, former, or current smoking and, among current smokers, measured by pack-years; physical activity, assessed by self-report of leisure-time activities for the previous 12 months; and BMI, calculated as weight divided by height squared (kg/m^2).

Socioeconomic and social support variables. Socioeconomic status was assessed by self-report of annual family income, with the bottom two quintiles of the distribution considered to be low socioeconomic status. Total amount of social support (emotional, instrumental, tangible) and quality of relationships were assessed by two self-report scales consisting of six and eight items (Cronbach's $\alpha = 0.87$ and 0.74), respectively. The scales were factor-analytically derived from a pool of 69 items that assessed various aspects of social connections, including extent, quality, and satisfaction with social support, marital status, religious practices, and shyness (43). Responses to all items were standardized to have a range of 0–10, with higher scores indicative of greater social integration. Scale scores were created by summing responses to the individual standardized items.

Prevalent chronic diseases. Participants were considered to have prevalent ischemic heart disease at baseline if they had a history of angina pectoris or prior myocardial infarction, currently used antiangina medication, or had positive findings of angina according to the Rose Questionnaire (44). (Mortality analyses that excluded men with prevalent ischemic heart disease at baseline produced essentially the same pattern of results. Therefore, we chose to present findings from the full sample, adjusting for prevalent ischemic heart disease.) Prevalence of hypertension was assessed by resting blood pressure and medication review. A participant was considered hypertensive if his resting blood pressure was equal to or greater than 165 mmHg systolic and/or 95 mmHg diastolic or if he were taking medication for hypertension. Prevalence of diabetes was assessed by medication review and fasting blood glucose level, obtained from whole blood samples after at least 12 hours of overnight fasting and measured with the glucose dehydrogenase method after precipitation of the proteins with trichloroacetic acid (Granutest 100, Merck, Darmstadt, Germany). A person was considered diabetic if he currently were using diet or taking medication to control diabetes, or if he had a fasting blood glucose level of 6.7 mmol/liter or greater (120 mg/dl). Self-reported history of stroke and cancer was also recorded.

Data analyses

The association between cynicism and all-cause mortality was assessed with a series of Cox proportional hazards models (45) with responses on the Cynical Distrust Scale modeled both continuously and categorically. Subsequent age-adjusted models separately examined the influence of biologic risk factors, behavioral risk factors, socioeconomic status, social support, and prevalent chronic diseases on the cynicism-mortality relation to systematically examine the impact of these potential mediating mechanisms. A model that simultaneously adjusted for all of the risk factors was also calculated. These models were then repeated with cardiovascular mortality, noncardiovascular mortality, and incident myocardial infarction as the outcomes. All analyses were performed using GLM and PHREG procedures in SAS, version 6.09

(SAS Institute, 1990), installed on a Sun SPARCstation 20.

RESULTS

The means ± standard error or prevalence (percent) for age, resting systolic blood pressure, high and low density lipoprotein cholesterol, BMI, income, education, smoking, alcohol consumption, physical activity, social support, quality of relationships, and chronic diseases are shown in table 1. In table 2, number of participants, person-years at risk, number of all-cause, cardiovascular, and noncardiovascular deaths, and mortality ratios per 1,000 person-years are reported by quartiles on the Cynical Distrust Scale. Relative hazard (RH) ratios and 95 percent confidence intervals (CIs) from the age- and risk factor-adjusted Cox models examining the association between hostility and all-cause and cause-specific mortality and myocardial infarction are shown in tables 3 and 4, respectively. Age-adjusted RH by quartiles of cynical distrust for the mortality outcomes are presented in figure 1.

All-cause mortality

In an age-adjusted Cox proportional hazards model with Cynical Distrust Scale scores modeled continuously, each one-unit increase in hostility was associated with an increase of approximately 8 percent in risk of all-cause mortality (RH 1.078, 95 percent CI 1.04–1.12). This association remained significant in the subsequent risk factor-adjusted models ($p < 0.005$).

Modeling Cynical Distrust Scale scores in quartiles revealed that only those men with scores in the upper quartile were at increased risk of all-cause mortality, relative to those in the lowest quartile (age-adjusted RH 2.30, 95 percent CI 1.47–3.59) (see figure 1). As shown in table 3, this elevation in risk was decreased by less than 15 percent and remained significant in subsequent models that included adjustments for biologic risk factors, socioeconomic status, social support, or prevalent diseases. However, the risk associated with the fourth quartile of Cynical Distrust Scale scores was diminished by more than 25 percent after adjustment for the behavioral risk factors of smoking, alcohol consumption, physical activity, and BMI (RH 1.71, 95 percent CI 1.08–2.70). Simultaneous adjustment for all risk factors nearly eliminated the observed association between cynical hostility and all-cause mortality (table 3).

To examine the contribution of each of the behavioral risk factors to the association between hostility

TABLE 1. Mean ± standard error (SE) or prevalence (%) of baseline covariates for 2,125 eastern Finnish men

	Mean ± SE	Prevalence (%)
Cynical Distrust Scale score	12.7 ± 0.09	
Age (years)	52.6 ± 0.11	
Resting systolic blood pressure (mmHg)	134 ± 0.37	
Low density lipoprotein cholesterol (mmol/liter*)	4.03 ± 0.02	
High density lipoprotein cholesterol (mmol/liter*)	1.30 ± 0.01	
Body mass index (kg/m²)	26.8 ± 0.08	
Income (Finnish marks)	78,712 ± 1,096	
Education (years)	8.7 ± 0.07	
Cigarette smoking		
Never smokers		27.0
Former smokers		40.8
Current smokers		32.2
Alcohol consumption (g/week)†	73.5 ± 2.69	
Physical activity (hours/week)	2.15 ± 0.06	
Total social support‡	5.03 ± 0.05	
Quality of relationships‡	7.14 ± 0.03	
Chronic disease		
Ischemic heart disease		23.8
Hypertension		41.1
Diabetes		4.0
Stroke		2.0
Cancer		1.8

* To convert mmol/liter to mg/dl, divide by 0.02586.
† One drink has approximately 13 g of alcohol.
‡ Scores on the measures of total social support and quality of relationships ranged from 0 to 10, with higher scores indicative of higher levels of emotional, instrumental, and tangible support received as well as better perceived relationship quality, respectively.

TABLE 2. Person-years of exposure, deaths, and mortality rates by quartiles of the Cynical Distrust Scale among 2,125 eastern Finnish men

	Cynical Distrust Scale quartiles			
	1 (n = 506)	2 (n = 544)	3 (n = 556)	4 (n = 519)
Exposure (person-years)	3,654	3,925	3,968	3,654
Deaths				
All-cause	27	40	41	69
Mortality rate/1,000	7.4	10.2	10.3	18.9
Cardiovascular	9	18	19	27
Mortality rate/1,000	2.5	4.6	4.8	7.4
Noncardiovascular	18	22	22	42
Mortality rate/1,000	4.9	5.6	5.5	11.5

TABLE 3. Relative hazards (RHs) and 95% confidence intervals (CIs) for all-cause, cardiovascular, and noncardiovascular mortality by Cynical Distrust Scale* quartiles among 2,125 eastern Finnish men

Risk factor adjustments	Cynical Distrust Scale quartiles						
	1 (low)	2		3		4 (high)	
	RH	RH	95% CI	RH	95% CI	RH	95% CI
All-cause mortality (177 events)							
Age	Reference	1.30	0.80–2.13	1.33	0.82–2.16	2.30	1.47–3.59
Age + biologic†		1.26	0.77–2.06	1.28	0.79–2.09	2.18	1.39–3.40
Age + socioeconomic‡		1.22	0.75–2.00	1.22	0.75–1.99	1.97	1.26–3.09
Age + behavioral§		1.18	0.72–1.93	1.17	0.72–1.91	1.71	1.08–2.70
Age + social support¶		1.29	0.79–2.11	1.31	0.80–2.14	2.25	1.42–3.55
Age + prevalent diseases#		1.27	0.78–2.07	1.27	0.78–2.06	2.10	1.34–3.30
Age + all risk factors		1.07	0.65–1.75	0.94	0.57–1.56	1.39	0.86–2.32
Cardiovascular mortality (73 events)							
Age	Reference	1.76	0.79–3.93	1.85	0.84–4.10	2.70	1.27–5.76
Age + biologic†		1.59	0.71–3.54	1.67	0.75–3.70	2.36	1.10–5.03
Age + socioeconomic‡		1.67	0.75–3.72	1.72	0.78–3.80	2.35	1.10–5.02
Age + behavioral§		1.60	0.71–3.58	1.57	0.71–3.48	1.84	0.85–3.98
Age + social support¶		1.76	0.79–3.93	1.83	0.82–4.07	2.63	1.21–5.69
Age + prevalent diseases#		1.70	0.76–3.80	1.70	0.77–3.76	2.30	1.08–4.93
Age + all risk factors		1.43	0.63–3.23	1.16	0.51–2.65	1.46	0.66–3.25
Noncardiovascular mortality (104 events)							
Age	Reference	1.07	0.58–2.00	1.07	0.57–2.00	2.09	1.20–3.64
Age + biologic†		1.08	0.58–2.02	1.07	0.57–2.00	2.09	1.20–3.64
Age + socioeconomic‡		1.00	0.54–1.87	0.98	0.52–1.83	1.78	1.02–3.11
Age + behavioral§		0.98	0.53–1.84	0.97	0.52–1.81	1.67	0.94–2.95
Age + social support¶		1.06	0.57–1.98	1.05	0.56–1.98	2.06	1.17–3.63
Age + prevalent diseases#		1.07	0.57–1.99	1.05	0.56–1.96	2.03	1.16–3.54
Age + all risk factors		0.91	0.48–1.72	0.84	0.44–1.59	1.42	0.78–2.58

* Cynicism was measured by the eight-item Cynical Distrust Scale: 1st quartile—score ≤9; 2nd quartile—score = 10–12; 3rd quartile—score = 13–15; 4th quartile—score >15.
† Biologic risk factors included systolic blood pressure, low density lipoprotein cholesterol, and high density lipoprotein cholesterol.
‡ Socioeconomic status was assessed by annual income.
§ Behavioral risk factors were cigarette smoking, alcohol consumption, physical activity, and body mass index.
¶ Social support factors included self-reported quality of relationships and total amount of emotional, tangible, and instrumental social support received.
# Prevalent diseases included history of symptomatic cardiovascular diseases, hypertension, stroke, diabetes, and cancer.

and all-cause mortality, we then calculated four age-adjusted Cox models that also included a covariate for either smoking, alcohol consumption, physical activity, or BMI. All four behavioral risk factors were significant covariates in these models ($p < 0.024$), and the increased risk of mortality associated with the fourth quartile of cynical distrust remained significant in each model (RH 1.96, 2.11, 2.25, and 2.17 after adjustment for smoking, alcohol consumption, physical activity, and BMI, respectively ($p < 0.0034$)). These findings suggest that the combined effect of these behavioral factors is involved in mediating the

TABLE 4. Relative hazards (RHs) and 95% confidence intervals (CIs) for incident myocardial infarction* by Cynical Distrust Scale quartiles among 1,599 eastern Finnish men

Risk factor adjustments	Cynical Distrust Scale quartiles						
	1 (low)	2		3		4 (high)	
		RH	95% CI	RH	95% CI	RH	95% CI
Age	Reference	1.35	0.60–3.04	1.72	0.79–3.76	2.18	1.01–4.70
Age + biologic†		1.19	0.53–2.69	1.53	0.70–3.34	1.87	0.86–4.04
Age + socioeconomic‡		1.33	0.59–3.01	1.69	0.77–3.69	2.11	0.98–4.57
Age + behavioral§		1.37	0.61–3.09	1.61	0.73–3.51	1.82	0.83–3.96
Age + social support¶		1.28	0.56–2.88	1.57	0.71–3.46	1.95	0.89–4.30
Age + prevalent diseases#		1.30	0.58–2.94	1.65	0.75–3.60	2.09	0.97–4.52
Age + all risk factors		1.15	0.51–2.63	1.21	0.54–2.72	1.43	0.63–3.26

* $n = 60$.
† Biologic risk factors included systolic blood pressure, low density lipoprotein cholesterol, and high density lipoprotein cholesterol.
‡ Socioeconomic status was assessed by annual income.
§ Behavioral risk factors were cigarette smoking, alcohol consumption, physical activity, and body mass index.
¶ Social support factors included self-reported quality of relationships and total amount of emotional, tangible, and instrumental social support received.
# Prevalent diseases included history of hypertension, diabetes, and cancer.

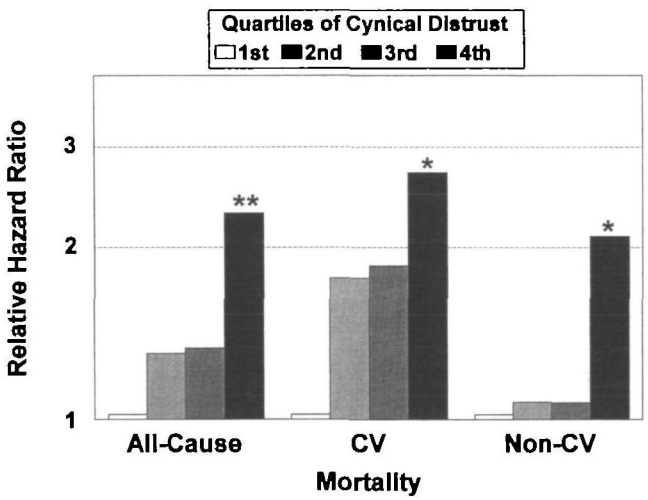

FIGURE 1. Age-adjusted relative risk of mortality by quartiles of cynical distrust among 2,125 eastern Finnish men. Results are from age-adjusted Cox proportional hazards models. The reference category in each model was the first quartile of Cynical Distrust Scale scores. CV, cardiovascular; non-CV, noncardiovascular; *, $p < 0.01$; **, $p < 0.0003$.

relation between cynical distrust and mortality from all causes.

Cardiovascular mortality

An age-adjusted Cox proportional hazards model revealed that each one-point increase in cynical distrust was associated with an increase greater than 6 percent in risk of cardiovascular mortality (RH 1.066, 95 percent CI 1.01–1.13). Subsequent analyses that modeled Cynical Distrust Scale scores categorically showed that men in the fourth quartile of scores were at more than two and a half times the risk of cardiovascular mortality, relative to men in the first quartile (age-adjusted RH 2.70, 95 percent CI 1.27–5.76) (see figure 1). Men in the second and third quartiles experienced a 75–85 percent increase in risk relative to those in the lowest quartile, but this increase did not reach statistical significance (table 3). The risk of cardiovascular mortality among the most cynical group was diminished slightly but remained more than twofold and was significant ($p < 0.032$) in subsequent models that adjusted for biologic risk factors, socioeconomic status, social support, or prevalent diseases, including ischemic heart disease and hypertension, and history of stroke, diabetes, and cancer (see table 3). However, behavioral risk factors clearly had the largest impact on the observed association between cynical hostility and mortality due to cardiovascular causes, with adjustment for these factors decreasing the risk associated with the fourth quartile by more than 32 percent to 1.84 (95 percent CI 0.85–3.98). Simultaneous adjustment for all risk factors reduced the observed relation even further (table 3).

Separate age-adjusted Cox models also were conducted to examine the contributions of each of the behavioral risk factors to the observed relation between cynical distrust and cardiovascular mortality. Current smoking, total weekly alcohol consumption, and BMI were significant covariates in these models ($p < 0.02$); and physical activity was marginally significant ($p = 0.058$). The increased risk of cardiovascular mortality associated with the top quartile of Cynical Distrust Scale scores remained significant in each of these models (RH 2.29, 2.54, 2.63, and 2.34 after adjustment for smoking, alcohol consumption, physical activity, and BMI, respectively ($p < 0.04$)), suggesting that the combined effect of smoking, alcohol intake, and BMI is involved in mediating the

relation between cynical distrust and cardiovascular mortality.

Noncardiovascular mortality

To determine whether the relation between cynical distrust and all-cause mortality was predicated on its association with cardiovascular mortality, we also examined the association between Cynical Distrust Scale scores and total noncardiovascular mortality. An age-adjusted Cox proportional hazards model revealed that each one-point increase in cynical distrust was associated with an increase greater than 8 percent in risk of noncardiovascular mortality (RH 1.087, 95 percent CI 1.04–1.14). Subsequent analyses that modeled Cynical Distrust Scale scores categorically showed a significantly increased risk of noncardiovascular mortality among men in the top quartile of those scores, relative to men with the lowest scores (RH 2.09, 95 percent CI 1.20–3.64) (see figure 1). Men in the second and third Cynical Distrust Scale quartiles were not at increased risk. Risk factor adjustments produced a pattern similar to those seen with all-cause and cardiovascular mortality, with behaviorai risk factors having the greatest impact on the association and contributing to a decline greater than 20 percent in the risk estimate for the most hostile men (RH 1.67, 95 percent CI 0.94–2.95). Simultaneous risk factor adjustment eliminated the association (see table 3).

We next calculated four age-adjusted Cox models that included a covariate for either smoking, alcohol consumption, physical activity, or BMI. Current smoking and weekly alcohol consumption were highly significant covariates ($p < 0.0001$), whereas BMI and physical activity were not ($p > 0.17$). The increased risk of noncardiovascular mortality seen among the most cynical men remained approximately twofold and was significant in these models (RH 1.80, 1.90, 2.06, and 2.11 after adjustment for smoking, alcohol consumption, physical activity, and BMI, respectively, $p < 0.04$). These results again demonstrate that the combination of behavioral factors is important in mediating the relation between cynicism and noncardiovascular mortality.

Myocardial infarction

An age-adjusted Cox proportional hazards model with Cynical Distrust Scale scores modeled continuously revealed that each one-unit increase in hostility was associated with an increased risk of incident myocardial infarction of nearly 8 percent (RH 1.078, 95 percent CI 1.02–1.15). This association remained significant in the subsequent risk factor-adjusted models ($p < 0.05$) but became nonsignificant in the fully adjusted model ($p = 0.17$).

With Cynical Distrust Scale scores modeled categorically, the age-adjusted Cox model showed a dose-response relation between hostility and incident myocardial infarction with men in the top quartile of scores at significantly increased risk of myocardial infarction (RH 2.18, 95 percent CI 1.01–4.70) relative to the referent group. The elevated risk among men in the second and third quartiles was not statistically significant. Subsequent Cox models that included risk factor adjustments for biologic factors, socioeconomic status, social support, behavioral factors, or prevalent diseases revealed that behavioral risk factors had the largest impact on the observed association between hostility and incident myocardial infarction (see table 4). Simultaneous risk factor adjustment reduced the risk associated with the top quartile to 1.4 and made it nonsignificant.

Contributory mechanisms

It is clear from the preceding analyses that behavioral risk factors were important mediating factors in the observed associations between hostility and mortality and myocardial infarction. However, the biologic and socioeconomic status factors and the measures of social support and health status also contributed to the models. Given that these variables all have been implicated as important mechanisms underlying the hostility-disease association, we conducted a series of age-adjusted cross-sectional analyses examining the relation between Cynical Distrust Scale scores and systolic blood pressure, high and low density lipoprotein cholesterol, physical activity, alcohol and cigarette consumption, BMI, social support, income, education, and number of chronic diseases. Means ± standard error or prevalence (percent) for these risk factors by Cynical Distrust Scale quartiles and associated p values are shown in table 5.

Higher levels of cynical distrust were associated with increasingly greater BMI, lower high density lipoprotein cholesterol levels, less education, less income, and more chronic diseases ($p < 0.004$). Cynical hostility was also significantly associated with alcohol consumption ($p = 0.005$), with the most cynical men reporting 55 percent more alcohol consumption than the least cynical men. More cynical men also appeared to be less well integrated socially, as indicated by lower levels of total social support and poorer quality of relationships ($p < 0.0001$). Although the overall effect of cynical distrust on pack-years of smoking was nonsignificant ($p < 0.231$), it is evident from table 5 that the least cynical men smoked less than their more hostile counterparts. Resting blood pres-

TABLE 5. Risk factor levels by Cynical Distrust Scale quartiles among 2,125 eastern Finnish men

	Cynical Distrust Scale quartiles								
	1 (n = 506)		2 (n = 544)		3 (n = 556)		4 (high) (n = 519)		p*
	Mean ± SE†	%	Mean ± SE	%	Mean ± SE	%	Mean ± SE	%	
Age (years)	52.5 ± 0.2		53.0 ± 0.2		53.0 ± 0.2		53.8 ± 0.2		<0.002
Systolic blood pressure	132 ± 0.8		132 ± 0.8		133 ± 0.8		134 ± 0.8		<0.501
Low density lipoprotein cholesterol (mmol/liter‡)	3.89 ± 0.05		3.92 ± 0.05		3.98 ± 0.05		3.981 ± 0.05		<0.394
High density lipoprotein cholesterol (mmol/liter‡)	1.33 ± 0.01		1.28 ± 0.01		1.28 ± 0.01		1.27 ± 0.01		<0.004
Physical activity (hours/week)	2.1 ± 0.1		2.3 ± 0.1		2.2 ± 0.1		2.3 ± 0.1		<0.423
Body mass index (kg/m²)	26.4 ± 0.2		26.5 ± 0.2		26.7 ± 0.2		27.5 ± 0.2		<0.0001
Alcohol (g/week)§	66 ± 5.8		72 ± 5.5		79 ± 5.6		103 ± 5.8		<0.0001
Smoking (pack-years)	25 ± 1.6		28 ± 1.5		29 ± 1.4		29 ± 1.3		<0.231
Income (Finnish marks)	94,310 ± 2,289		88,681 ± 2,197		79,434 ± 2,205		73,014 ± 2,287		<0.0001
Education (years)	10 ± 0.2		9 ± 0.2		9 ± 0.2		8 ± .2		<0.0001
Total social support¶	5.7 ± 0.1		5.3 ± 0.1		4.8 ± 0.1		4.3 ± 0.1		<0.0001
Quality of relationships¶	7.6 ± 0.1		7.2 ± 0.1		7.0 ± 0.1		6.9 ± 0.1		<0.0001
Chronic diseases									<0.001
0		52.8		48.0		45.5		40.5	
1		34.8		37.1		37.6		37.4	
≥2		12.5		14.9		16.9		22.2	

* p values are from one-way analyses of variance (χ^2 test for chronic diseases) examining the effect of cynical distrust on each risk factor.
† SE, standard error.
‡ To convert mmol/liter to mg/dl, divide by 0.02586.
§ One drink has approximately 13 g of alcohol.
¶ Higher scores on the measures of total social support and quality of relationships indicate higher levels of emotional, instrumental, and tangible support received as well as better perceived relationship quality, respectively.

sure, level of low density lipoprotein cholesterol, and reported amount of weekly physical activity did not differ by level of hostility.

DISCUSSION

The present study demonstrates that high levels of cynical hostility are associated with more than a two-fold increase in risk of all-cause and cardiovascular mortality and incident myocardial infarction in a randomly selected sample of middle-aged men. A high level of hostility also was related to increased risk of noncardiovascular mortality in our sample. Our results support the health behavior model of hostility and disease, which suggests that hostile individuals are at increased risk for disease because of poor health habits (24). We found that behavioral risk factors, particularly greater alcohol consumption and smoking and a higher BMI among the most cynical men, were significant mediating factors in the relations between hostility and mortality and myocardial infarction. These findings suggest that hostility itself may not be pathogenic; rather, hostility may be a marker for behaviors that increase risk for mortality and morbidity. Alternatively, hostility may be associated with the development and maintenance of such behaviors (27).

Prior research has demonstrated both cross-sectional and prospective associations between high levels of cynical hostility in young adulthood and greater prevalence of coronary risk behaviors (26, 27). However, few studies have systematically assessed the influence of these behavioral risk factors on the relation between hostility and mortality. Almada and colleagues (8) argue that the association between cynicism and all-cause and cardiovascular mortality after 25 years of follow-up in the Western Electric Study was likely mediated through cigarette smoking and excessive alcohol consumption among the highly cynical men. However, adjustment for smoking and alcohol consumption, as well as systolic blood pressure and total serum cholesterol, did not significantly influence the cynicism-mortality associations in that study, an effect that the authors indicated was due to incomplete statistical adjustment for the behavioral factors. In contrast, behavioral risk factors did have a significant impact on the associations between hostility and mortality and acute myocardial infarction in the present study. It should be noted, however, that the influence of these risk factors may be even greater than what was seen here. A single assessment of risk factors at one point in time may not adequately capture one's exposure to these factors; hence, the effects of these variables on the observed relations may be underestimated. Alternatively, imprecise measurement of risk factors could have introduced some bias into our mod-

els, thereby either obscuring or inflating the impact of behavioral factors on the associations between hostility and the outcomes. Because of the state-of-the-art measurement technology and detail given to quality control in the KIHD study (37), however, we have no reason to suspect that measurement error accounts for the present findings.

Our study was unique because we were able to examine multiple pathways and thus evaluate several proposed mechanisms that may underlie the hostility-mortality relation. Although it is apparent that behavioral mechanisms are involved in the relation between hostility and mortality in an important way, it should be emphasized that socioeconomic status also is an important component to consider. In the present study, income was a significant covariate in the Cox models assessing all-cause (RH for low socioeconomic status 2.46, 95 percent CI 1.79- 3.37), cardiovascular (RH for low socioeconomic status 2.31, 95 percent CI 1.42–3.76), and noncardiovascular mortality (RH for low socioeconomic status 2.57, 95 percent CI 1.70–3.90); and increasingly higher levels of hostility were associated with lower incomes as well as less education ($p < 0.0001$) in the cross-sectional analyses. Because the measures of hostility, socioeconomic status, and behavior were obtained at the same point in time in this study, it is not possible to determine their causal associations, if any. However, previous analyses of the KIHD cohort indicate that lower socioeconomic status in childhood is associated with higher levels of hostility, depression, and hopelessness; greater tobacco consumption and alcohol abuse; less leisure-time physical activity; and a less nutritious diet in adulthood (46). The extensive literature on socioeconomic inequalities in health also has shown that behavioral and psychosocial factors, including diet, smoking, physical activity, depression, and hostility, are distributed by socioeconomic status (19, 47–50). Indeed, there are compelling reasons to believe that social, psychological, and behavioral determinants of disease have socioeconomic origins (51, 52).

The findings from this study support the idea that hostility is an important component of coronary-prone behavior (53). Until relatively recently, the concept of coronary-prone behavior was discussed almost exclusively in terms of the Type A behavior pattern, which was accepted as an established risk factor for coronary heart disease approximately 15 years ago (4). However, it is now recognized that not all components of the Type A behavior pattern contribute to "coronary proneness"; and, in fact, hostility has received the greatest attention and support as the toxic component of Type A. It should be noted, however, that the hostile attitude and cynical distrust measured by the Cynical Distrust Scale used here (or that measured by the full Cook-Medley Hostility Scale) is not identical to the free-floating hostility that was originally described in the literature on Type A (54, 55). The latter was characterized as a behavioral response to things or people that impeded the progress of Type A persons, whereas the former appears to tap a more enduring personality characteristic that includes a basic mistrust of others. This distinction may help explain some of the inconsistencies in the literature regarding the relation between Type A, hostility, coronary heart disease incidence, mortality, and survival (cf., (56–61)). It is interesting to note that, although not unequivocal (e.g., (11–13)), hostility as measured by the Cook-Medley Hostility Scale, its item subsets and related scales, has been associated with a number of cardiovascular outcomes as well as all-cause and noncardiovascular mortality in clinical and population samples (7–9, 41, 62) and indeed, with both mortality and incidence in the present study. Thus, hostility appears to be more broadly and consistently related to health outcomes than Type A.

The present study was conducted on middle-aged white men; therefore, it remains to be seen whether similar results would be obtained in female or minority populations. Relatively few studies investigating the effects of hostility on health outcomes have included women. A recent study by Barefoot et al. (9) found that high scores on an abbreviated version of the Cook-Medley Hostility Scale were associated with an increased risk of myocardial infarction and all-cause mortality after 27 years of follow-up in the Glostrup (Denmark) study, which included more than 300 women. Two earlier studies by Dembroski et al. (59) and Williams and colleagues (62), which included small numbers of women, found that high levels of hostility were significantly associated with severity of coronary atherosclerosis. Thus, available data suggest a positive association between hostility and adverse health outcomes among women. Nevertheless, because gender differences in behavioral risk factors may differentially influence the association between hostility and health outcomes, additional studies that include female participants are needed to more fully evaluate the relations among hostility, behavior, morbidity, and mortality.

To our knowledge, no prior studies on hostility and morbidity and mortality outcomes have included a large enough sample of minority participants to warrant separate analyses according to race or ethnicity. It has been reported that blacks, particularly those of low socioeconomic status, have higher self-reported levels of hostility than whites or people of higher socioeconomic status (15). It is unknown whether this racial

difference has any impact on the association between hostility and health outcomes. However, it is plausible that the socioeconomic patterning of behavioral and psychosocial risk factors and resultant inequalities in health, which are equally evident among women and men (17, 63), may be more pronounced among minority populations because of the larger proportion of minorities who are socioeconomically disadvantaged; and this may in turn influence the hostility-health relation.

Our study had a relatively short follow-up time of 9 years. With longer follow-up and repeated behavioral assessments, we will be able to determine whether changes or fluctuations in behavioral characteristics influence the relations between hostility and mortality and myocardial infarction. This is an important consideration for future research given that health promotion guidelines (e.g., *Healthy People 2000*) (64) largely focus on changing behavior as a means of improving health.

In sum, this study contributes important epidemiologic evidence to the literature on the adverse health effects of hostility and strongly suggests that these effects are mediated primarily through behavioral risk factors. Future research should focus on the important socioeconomic determinants of these associations and explore the relations among hostility, behavior, and health outcomes in populations of women and minorities.

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