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# Hostility, Coronary Heart Disease, and Total Mortality: A 33-Year Follow-Up Study of University Students

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*Hostility as measured by the Cook–Medley Hostility (HO) Scale on the Minnesota Multiphasic Personality Inventory has been suggested as a risk factor for coronary heart disease (CHD) and total mortality. This study tested the HO–CHD hypothesis in a sample of 1399 men who entered the University of Minnesota in 1953 and, as part of freshman orientation, completed the MMPI. Current health status was ascertained for 94% of the sample through telephone interviews 33 years later. Higher HO scores did not predict CHD mortality, CHD morbidity, or total mortality either before or after adjustment for baseline risk factors. Among the plausible explanations for these results are that (1) hostility is not a risk factor in all populations, (2) the HO scale at age 19 does not assess a stable psychological characteristic, or (3) the HO scale is not an adequate measure of hostility.*

**KEY WORDS:** hostility; coronary heart disease; mortality; Cook–Medley Hostility Scale.

## INTRODUCTION

Two separate lines of research have identified hostility as a potential risk factor for coronary heart disease (CHD). The first has focused on hostility

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as a component of the Type A behavior pattern (TABP), where several studies have found hostility to be highly predictive of CHD outcomes (Jenkins *et al.*, 1966; Matthews *et al.*, 1977; Dembroski *et al.*, 1985; MacDougall *et al.*, 1985). Hostility has also been studied apart from its relationship to TABP in studies which used as a measure of hostility the Cook–Medley (1954) Hostility (HO) Scale derived from the Minnesota Multiphasic Personality Inventory (MMPI). In one cross-sectional and three prospective studies, high levels of HO were associated with increased CHD incidence and mortality independent of other risk factors (Williams *et al.*, 1980; Barefoot *et al.*, 1983; Shekelle et al., 1983; Barefoot *et al.*, 1987). Two studies have failed to support these findings (McCraine *et al.*, 1986; Leon *et al.*, 1988). Most of these studies have been conducted in small or highly selective samples and have been weakened by low response rates. This study tested the HO–CHD relation in a more general population and achieved a much higher follow-up rate.

## METHODS

*Design.* A retrospective cohort design was used to test the HO–CHD hypothesis in a sample of college-age MMPI respondents ($N = 1399$) followed over a 33-year period. MMPI data were collected in 1953 and a follow-up telephone survey for health and vital status was conducted in 1985–1986. A case-control study was conducted within the cohort study in order to examine the relationship between HO and CHD in the presence of traditional CHD risk factors measured in 1953. Based on the information obtained through the tracking and telephone survey, the sample was defined for the smaller case-control study. Cases were those who had died and those who had a history of CHD ($N = 110$). From those remaining ($N = 1174$), an equal number of healthy controls ($N = 110$) was randomly chosen within strata of the HO scale in order to match that distribution in the larger sample.

*Sample.* Potential subjects included those men who entered the University of Minnesota in 1953 and, as part of freshman orientation, completed the MMPI. MMPI data were located for 1408 men. According to admissions records for new freshmen at the close of the second week of class, this sample included over 90% of new male registrants in the School of Liberal Arts and the Institute of Technology in 1953. The mean age was 18.9 years (SD = 2.0 years). The vast majority graduated from public high schools in Minnesota. University admissions standards for 1953 suggest that they all ranked above the fortieth percentile on an average of high-school class rank and a college aptitude test.

*Baseline Methods and Measures.* Freshmen completed the MMPI at the time of college orientation in the context of a mass testing involving other personality and achievement measures. MMPI item responses were combined to yield scores on the 50-item HO scale as well as the major validity and clinical scales of the MMPI.

The university also required a physical examination of all entering students. From the 1953 medical record, data were abstracted for the case-control sample regarding (1) evidence of family history of CHD (death due to CHD before age 60 years in either of the parents; history of stroke, hypertension, and CHD in parents or other relatives) and (2) evidence of risk factors in the subject (tobacco use; hypertension).

*Follow-Up Methods and Measures.* Extensive tracking methods were employed to locate these men 33 years later. Primary resources included university records and drivers license bureaus. For subjects not located through either of these methods, a more individualized approach was used. Resources included high school records, former places of employment, former neighbors, the military, and high-school and college classmates.

A telephone survey was conducted over a 9-month period in 1985–1986 of subjects located through the tracking procedure. Information regarding current and past levels of cigarette use, history of hypertension and high cholesterol, history of CHD events, and family history of CHD was self-reported from the telephone interview.

If a survey respondent reported a history of CHD events (myocardial infarction, angina, stroke, or coronary artery bypass surgery), medical records were obtained a verify the diagnosis. Diagnosis of the CHD events was coded into one of four groups: (1) definite CHD; (2) probable CHD; (3) possible CHD; and (4) some other disease, not CHD. Placement into Group 1 was based on information in the medical records which detailed a history of a myocardial infarction or enzyme changes indicative of a myocardial infarction, an angiogram which documented coronary disease, or history of coronary artery bypass surgery. For those in Group 2, there was documentation from a physican which indicated a history of CHD, although the definitive diagnostic information was not present in the medical record. In Group 3, there was suspected CHD, but the medical records did not provide confirming evidence. For those in Group 4, there was evidence of disease other than CHD. Only those in Group 1 and 2 were included in the CHD morbidity analyses.

For those found to be deceased, the underlying cause of death was coded from the death certificate according to the Ninth Revision of the International Statistical Classification of Diseases (ICD-9). Deaths were categorized into one of four groups: CHD (ICD-9 410-414, 427); cancer (ICD-9 147-204); accidents, suicides, and homicides (ICD-9 E812-E994); and all other causes.

## RESULTS

### Tracking and Classification of Subjects for CHD and Death

Of the 1408 men for whom 1953 MMPI data were found, 9 were excluded for missing more than four items on the HO scale. Information on vital status was ascertained for 93.9% (1313/1399) of the sample. This group constitutes the analysis sample for the study. Of those, 1205 completed the survey, 69 were found to be deceased, and 39 were either unwilling or unable to respond. Of those who completed the survey, 59 reported a history of CHD. After reviewing the medical records, 41 of those were categorized as either definite or probable CHD. Of the 69 deaths, 13 were attributable to CHD; 13 to cancer; 27 to accidents, suicides, and homicides; and 16 to other causes.

### Follow-Up Demographics

The mean age at follow-up was 52.3 years (SD = 2.0 years). The mean age at death was 40.4 years (SD = 10.5 years). Data from both the telephone survey and the death certificates reveal a highly educated sample, most of whom (65%) were pursuing professional or managerial careers. With regard to educational status, 74% had completed at least 4 years of college and 30% had obtained at least one graduate or professional degree.

### HO Scores

Scores of sample members ranged from 2 to 46. The average HO score for the sample was 17.2 (SD = 7.8), with a median of 16. These values are higher than any of the HO studies to date but most comparable to those found by Shekelle *et al.* (1983). The 1st, 50th, and 99th percentile values were 3, 16, and 37 points, respectively.

### Sample Attrition

An examination of those lost to follow-up showed that, although those never located were significantly older at baseline (19.6 vs. 18.9; $t = -2.80$, $p = .01$), there was no significant difference in the mean HO scores of those not found and those included in the analyses (16.5 vs. 17.2 $t = 0.76$, $p =$

**Table I.** Combined Incidence of CHD Events and CHD Death, According to Level of Hostility Score

| Hostility score | | | No. at | CHD incidence | |
|---|---|---|---|---|---|
| Min. | Max. | Mean | risk | No. | % |
| 2 | 11 | 8 | 337 | 12 | 3.6 |
| 12 | 16 | 14 | 333 | 14 | 4.2 |
| 17 | 22 | 20 | 322 | 16 | 5.0 |
| 23 | 46 | 28 | 321 | 12 | 3.7 |
| Total | | 17 | 1313 | 54 | 4.1 |

$\chi^2 = 0.98$, df = 3, $p = .81$

.45). Similarly, there was no difference in the mean HO scores between those who completed the survey and those who refused (17.2 vs. 16.4; $t = 0.67$; $p = .50$).

## Cohort Study

*CHD Mortality and Morbidity.* Table I presents the combined incidence of CHD events and deaths due to CHD according to level of hostility score. CHD was the cause of 13 deaths and 41 respondents had a documented history of myocardial infarction or coronary artery disease, confirmed by medical records. HO scores were not associated with CHD incidence ($\chi^2 = 0.98$, df = 3, $p = .81$). The CHD incidence density (Kleinbaum *et al.,* 1982) was 1.3 per 1000 person-years of follow-up for those with HO scores above the sample median and 1.2 per 1000 person years of follow-up for subjects at or below the median. This yielded an incidence density ratio of 1.1 ($Z = .43$, $p = .33$).

To test whether hostility may have a different effect on those who suffered, but did not die, from a CHD event, another analysis was done excluding all deceased subjects. Again, there were no significant differences among the groups ($\chi^2 = 1.72$, df = 3, $p = .63$). Nor was any relationship observed after adjustment for self-reported baseline CHD risk factors using logistic regression; the logistic coefficient for the HO scale was 0.0252 ($Z = 1.235$, $p_{1\text{-tailed}} = .12$).

*Mortality.* There were no significant differences among the hostility quartiles for deaths due to CHD, to cancer, or to accidents, suicides, and homicides or for total mortality in the crude analyses (Table II). The total mortality density (Kleinbaum *et al.,* 1982) for those with HO scores above the sample median was 1.8 per 1000 person-years of follow-up, compared to 1.5 per 1000 person-years of follow-up for subjects at or below the medi-

**Table II.** Thirty-Three-Year Cause-Specific and Total Mortality According to Level of Hostility

| Hostility score | | | No. at | Coronary heart disease | | Cancer | | Accidents, suicides, and homicides | | Total mortality | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Min. | Max. | Mean | risk | No. | % | No. | % | No. | % | No. | % |
| 2 | 11 | 8 | 337 | 5 | 1.5 | 2 | 0.6 | 8 | 2.4 | 19 | 5.6 |
| 12 | 16 | 14 | 333 | 2 | 0.6 | 3 | 0.9 | 6 | 1.8 | 13 | 3.9 |
| 17 | 22 | 20 | 322 | 6 | 1.9 | 6 | 1.9 | 6 | 1.9 | 25 | 7.8 |
| 23 | 46 | 28 | 321 | 0 | 0.0 | 2 | 0.6 | 7 | 2.2 | 12 | 3.7 |
| Total | | 17 | 1313 | 13 | 1.0 | 13 | 1.0 | 27 | 2.1 | 69 | 5.3 |
| | | | | $\chi^2 = 7.07$<br>$p = 7.07$ | | $\chi^2 = 3.51$<br>$p = .32$ | | $\chi^2 = .36$<br>$p = .95$ | | $\chi^2 = 6.87$<br>$p = .08$ | |
| Proportional hazards regression coefficient for HO score, age held constant | | | | −.044 | | .026 | | −.014 | | −.006 | |
| $Z$ | | | | −1.122 | | .743 | | −.569 | | −0.354 | |
| $P$ (1-tailed) | | | | .87 | | .23 | | .72 | | .64 | |
| Log-likelihood-ratio $\chi^2$ (df = 1) | | | | 1.34 ($p = .25$) | | .54 ($p = .46$) | | .33 ($p = .57$) | | .13 ($p = .72$) | |

and ($Z = .78, p = .22$). These associations persisted in Cox-model analyses, adjusting for age, as shown by the regression coefficients and likelihood-ratio chi-squares for the HO scale found in Table II.

## Case-Control Study

*Baseline Risk Factors.* Health data abstracted from the 1953 medical record indicated that the prevalence of the traditional CHD risk factors—cigarette use, hypertension, and family history of CHD—was higher among cases than controls. Analysis of the baseline risk factors according to the level of HO scores showed HO to be unrelated to any of the factors (Table III).

*CHD and Total Mortality.* Baseline health data (except age) coded as (0) no and (1) yes and HO score were entered into a Cox model. Hypertension was defined as a diastolic blood pressure greater than 90 mm Hg. The results are presented in Table IV. While hypertension and family history of CHD were significantly related to death from CHD, HO was not related to survival after adjustment for the other risk factors as shown by the regression coefficients and the log-likelihood chi-squares. Similarly, HO was not related to all-cause mortality.

*CHD Incidence and Morbidity.* HO was also unrelated to combined CHD mortality and morbidity and CHD morbidity alone in multivariate logistic regression analyses. The logistic coefficient for combined CHD incidence was .0119 ($Z = .5302$, $p_{1\text{-tailed}} = .30$) and that for CHD morbidity alone was .02883 ($Z = 1.159$, $p_{1\text{-tailed}} = .13$).

## Replication of Previous Analyses

Because these findings differed from those of several previous studies, further analyses were performed. First, to investigate the possibility that these results may be due to a differing hostility score distribution, the cohort analysis sample was divided into the quartile categories employed by Barefoot *et al.* (1983) and the quintile categories employed by Shekelle *et al.* (1983). As Table V suggests, the analyses of CHD morbidity and mortality using these cutpoints did not alter the results ($\chi^2 = 0.37$, df $= 3, p = .95$, for the Barefoot *et al.* quartiles and $\chi^2 = 0.48$, df $= 4, p = .98$, for the Shekelle *et al.* quintiles).

Second, in order to examine the hypothesis of Williams *et al.* (1980) and replicate the findings of Shekelle *et al.* (1983) that men with HO scores greater than 10 would be at a greater risk for CHD than men with HO scores less than 10, another multiple logistic regression was performed in the case-

**Table III.** Baseline Risk Factors Among Cases and Controls According to Level of Hostility Score

| | Hostility score | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2–11 ($N$ = 56) | | 12–16 ($N$ = 50) | | 17–22 ($N$ = 63) | | 23–46 ($N$ = 51) | | Total ($N$ = 220) | | |
| Baseline risk factor | No. | % | No. | % | No. | % | No. | % | No. | % | $p$ value |
| Mean value for age | 19.3 | | 19.4 | | 19.1 | | 19.0 | | 19.2 | | .81[a] |
| Cigarette use | 17 | 33.3 | 13 | 27.7 | 22 | 35.5 | 15 | 33.3 | 67 | 32.7 | .85[b] |
| Hypertension (diastolic ≥90 mm Hg) | 2 | 3.9 | 5 | 10.6 | 7 | 11.3 | 4 | 8.9 | 18 | 8.8 | .53[b] |
| Family history of CHD | 26 | 51.0 | 22 | 46.8 | 34 | 54.8 | 20 | 44.4 | 102 | 49.8 | .72[b] |

[a]Determined from $F$ ratio with 3 and 216 df.
[b]Determined from chi-square with 3 df.

**Table IV.** Coefficients for the Cox Regression of CHD and Total Mortality

| Variable | CHD mortality | | | | Total mortality | | | |
|---|---|---|---|---|---|---|---|---|
| | Coefficient | SE | $Z$ | $p_{(1\text{-tailed})}$ | Coefficient | SE | $Z$ | $p_{(1\text{-tailed})}$ |
| HO score | −.069 | .044 | −1.566 | .94 | −.012 | .016 | −.747 | .77 |
| Age | .070 | .088 | .792 | .22 | −.026 | .054 | −.485 | .69 |
| Cigarette use | .744 | .573 | 1.300 | .10 | .001 | .265 | .003 | .50 |
| Hypertension | 1.394 | .726 | 1.921 | .03 | .634 | .367 | 1.726 | .04 |
| Family history of CHD | 1.985 | .778 | 2.551 | .01 | .377 | .245 | 1.535 | .07 |
| | Likelihood-ratio $\chi^2 = 2.63$, df = 1, $p = .10^a$ | | | | Likelihood-ratio $\chi^2 = .56$, df = 1, $p = .45^a$ | | | |

[a]The chi-square and corresponding $p$ value resulted from a test of the difference of log-likelihoods under the full model (all variables) and the restricted model (all variables except HO score).

**Table V.** Combined Incidence of CHD Events and CHD Death, According to Level of Hostility Score Defined in the Barefoot *et al.* (1983) and Shekelle *et al.* (1983) Studies

| Barefoot *et al.* (1983) | | | | | Shekelle *et al.* (1983) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Hostility score | | No. at | CHD incidence | | Hostility score | | No. at | CHD incidence | |
| Min. | Max. | risk | No. | % | Min. | Max. | risk | No. | % |
| 2 | 8 | 170 | 6 | 3.5 | 2 | 8 | 170 | 6 | 3.5 |
| 9 | 13 | 293 | 12 | 4.1 | 9 | 12 | 233 | 10 | 4.3 |
| 14 | 17 | 264 | 10 | 3.8 | 13 | 17 | 324 | 12 | 3.7 |
| 18 | 46 | 586 | 26 | 4.4 | 18 | 23 | 324 | 14 | 4.3 |
| | | | | | 24 | 46 | 262 | 12 | 4.6 |
| Total | | 1313 | 54 | 4.1 | | | 1313 | 54 | 4.1 |
| $\chi^2 = .37$, df = 3, $p = .95$ | | | | | $\chi^2 = .48$, df = 4, $p = .98$ | | | | |

control sample with the baseline CHD risk factors and with the HO scale coded as (1) HO $\leq$ 10 and (0) HO $>$ 10. The logistic coefficient for HO was .0823 ($Z = .413$, $p_{1\text{-tailed}} = .34$). Thus, the adjusted relative odds of CHD for men with HO scores $\leq$10 was essentially no different for those men with HO scores $>$10: exp (.0823) = 1.08.

Third, since positive results have been seen in samples of physicians (Barefoot *et al.*, 1983) and lawyers (Barefoot *et al.*, 1987), the analyses were repeated restricting the analysis sample to that portion in professional occupations ($N = 465$). HO scores were unrelated to CHD mortality ($\chi^2 = 2.13$, df = 3, $p = .55$), total mortality ($\chi^2 = 4.81$, df = 3, $p = .19$), combined incidence of CHD morbidity and mortality ($\chi^2 = 1.18$, df = 3, $p = .76$), and CHD morbidity ($\chi^2 = 2.03$, df = 3, $p = .57$).

Finally, in order to investigate the possibility that some subsets of HO items are more strongly related to survival than others, as suggested by Barefoot *et al.* (1987, 1988), the predictive validity of six HO item subsets rationally defined by Barefoot *et al.* (1988) was tested. In separate Cox models controlling for age, none of these subsets (Cynicism, Hostile Attribution, Hostile Affect, Aggressive Responding, Social Avoidance, Other, and a combination of the subsets of Cynicism, Hostile Affect, Aggressive Responding) was a significant predictor of survival.

## DISCUSSION

The findings of this study do not support the hypothesis that hostility is related to CHD outcomes or mortality. The univariate analyses found that higher scores on the Cook-Medley (1954) Hostility (HO) scale did not predict CHD incidence, CHD death, or total mortality in this sample. For those for whom baseline health data were obtained, HO was unrelated to any outcome in multivariate analyses which controlled for baseline CHD risk factors.

To interpret the findings in light of previous studies, several possible explanations for the results may be considered: (1) the nature of the sample,

(2) statistical power, (3) low base rates, (4) sample attrition, (5) the collection and specification of outcome variables, (6) the distribution of HO scale scores in the sample, (7) MMPI testing procedures, (8) the stability of the HO scale measure over time, and (9) construct validity of the HO scale.

## The Nature of the Sample

Positive findings have been seen prospectively in samples of physicians (Barefoot *et al.,* 1983), lawyers (Barefoot *et al.,* 1981), and men employed in the Midwest (Shekelle *et al.,* 1983). Negative findings have been seen in physicians (McCranie *et al.,* 1986), business and professional men (Leon *et al.,* 1988), and now in former students at a Midwestern university. These groups may have differed on one or more risk factors for CHD or on some other characteristic such as education, socioeconomic status, life events, or other personality traits. Such factors may influence the effect of hostility on CHD outcomes, either potentiating deleterious outcomes or protecting the individual from disease. The disparate findings may thus be a result of odd selection factors. Unfortunately, there are no clues at present to suggest what that selection bias might be.

## Statistical Power

In those studies where a positive relationship was found between HO and CHD, the relative risks for those high on HO have ranged from 5.0 (Barefoot *et al.,* 1983) to 4.14 (Barefoot et al., 1987) to 1.42 (Shekelle *et al.,* 1983). Conditional on the number of events observed, this study had 90% power at an alpha of .05 to detect a twofold increase in risk between the lower and the upper halves of the HO distribution for all-cause mortality and 82% power for CHD incidence (Fleiss, 1981). If the true relative risk is higher, then the study had an even greater chance of detecting a significant difference, had any existed. Thus, the present results cannot be dismissed on the basis of a lack of statistical power.

## Low Base Rates

Separate from the issue of statistical power is the problem of low base rates of death and morbidity in these studies. Particularly in the younger populations (Barefoot *et al.,* 1983, 1987; McCranie *et al.,* 1986; and this study), the proportions of death and CHD events are relatively small (less than 12% of the sample for total mortality; less than 5% for CHD deaths; less than 6% for CHD events). Meehl and Rosen (1955) conclude that when base rates of the criterion deviate greatly from 50%, the use of a test of predict the criterion

may not improve classification. That is, the test will have difficulty doing better in predicting the outcome than would classification solely in terms of base rates alone. Had the sample in this study had a higher base rate (e.g., an older sample), the accuracy of the HO scale as a predictor might have been treater.

## Sample Attrition

A potential problem in studies involving long follow-up periods is attrition of the study population. In previous HO-CHD studies, approximately one-quarter of the eligible population was not included in the final analyses. In this research, only 6% of the original sample was lost to follow-up. Thus, it is the previous studies which may be at greater risk from differential attrition than the one described here.

## Collection and Specification of Outcome Variables

To minimize the possibility of misclassification bias in this study, self-reported diagnoses of CHD were confirmed through a review of medical records in order to eliminate the inaccuracy inherent in self-reported data. Still, follow-up medical data were not collected for everyone in the sample. Respondents who had a history of CHD but did not report it were not uncovered. Another source of misclassification could have occurred with the coding of cause of death from death certificates. Because autopsy data were not available, the true cause of death could have been inaccurately specified on the death certificate. The sources of misclassification and the resulting threats to the findings are shared by all the HO-CHD studies which have relied on self-report and death certificate data. It is important to recognize, however, that the potential threat from this problem is greatest in those studies with particularly small sample sizes. When very few subjects are defined as cases (those deceased or those who had experienced a CHD event), then misclassification of even a few cases could have a dramatic effect on the results.

## Distribution of HO Scale Scores in the Sample

Prior to this study, differences in mean levels of HO scores across the different study populations were considered a possible explanation of the disparate results. Until this study, the positive findings were seen in studies with the highest range of HO scores. This led to the possibility that negative results were a consequence of a range truncation in the HO measure. In the present sample, however, HO scores covered nearly the entire range of the scale, with the highest mean of all the studies to date. Further, additional analyses replicating the score groupings in the other studies failed to find an associa-

tion between HO and any of the outcome variables. The HO scale score distribution therefore cannot be used to account for the negative findings here.

## MMPI Testing Procedures

The circumstances of the administration of the MMPI have also varied across studies: (1) as part of medical school training (Barefoot *et al.,* 1983), (2) as part of the medical-school admissions process (McCranie *et al.,* 1986), (3) as part of prospective studies of CHD (Shekelle *et al.,* 1983; Leon *et al.,* 1988), and (4) as part of college freshman orientation (present study). Since it is clear that the procedures were not standardized and it is well established that testing conditions can influence the item responses, we cannot assume that the measure of hostility is the same across examining conditions. While it has been demonstrated that the place in which the MMPI is administered has little effect on the subject's responses, there is an important interaction between aspects of the testing situation such as the stated purpose of the testing and the motivation and needs of the individual test subjects (Dahlstrom *et al.,* 1975). Such individual by setting interactions may explain some of the varied results.

To investigate the possibility that test-taking attitude may have influenced the present study's results, additional analyses were conducted using the MMPI validity scales. The mean raw score on the L scale was 3.4 (SD = 2.1; range, 0 to 11), that on the F scale was 3.6 (SD = 2.8, range, 0 to 23), and that on the K scale was 15.8 (SD = 4.8; range, 2 to 28). The mean F–K raw index score was −12.2 (SD = 6.4; −28 to 12). All of these are within normal range for this population (Graham, 1987).

Because elevated scores on the L, F, or K scale can indicate a deviant test-taking attitude that may produce invalid MMPI scores, the HO–outcome analyses were repeated eliminating respondents with standardly accepted extreme values on the L, F, and K scales (see Graham, 1987): those with L scores greater than or equal to a raw score of 10 ($N = 11$), those with K scores greater than or equal to a raw score of 23 ($N = 103$), and those with F-score values greater than or equal to a raw score of 12 ($N = 25$). The study findings were unchanged.

HO scores were significantly inversely related to K scores: $r = -.80$, $p < .01$. To determine whether subject defensiveness may have affected the results, the presence of an interaction among HO scores, K scores, and CHD incidence or total mortality was tested in separate log-linear models with HO and K scores divided at the median. No significant three-way interaction was found for either outcome ($\chi^2_{\text{interaction}} = .01$, df = 1, $p = .93$ for CHD incidence; $\chi^2_{\text{interaction}} = .64$, df = 1, p = .42 for total mortality). Thus, test-taking attitude does not appear to have obscured the HO–outcome relationships in this sample.

## The Stability of the HO Measure Over Time

There is little evidence on the consistency of HO scores on different occasions: only two studies have reported test-retest data (Barefoot *et al.*, 1983; Shekelle *et al.*, 1983). Although the reliability coefficients were high (.85 and .84) and generated from different age groups (25 and 47 years), the data were collected over short time periods (one and four years).

The average age and life circumstance of subjects at the time the MMPI was given in the HO-CHD studies varied appreciably. The study samples represent mean ages of 19 (the present study), 22 (McCranie *et al.*, 1986), 25 (Barefoot *et al.*, 1983), 45 (Leon *et al.*, 1988), and 47 (Shekelle *et al.*, 1983) years. For this study, the sample represents the earliest age when the MMPI was taken, 19 years, a time of life when adult career and family patterns are not settled. Since there is evidence that college attendance affects an individual's psychological development (Feldman and Newcomb, 1973), it is possible that the construct being measured by the HO scale at age 19 years is quite different from that 33 years later. Thus, it may be that the HO score obtained in this study did not reflect the same construct as it might have at a later time.

## The Construct Validity of the HO Scale

In addition to concerns regarding the reliability of the HO scale, several researchers have questioned whether the HO scale is an appropriate measure of hostility. Items on the HO scale were chosen originally on the basis of manifest content and discrimination between teachers with good versus poor rapport with students as defined by the Minnesota Teacher Aptitude Inventory (MTAI). MMPI items that empirically discriminated the poor teacher were submitted to clinical psychologists who sorted them into two scales: pharisaic-virtue and hostility. On the basis of interrater agreement, the 50-item HO scale was constructed. Cook and Medley (1954) concluded that the HO scale reveals an individual characterized by a "dislike for and distrust of others" who sees people as "dishonest, unsocial, immoral, ugly and mean and believes they should be made to suffer for their sins. Hostility amounts to chronic hate and anger" (pp. 417-418). The intent of the developers was for the scale to be used in personnel selection and in counseling people who needed to interact effectively with groups. Now it is being used to measure a characteristic thought to be predictive of CHD outcomes.

In the research on hostility and health consequences, there is a great deal of ambiguity surrounding the definition of hostility and how to measure it. Hostility is thought to involve many different facets of personality and behavior—direct and indirect aggression, negativism, animosity, chronic hate, and anger (Chesney and Rosenman, 1985). There is no evidence that

the HO scale adequately assesses each of these dimensions. The results of factor analytic work and validity studies suggest that the HO scale measures a specific type of hostility characterized by cynicism, resentment, and suspicion (see Costa *et al.*, 1985, 1986; Smith and Frohm, 1985; Johnson *et al.*, 1984).

In this study's sample, the full HO scale was positively correlated with the MMPI clinical scale for Hypochondriasis, Psychopathic Deviate, Psychasthenia, Schizophrenia, Hypomania, and Social Introversion and negatively correlated with Hysteria and Paranoia. Correlations with MMPI factor scales defined by Costa *et al.* (1985) showed HO in this sample to be substantially related to the scales of Neuroticism, Psychoticism/Infrequency, Somatic Complaints, Inadequacy, and Cynicism. This pattern of associations exactly parallels that previously found by Costa *et al.* (1986). Since the MMPI clinical scales and the factor scale of Neuroticism have been shown not to be predictive of CHD (Gillum *et al.*, 1980; Costa, 1986) and since the present study found HO scores to be closely related to these scales, the absence of a relationship between HO and CHD in this study was unsurprising.

## FUTURE RESEARCH

It would be inappropriate to conclude on the basis of these findings that hostility does not confer a risk for CHD. However, these results, placed in the context of other research, do raise concerns regarding the robustness of the hostility hypothesis and the use of the Cook–Medley (1954) Hostility (HO) Scale to assess hostility.

Additional research is needed to determine the consistency of HO scores over time. This would provide evidence of the long-term stability of the scale attributes and greatly strengthen any interpretation that the attributes relate prospectively to CHD outcomes. In studies which use the HO scale, conditions of testing should be standardized so that the results will be comparable and measurement errors minimized. Further, caution must be used in establishing threshold HO scale scores for high and low CHD risk. Data from a randomly drawn community sample (Colligan and Offord, 1988) show a mean HO score for men of 19.6, a mean higher than found in any HO–CHD risk study. If the cut points for high HO proposed in earlier studies [$\geq 11$ by Williams *et al.* (1980), $\geq 14$ by Barefoot *et al.* (1983)] are applied to this normative sample, then 70 to 90% fall into the high CHD risk category, a figure disproportionate to the observed CHD incidence and prevalence rates. Thus, the specificity of the HO scale becomes very poor; the likelihood is great that those defined as high on HO will be free of disease.

To further our understanding and assessment of hostility, additional research on the reliability and validity of the HO scale is critical. More data are needed to determine the consistency of HO scores over time. This would

provide evidence of the long-term stability of the scale attributes and greatly strengthen any interpretation that the attributes relate prospectively to health outcomes. Of fundamental importance is the adequacy of the HO scale to assess the hostility construct. The HO scale appears to reflect only certain dimensions of hostility, namely, cynical distrust, suspicion, and resentment. Also, given its high correlations with measures of psychopathology, the HO scale may reflect a particularly unhealthy profile. Further, the HO scale may contain items associated with dissimilar and irrelevant constructs such as neuroticism. A test of the predictive validity of the HO scale for health outcomes does not, therefore, comprise a test of the predictive validity of the hostility construct. Other measures are necessary to comprehensively address the hostility–CHD hypothesis. It would be advisable to include in future CHD studies multiple measures of hostility in order to develop and validate better assessment techniques. Until this is done, the true association between hostility and CHD will not be detectable.

## REFERENCES


Barefoot, J. C., Dahlstrom, W. G., and Williams, R. B. (1983). Hostility, CHD incidence, and total mortality: A 25-year follow-up study of 255 physicians. *Psychosom. Med.* 45: 59-63.

Barefoot, J. C., Williams, R. B., Dahlstrom, W. G., and Dodge, K. A. (1987). Predicting mortality from scores on the Cook-Medley Scale: A follow-up study of 118 lawyers. *Psychosom. Med.* 49: 210.

Barefoot, J. C., Dodge, K. A., Peterson, B. L., Dahlstrom, W. G., and Williams, R. B. (1988). The Cook–Medley hostility scale: Item content and ability to predict survival (unpublished manuscript).

Chesney, M. A., and Rosenman, R. H. (1985). *Anger and Hostility in Cardiovascular and Behavioral Disorders,* Hemisphere, Washington, D.C.

Cook, W. W., and Medley, D. M. (1954). Proposed hostility and pharisaic-virtue scales for the MMPI. *J. Appl. Psychol.* 38: 414-418.

Colligan, R. C., and Offord, K. P. (1988). The risky use of the MMPI hostility scale in assessing risk for coronary heart disease. *Psychomatics,* 29: 188-196.

Costa, P. T. (1986). Is neuroticism a risk factor for CAD? Is Type A measure of neuroticism? In Schmidt, T., Dembroski, T., and Blumchen, G. (ed.), *Biological and Psychological Factors in Cardiovascular Disease,* Springer-Verlag, New York.

Costa, P. T., Zonderman, A. B., McCrae, R. R., and Williams, R. B. (1986). Cynicism and paranoid alienation in the Cook and Medley HO Scale. *Psychosom. Med.* 48: 283-285.

Costa, P. T., Zonderman, A. B., McCrae, R. R., and Williams, R. B. (1985). Content and comprehensiveness in the MMPI: An item factor analysis in a normal adult sample. *J. Personal. Soc. Psychol.* 48: 925-933.

Dahlstrom, W. G., Welsh, G. S., and Dahlstrom, L. E. (1975). *An MMPI Handbook. Vol. II. Research Applications,* University of Minnesota, Minneapolis.

Dembroski, T. M., MacDougall, J. M., Williams, R. B., Hanley, T. L., and Blumenthal, J. A. (1985). Components of Type A, hostility, and anger-in: Relationship to angiographic findings. *Psychosom. Med.* 47: 219-233.

Feldman, K. A., and Newcomb, T. M. (1973). *The Impact of College on Students, Vol. I,* Jossey-Bass, San Francisco.

Fleiss, J. L. (1981). *Statistical Methods for Rates and Proportions,* John Wiley & Sons, New York.

Gillum, R., Leon, G. R., Kamp, J., and Becerra-Aldama, J. (1980). Prediction of cardiovascular and other disease onset and mortality from 30-year longitudinal MMPI data. *J. Consult. Clin. Psychol.* 48: 405-506.

Graham, J. (1987). *The MMPI: A Practical Guide,* Oxford University Press, New York.

Jenkins, C. D., Rosenman, R. H., and Friedman, M. (1966). Components of the coronary-prone behavior pattern: Their relation to silent myocardial infraction and blood lipids. *J. Chron. Dis.* 19: 599-609.

Johnson, J. H., Butcher, J. N., Null, C., and Johnson, K. N. (1984). Replicated item level factor analysis of the full MMPI. *J. Personal. Soc. Psychol.* 47: 105-114.

Kleinbaum, D. G., Kupper, L. L., and Morgenstern, H. (1982). *Epidemiological Methods.* Wadsworth, Belmont, Calif.

Leon, G. R., Finn, S. E., Murray, D., and Bailey, J. M. (1988). The inability to predict cardiovascular disease from hostility scores or MMPI items related to Type A behavior. *J. Consult. Clin. Psychol.* 56: 597-600.

MacDougall, J. M., Dembroski, T. M., Dimsdale, J. E., and Hackett, T. P. (1985). Components of Type A, hostility, and anger-in: further relationship to angiographic findings. *Health Psychol.* 4: 137-152.

Matthews, K. A., Glass, D. C., Rosenman, R. H., and Bortner, R. W. (1977). Competitive drive, pattern A, and coronary heart disease: A further analysis of some data from the Western Collaborative Group Study. *J. Chron. Dis.* 30: 489-498.

McCranie, E. W., Watkins, L. O., Brandsma, J. M., and Sisson, B. D. (1986). Hostility, coronary heart disease (CHD) incidence, and total mortality: Lack of an association in a 25-year follow-up study of 478 physicians. *J. Behav. Med.* 9: 119-125.

Meehl, P. E., and Rosen, A. (1955). Antecedent probability and the efficiency of psychometric signs, patterns, or cutting scores. *Psychol. Bull.* 52: 194-216.

Shekelle, R. B., Gale, M., Ostfeld, A. M., and Oglesby, P. (1983). Hostility, risk of coronary heart disease, and mortality. *Psychosom. Med.* 45: 109-114.

Smith, T. W., and Frohm, K. D. (1985). What's so unhealthy about hostility? Construct validity and psychosocial correlates of the Cook and Medley HO Scale. *Health Psychol.* 4: 503-520.

Williams, R. B., Haney, T. L., Lee, K. L., Kong, Y., Blumenthal, J. A., and Whalen, R. E. (1980). Type A behavior, hostility, and coronary atherosclerosis. *Psychosom. Med.* 42: 539-549.