Original Contributions

THE MRFIT BEHAVIOR PATTERN STUDY

II. TYPE A BEHAVIOR AND INCIDENCE OF CORONARY HEART DISEASE

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Behavior pattern was assessed by interview for 3,110 men at eight centers in the Multiple Risk Factor Intervention Trial (1973–1976). The Type A pattern was not significantly associated with risk of first major coronary events (coronary death and definite nonfatal myocardial infarction) after a mean follow-up of 7.1 years. Crude relative risks for Types A1–A2 versus X-B were 1.08 in usual care, 0.82 in special intervention, and 0.92 overall. Adjustment for age, blood pressure, cigarette smoking, serum cholesterol, consumption of alcohol, and educational attainment yielded relative risks of 0.99 in usual care, 0.81 in special intervention, and 0.87 overall (95% confidence interval = 0.59–1.28). The Jenkins Activity Survey Type A score, obtained for 12,772 men at all 22 centers, was also not significantly associated with risk of first major coronary events. Overall, crude risks in the lowest (Type B) through highest (Type A) quintiles of the score's distribution were 5.0%, 4.4%, 4.0%, 4.3%, and 4.1%, respectively. The proportional hazards regression coefficient, adjusted for the variables listed above, was −0.006 (95% confidence interval = −0.015–0.003). These results raise questions regarding the robustness of the Type A hypothesis in its present form. Further studies are needed to investigate these questions and to evaluate the validity of procedures used to assess behavior patterns.

The Type A behavior pattern, manifested primarily by competitiveness, excessive drive, and enhanced sense of time urgency during a structured interview, was associ-
ated prospectively in the Western Collaborative Group Study with a twofold increase in risk of coronary heart disease compared with the Type B pattern (1, 2). A positive association with incidence of coronary heart disease was also observed when behavior pattern was assessed by a self-administered, machine-scored questionnaire, the Jenkins Activity Survey (3).

Although the weight of evidence supports an association between Type A and risk of coronary disease (4, 5), few prospective investigations of this hypothesis have been reported. In fact, the Western Collaborative Group Study is the only prospective study that has reported results based on assessments of behavior pattern made by the structured interview. More information, particularly from prospective epidemiologic studies, is needed to determine the consistency of this association in a variety of populations (6).

The authors thank Dorothy Amundsen, Joyce Graham, Susan Grube, Victoria Perez, Beth Shucker, Audrey Simberkoff, and Dorothy White for interviewing participants and auditing the recordings; Steven Broste for overseeing data management; Dr. Ray H. Rosenberg for his important contributions to all matters regarding assessments of behavior pattern; Drs. C. David Jenkins and Stephen J. Zyzanski for providing the procedure for scoring the Jenkins Activity Survey; and the participants for their cooperation.

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In view of these promising results and the importance of confirming relationships that might lead to further knowledge about causes and prevention of coronary heart disease, the Steering Committee of the Multiple Risk Factor Intervention Trial (MRFIT) decided in 1973 to conduct a prospective study of the behavior pattern hypothesis.

**Materials and methods**

MRFIT was a randomized primary prevention trial designed to test effects of multifactor intervention on risk of death from coronary heart disease in men who, at entry, were 35 to 57 years of age, had no clinical evidence of coronary disease, and had levels of cigarette smoking, serum cholesterol, and diastolic blood pressure sufficiently high to place them in the upper portion—initially the upper 15 per cent, subsequently the upper 10 per cent—of the distribution of a risk score derived from the Framingham Heart Study. Men were ineligible for MRFIT for any of the following reasons: serum cholesterol of 350 mg/dl or higher; diastolic blood pressure of 115 mmHg or higher; body weight greater than or equal to 150 per cent of desirable weight; diabetes mellitus requiring medication or untreated symptomatic diabetes; treatment with guanethidine, hydralazine, insulin, oral hypoglycemic agents, or lipid-lowering drugs; illnesses or disabilities likely to impair full participation in the trial; diets incompatible with the MRFIT food pattern; and intention to leave the clinic’s geographic area in the near future. Eligibility was determined at three successive screening visits. Various recruitment procedures were used, but the most common was voluntary screening of industrial and governmental employee groups. All participants were informed at the first as well as at subsequent screening visits of the randomized nature of the trial. Men accepted into MRFIT were randomly assigned to special intervention—a program comprising treatment for hypertension, counseling for cessation of cigarette smoking, and dietary advice for lowering blood cholesterol concentrations—or to usual care, i.e., referral to usual sources of health care. The numbers of men attending the first, second, and third screening visits were 361,662, 22,080, and 14,111, respectively; 12,866 were randomized into the trial. The first participant was randomized in December 1973 and the last on February 28, 1976. Details of the trial have been published (7).

Both the structured interview (8, 9) and the Jenkins Activity Survey (10) were used to assess behavior pattern at entry, but, in view of its cost, the structured interview was done at a limited number of clinics: four in Chicago and one each in Newark, New Jersey, Minneapolis, San Francisco, and Davis, California. Details regarding use of the structured interview in MRFIT have been published (9). Interviewers were trained centrally under the supervision of Dr. Ray H. Rosenman, Principal Investigator of the Western Collaborative Group Study, and were required to meet predetermined standards of performance before interviewing for MRFIT. The training sessions generally lasted five days and comprised lectures and demonstrations, practice with prerecorded materials, and interviews with volunteers. Following the training sessions, each trainee independently judged a standard set of 100 prerecorded interviews; at least 75 per cent agreement with Dr. Rosenman in judging major category was required for certification. In addition, each trainee interviewed 16 to 20 pilot participants, and Dr. Rosenman audited the recordings. At least 75 per cent agreement and a rating of "good" or better in interviewing technique—i.e., rapport with the participant, pace of the questions, emphasis of keywords, appropriateness of follow-up questions, tailoring questions in relationship to the subject’s manner of response, use of appropriate interruption, and skill on the delay question—were also required for certification. Twelve persons were selected to receive training, and six
were certified. In addition, two auditors also passed the procedures for certification.

Behavior pattern was judged on a four-point scale: A1, A2, X, and B. A1 indicated participants who exhibited most or all of the Type A characteristics—i.e., marked aggressiveness, competitiveness, ambitiousness, chronic sense of time urgency, tightening of facial muscles during the interview, gesturing with a clenched fist to emphasize points, interrupting the interviewer, hurrying the pace of speech, using an explosive manner of speech, and grimacing (8). A2, X, and B indicated decreasing levels of similarity to this pattern.

Interviews were recorded and sent to the MRFIT Coordinating Center. Information about behavior pattern was not retained at clinics. One or the other of two auditors at the San Francisco clinical center listened to each interview and recorded a second assessment of behavior pattern without knowledge of the interviewer's assessment. A statistical quality control procedure was used throughout the period of recruitment to ensure that the frequency of disagreement between each interviewer and the auditors in judging major category—A1-A2 versus X-B—remained below 20 per cent. All disagreements in major category that did occur were referred to Dr. Rosenman, who adjudicated the discrepancy. In addition, probability samples of all interviews were selected continuously throughout the period of recruitment for assessment by Dr. Rosenman. The assessment used in the present report was Dr. Rosenman's or, when that was not available, the auditor's. Interviewers were site-visited once by Dr. Rosenman and again by one of the auditors to provide additional training during the period of recruitment. Also, Dr. Rosenman and the auditors noted deficiencies in the technique of interviewing while listening to the recordings, and their suggestions for improvement were transmitted to the interviewers. This procedure was intended to provide corrective feedback, but its effectiveness was impaired by the delay of several weeks that occurred between the time an interview was done and the time it was audited by Dr. Rosenman.

Form B of the Jenkins Activity Survey (10)—a 54-item, self-administered, multiple choice, precoded, machine-scored questionnaire developed to predict interviewer assessment of behavior pattern in the Western Collaborative Group Study—was given at entry to participants at all 22 clinics. The Type A score, calculated at the MRFIT Coordinating Center according to directions supplied by Drs. Jenkins and Zyzanski, had been standardized in the Western Collaborative Group Study to distribute with mean of zero and standard deviation of 10 points. Positive scores indicated Type A responses, while negative scores indicated Type B responses.

All participants were followed through February 28, 1982—a period of six to eight years (mean = 7.1 years). Deaths were systematically ascertained by clinic staff, and cause of death was assigned by a three-member panel of cardiologists not associated with any MRFIT center. Neither this panel nor the clinic staff had access to assessments of behavior pattern.

Resting 12-lead electrocardiograms were obtained according to a standard protocol at entry and annual reexaminations. They were analyzed according to Minnesota coding criteria (11) by visual procedures and, independently, by computer. Disagreements for major Q wave codes (codes 1-1 and 1-2-1 to 1-2-7) were adjudicated by two cardiologists. Electrocardiograms exhibiting major Q waves were compared visually to tracings recorded at entry; those that also met criteria for clinically significant serial change were classified as indicating definite nonfatal myocardial infarction. All judgments were based solely on the electrocardiograms, without any other information about the participants.

The major purpose of the MRFIT Behavior Pattern Study was to investigate the hypothesis that men assessed as Type A (A1-A2) would have a higher incidence of
first major coronary events, i.e., coronary
death and definite nonfatal myocardial in-
farction, in comparison to those who were
not Type A (X-B). The hypothesis was
formulated in this way—Type A versus not
Type A—because it was most comparable
to the procedure used previously in the
Western Collaborative Group Study. Log-
linear models (12) were used to determine
whether the association between behavior
pattern and risk of coronary heart disease
differed among clinics or between special
intervention and usual care. In the event
that results in special intervention differed
from those in usual care, the protocol spec-
ified that the critical test would be in usual
care, since men in this group did not par-
ticipate in a systematic intervention pro-
gram and, therefore, would presumably be
more comparable to men participating in a
strictly observational study.
After MRFIT began, but prior to its ter-
mination and analysis of data, Haynes and
colleagues (13) found that the Framingham
Type A score was associated prospectively
with risk of coronary heart disease among
men employed in nonclerical white-collar
occupations but not among men employed
in clerical or blue-collar occupations. In
view of this result, the protocol was
amended to include the following subgroup
hypothesis: In men employed full-time in
managerial, professional, and technical oc-
cupations (Census Bureau (14) codes 1–
245), those characterized as A1-A2 would
have a higher incidence of first major cor-
onary events than those characterized as
X-B.

The two null hypotheses were tested us-
ing the chi-square statistic calculated from
a fourfold contingency table. The critical
value was set at the one-sided 5 per cent
level of significance. Proportional hazards
(Cox-type) regression models (15) were
used to investigate the association of Type
A to risk of first major coronary event after
adjustment for age at entry, diastolic blood
pressure, serum cholesterol concentration,
number of cigarettes smoked per day, num-
ber of alcoholic drinks consumed per day
(represented by two dichotomous variables:
none and more than two), and educational
attainment (also represented by two di-
chotomous variables: graduated from four-
year college and graduated from high school
but not from college). When Type A (A1–
A2) was compared with not Type A (X-B),
assessments of behavior pattern were rep-
resented in the multivariate model by a
single dichotomous variable which was
coded 0 for patterns X-B and 1 for patterns
A1-A2. In other analyses, the interview as-
sessments were represented by three dichotomous variables—X, A2, and A1—each
coded 0 if absent or 1 if present. The regres-
sion coefficients were used to estimate the
risk associated with the corresponding be-
behavior pattern relative to the risk for pat-
tern B.

In analyses of the Jenkins Activity Sur-
vey, the distribution of Type A scores was
divided approximately into quintiles in or-
der to examine trends in morbidity and
mortality. Univariate tests for linear trends
were performed using a procedure described
by Wood (16). In multivariate regression
analyses, the Type A score was entered as a
continuous variable.

RESULTS

Interview assessments of behavior pattern

Behavior pattern was assessed by inter-
view at entry at eight clinics for 3,110 (85.5
per cent) of 3,636 eligible men; 1,103 (35.5
per cent) were Type A1; 1,211 (38.9 per
cent) Type A2; 269 (8.6 per cent) Type X;
and 527 (16.9 per cent) Type B. For A1–A2,
electrocardiograms were obtained at the
first through seventh annual reexamina-
tions for, respectively, 96, 95, 94, 92, 92, 93,
and 87 per cent of eligible participants.
Corresponding figures for X-B were 96, 95,
94, 95, 95, 95, and 89 per cent. Vital status
was known for all but three men (one Type
A1 and two Type A2) when follow-up ended
on February 28, 1982.

As shown in table 1, the four categories
of behavior pattern were similar at entry
with respect to mean age and diastolic blood pressure. Mean concentration of serum cholesterol was 3–4 mg/dl lower in Type B than in other men. Mean number of cigarettes smoked per day was highest for Type A1 (22.4/day), lowest for Type B (17.9/day), and intermediate for Types A2 and X.

Analysis by log-linear models indicated that neither the interviewers nor the treatment groups differed significantly among themselves with respect to the relative odds of coronary heart disease associated with Type A. In this analysis, likelihood ratio chi-square statistics were calculated for three models. In model 1, $\chi^2 = 7.36$ with 12 df for all main effects, second-order interactions, and third-order interactions except for that third-order interaction corresponding to coronary disease by behavior pattern by interviewer. In model 2, $\chi^2 = 5.77$ with 7 df for all main effects, second-order interactions, and third-order interactions except for that third-order interaction corresponding to coronary disease by behavior pattern by treatment group. In model 3, $\chi^2 = 4.55$ with 6 df for all main effects, second-order interactions, and third-order interactions. The hypothesis that interviewers were homogeneous with respect to the relative odds of coronary disease associated with Type A was tested by subtracting model 3 from model 1 ($\chi^2 = 2.81$ for the partial association, df = 6, $p = 0.83$). The corresponding hypothesis for treatment groups was tested by subtracting model 3 from model 2 ($\chi^2 = 1.22$ for the partial association, df = 1, $p = 0.27$).

In usual care, risks of first major coronary events were virtually identical for Types A1-A2 and X-B—3.95 per cent and 3.65 per cent, respectively (crude relative risk = 1.08, $\chi^2 = 0.070$, df = 1, $p = 0.40$ one-tailed). After adjustment by Cox-type regression analysis for age, diastolic blood pressure, serum cholesterol concentration, cigarettes, consumption of alcohol, and educational attainment, the adjusted relative risk was 0.99 with 95 per cent confidence interval = 0.54–1.81. In special intervention, the crude and adjusted relative risks were, respectively, 0.82 and 0.81 (95 per cent confidence interval = 0.48–1.36).

In light of these findings, detailed results have been presented in table 2 for usual care and special intervention combined and

### Table 1

**Mean values for age and coronary risk factors at entry, by interview assessment of behavior pattern: MRFIT Behavior Pattern Study, 1973–1976**

<table>
<thead>
<tr>
<th>Variables*</th>
<th>A1 (n = 1,103)</th>
<th>A2 (n = 1,211)</th>
<th>X (n = 269)</th>
<th>B (n = 527)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>46.7</td>
<td>46.3</td>
<td>47.0</td>
<td>46.9</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>98.6</td>
<td>98.8</td>
<td>99.1</td>
<td>99.3</td>
</tr>
<tr>
<td>Serum cholesterol (mg/dl)</td>
<td>255.4</td>
<td>260.7</td>
<td>256.0</td>
<td>251.7</td>
</tr>
<tr>
<td>Cigarettes (no./day)</td>
<td>22.4</td>
<td>19.7</td>
<td>19.4</td>
<td>17.9</td>
</tr>
</tbody>
</table>

* Age was assessed at randomization. The other three variables were assessed at the first screening visit.

### Table 2

**Incidence of first major coronary events, by interview assessment of behavior pattern in usual care and special intervention groups combined at eight clinical centers combined: MRFIT Behavior Pattern Study, mean follow-up of 7.1 years, 1973–1982**

<table>
<thead>
<tr>
<th>Behavior pattern</th>
<th>No. at risk</th>
<th>No.</th>
<th>%</th>
<th>Adjusted relative risk†</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>527</td>
<td>23</td>
<td>4.36</td>
<td>1.00</td>
<td>0.47–1.90</td>
</tr>
<tr>
<td>X</td>
<td>269</td>
<td>12</td>
<td>4.66</td>
<td>0.95</td>
<td>0.47–1.90</td>
</tr>
<tr>
<td>A2</td>
<td>1,211</td>
<td>40</td>
<td>3.30</td>
<td>0.73</td>
<td>0.43–1.22</td>
</tr>
<tr>
<td>A1</td>
<td>1,103</td>
<td>54</td>
<td>4.90</td>
<td>0.99</td>
<td>0.60–1.62</td>
</tr>
</tbody>
</table>

Total 3,110 129 4.15

* Coronary death or definite nonfatal myocardial infarction.
† Adjusted by Cox-type regression analysis for age, diastolic blood pressure, serum cholesterol concentration, cigarette smoking, consumption of alcohol, and educational attainment.
for the eight clinics combined. Variation among the four behavior patterns in risk of first major coronary event was small ($x^2 = 3.85, df = 3, p = 0.278$) and showed no clear evidence of a graded "dose-response" association. When Type A (A1-A2) was compared with not Type A (X-B), the crude relative risk was 0.92 (4.06 per cent/4.40 per cent), and the adjusted relative risk (calculated from a partial Cox regression coefficient of $-0.1417$ with standard error of 0.2000) was 0.87 with 95 per cent confidence interval = 0.59-1.28. In this multivariate regression analysis, risk of first major coronary event was positively and significantly associated with age at randomization ($p < 0.001$) and with first screen measurements of diastolic blood pressure ($p = 0.029$), serum cholesterol level ($p < 0.001$), and number of cigarettes reportedly smoked per day ($p < 0.001$).

Since use of beta blockers may modify the expression of Type A behavior, analyses were repeated omitting 519 men for whom propranolol had been prescribed for treatment of hypertension. Results were similar to those shown in table 2; risks of first major coronary events for Types B, X, A2, and A1 were 4.67, 5.00, 3.23, and 4.79 per cent, respectively.

For men employed in managerial, professional, and technical occupations, crude relative risks for A1-A2 versus X-B were less than unity and similar in usual care and special intervention (0.94 and 0.82, respectively). In both groups combined, incidence of first major coronary events was 3.41 per cent in 1,319 men judged A1-A2 and 3.85 per cent in 416 men judged X-B. The relative risks were 0.89 unadjusted and 0.84 (95 per cent confidence interval = 0.47-1.49) after adjustment by Cox-type regression analysis for the previously listed variables.

Assessments of behavior pattern were not significantly associated with risk of coronary death or with total mortality in usual care or special intervention, separately or together, and detailed results have been presented in table 3 for both groups combined. Differences between behavior patterns in risk of coronary death and risk of total mortality were small and provided no clear evidence for a graded association. Although angina pectoris was not included as an end point in this study, information about chest pain was systematically obtained by Rose questionnaire (17) at each annual reexamination. Analysis of these data showed that crude relative risks of responses consistent with angina pectoris for A1-A2 compared with X-B were 1.09 in special intervention, 1.01 in usual care, and 1.05 overall.

Since change in coronary risk factors might have modified an association between behavior pattern and risk of coronary heart disease, further regression analyses were done in which men who experienced a first major coronary event during the first year of the study were excluded, and changes in diastolic blood pressure, serum cholesterol, and cigarette smoking from entry to each annual reexamination were added as time-dependent covariates (15) to the set of regressors described earlier, i.e., age, diastolic blood pressure, serum cholesterol concentration, cigarettes

**Table 3**

Risk of death from coronary heart disease and from all causes, by interview assessment of behavior pattern in usual care and special intervention groups combined at eight clinical centers combined: MRFIT Behavior Pattern Study, mean follow-up of 7.1 years, 1973-1982

<table>
<thead>
<tr>
<th>Behavior pattern</th>
<th>Coronary deaths</th>
<th>All deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. at risk</td>
<td>%</td>
</tr>
<tr>
<td>B</td>
<td>527</td>
<td>10</td>
</tr>
<tr>
<td>X</td>
<td>269</td>
<td>6</td>
</tr>
<tr>
<td>A2</td>
<td>1,211</td>
<td>21</td>
</tr>
<tr>
<td>A1</td>
<td>1,103</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>3,110</td>
<td>62</td>
</tr>
</tbody>
</table>

* Adjusted by Cox-type regression analysis for age, diastolic blood pressure, cigarette smoking, serum cholesterol level, consumption of alcoholic beverages, and educational attainment. For coronary deaths, the 95 per cent confidence intervals were 0.33-2.80, 0.43-1.97, and 0.56-2.47 for Types X, A2, and A1, respectively. For all deaths, corresponding values were 0.38-1.65, 0.64-1.67, and 0.57-1.52.
smoked per day, consumption of alcohol, and educational attainment at entry. The adjusted relative risks of a first major coronary event for A1-A2 compared with X-B were 0.97 in usual care (95 per cent confidence interval = 0.53–1.79) and 0.78 in special intervention (95 per cent confidence interval = 0.45–1.35).

**Jenkins Activity Survey Type A scores**

A total of 12,772 (99.3 per cent) of 12,866 participants completed the Jenkins Activity Survey in sufficient detail for Type A scores to be calculated. The scores distributed approximately normally with mean of -0.9 and standard deviation of 9.6 points. Mean scores for men categorized by interview as A1, A2, X, and B were 2.0, -0.6, -3.7, and -5.0, respectively. Percentage agreement was 57.6 per cent between the Type A score dichotomized as equal to or greater than zero versus otherwise and interview assessments dichotomized as A1-A2 versus X-B.

The Type A score was not significantly related to incidence of first major coronary events in univariate analyses or in multivariate analyses which included age, diastolic blood pressure, cigarettes smoked per day, serum cholesterol concentration, consumption of alcohol, and educational attainment (table 4). Coefficients for the Type A score were negative in sign—i.e., scores at the lower (Type B) end of the scale tended to be associated with higher risk—but their 95 per cent confidence intervals included zero. Similar results were obtained when analyses were conducted in the usual care and special intervention groups separately; the Cox-type regression coefficients were -0.010 in usual care (95 per cent confidence interval = -0.022–0.003) and -0.003 in special intervention (95 per cent confidence interval = -0.015–0.010).

In both univariate and multivariate analyses of coronary death and total mortality, the Type A score had small negative coefficients in usual care and special intervention, but their 95 per cent confidence intervals included zero in all cases. Similar results were obtained when the analyses were restricted to 6,504 men employed in professional, technical, and managerial occupations.

**DISCUSSION**

These results have led us to conclude that assessments of Type A behavior were not associated with risk of coronary heart disease in MRFIT and to consider various possible explanations for this apparent absence of effect. The first concerns the issue of statistical power. Did the study have adequate power to test the main hypothesis? Under the assumptions that the incidence of first major coronary events was 4.15 per cent, that the true relative risk was 2.0 for Type A as compared with Type B men, and that the proportion of Type A men was 0.75, the probability of rejecting the null hypothesis at the one-sided 5 per cent level of significance was 0.67 with samples numbering 1,550 and 0.93 with samples numbering 3,110. Thus, the test based solely on results in usual care was not strong, but the test based on usual care and special intervention combined had entirely adequate power.

It is perhaps more useful, once a study has been completed, to consider the precision of the estimates that were obtained rather than the statistical power. After adjustment for age, diastolic blood pressure, serum cholesterol concentration, cigarette smoking, alcohol consumption, and educational attainment, the relative risk of a first major coronary event for Type A men (A1-A2 vs. X-B) was 0.99 in usual care (95 per cent confidence interval = 0.54–1.81), 0.81 in special intervention (95 per cent confidence interval = 0.48–1.36), and 0.87 overall (95 per cent confidence interval = 0.59–1.28). As indicated by the confidence intervals, none of these estimates is consistent with the hypothesis that the relative risk in the population was two. We conclude that error due to random sampling is an
Incidence of first major coronary events, by level of the Jenkins Activity Survey type A score in usual care and special intervention groups combined at eight clinical centers combined: MRFIT Behavior Pattern Study, mean follow-up of 7.1 years, 1973–1982

<table>
<thead>
<tr>
<th>Type A score*</th>
<th>No. at risk</th>
<th>First major coronary event†</th>
<th>Regression coefficient (b), standard error (SE), and 95% confidence interval (CI)</th>
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<td></td>
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<td>No.</td>
<td>%</td>
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<tr>
<td>-23.2 to -10.4</td>
<td>2,526</td>
<td>125</td>
<td>4.95</td>
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<tr>
<td>-10.3 to -4.0</td>
<td>2,664</td>
<td>117</td>
<td>4.39</td>
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<tr>
<td>-3.9 to 2.6</td>
<td>2,820</td>
<td>112</td>
<td>3.97</td>
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<tr>
<td>2.7 to 8.8</td>
<td>2,409</td>
<td>103</td>
<td>4.28</td>
</tr>
<tr>
<td>8.9 to 25.9</td>
<td>2,353</td>
<td>97</td>
<td>4.12</td>
</tr>
<tr>
<td>Total</td>
<td>12,772</td>
<td>554</td>
<td>4.34</td>
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* Mean values for the lowest (Type B) through the highest (Type A) quintiles of the score's distribution were -13.9, -7.2, -0.6, 5.5, and 13.4.
† Coronary death or definite nonfatal myocardial infarction.
‡ Linear regression of incidence in each category on that category's mean type A score.
§ Cox-type regression of time from entry to end point on the Type A score with adjustment for age, diastolic blood pressure, cigarette smoking, serum cholesterol, consumption of alcohol, and educational attainment.

unlikely explanation for the apparent absence of association between assessments of Type A behavior and risk of coronary heart disease in MRFIT.

Did the procedures for selecting participants in MRFIT bias the estimate of the association between Type A behavior and risk of coronary heart disease? This could have occurred, for instance, if Type A behavior were associated with increased risk of coronary disease primarily in persons who do not have elevated levels of blood pressure, serum cholesterol, and cigarette smoking. Results from both the Western Collaborative Group Study and the Framingham Heart Study, however, do not support this hypothesis. Rosenman et al. (1) showed that Type A men had higher risk of coronary heart disease in the Western Collaborative Group Study regardless of the presence or absence of other coronary risk factors. Brand (18) concluded that their data were consistent with a multiplicative model in which Type A behavior approximately doubled the risk conferred by age, blood pressure, serum cholesterol concentration, and cigarette smoking. His figure 1.2A shows that the difference in risk between Types A and B was larger among men with three or four risk factors than among those with only one or none. Analysis of the 10-year incidence data from the Framingham Heart Study by Haynes et al. (19) also indicated that the difference between Type A and Type B men in risk of coronary heart disease increased with increasing levels of other coronary risk factors.

Changing the prevalence of Type A from 50 to 74 per cent (the values observed in the Western Collaborative Group Study and MRFIT, respectively) could not by itself bias the association between behavior pattern and risk of coronary heart disease (20). A bias could have occurred, however, if the positive association between the global Type A assessment and risk of coronary heart disease (20).
A man who did not. Data to evaluate this hypothesis are not currently available, but it seems a promising area for further investigation.

Another question is whether misclassification according to behavior pattern obscured a true association between behavior pattern and risk of coronary heart disease. As noted above, the prevalence of Type A behavior was substantially higher in MRFIT than in the Western Collaborative Group Study. Whether this was due to misclassification or to real differences between populations cannot be determined conclusively. If it were due to misclassification, however, it seems reasonable to expect that such misclassification would have occurred most frequently between adjacent categories—e.g., A2 to A1, and B to X or A2—and would have had little effect on comparisons of the extreme categories, A1 with B. Since the adjusted relative risk of a first major coronary event for A1 versus B was 0.99, such misclassification is an unlikely explanation for the absence of a positive association in MRFIT.

Interjudge reliability was apparently similar in both studies (8, 9). Opportunity for direct supervision of interviewers, however, was much less in MRFIT than in the Western Collaborative Group Study. It is possible that MRFIT’s interviewers, despite the procedures for selection, training, and quality control (9), were less skilled as a group than the interviewers in the Western Collaborative Group Study, and that recorded materials on which the auditors and Dr. Rosenman relied were consequently less adequate. At no time during the period of intake did Dr. Rosenman or the auditors indicate that any interviewer was conducting interviews in an unacceptable manner, but data to evaluate less obvious deficiencies are not presently available. If this explanation were correct, however, it implies that formidable problems exist in ensuring validity of the assessments, and that procedures for making valid assessments may not be generally accessible to other investigators. These questions deserve serious attention.

Results with the Jenkins Activity Survey Type A score are relevant to this issue of misclassification, since this instrument was designed to predict the interview assessments of behavior pattern as these were done in the Western Collaborative Group Study (10, 21). The distributions of the Type A score in the Western Collaborative Group Study and MRFIT were similar. In the former study, the Type A score had a statistically significant positive association with incidence of coronary heart disease (3). In MRFIT, the observed associations were negative in sign, although none was significantly different from zero. Misclassification in assessing behavior pattern by interview cannot explain the absence of association between the Type A score and risk of coronary heart disease.

Bias due to misclassification could also have occurred if men who were correctly classified at entry subsequently changed both their behavior pattern and their risk of coronary heart disease. Data to examine this possibility are not available. Measurements of serum cholesterol concentration, diastolic blood pressure, and cigarette smoking at the first screening visit, however, were positively and significantly associated with risk of first major coronary events despite the attention that was focused on changing these risk factors. In contrast, no systematic attempt was made to change the Type A behavior pattern. Although change in Type A behavior cannot be ruled out as an explanation for the absence of an association in MRFIT, it is in our judgment an unlikely explanation.

With regard to end points, the crude relative risks associated with Type A in the Western Collaborative Group Study were 2.12 for all coronary events, 2.16 for symptomatic myocardial infarction, 2.12 for clinically unrecognized myocardial infarction, 2.97 for angina pectoris (1), and 2.21 for coronary death (2). The fact that behavior pattern was uniformly associated in the
Western Collaborative Group Study with these various categories of end points, and the absence of an association in MRFIT between behavior pattern and coronary death, make differences in procedures for detecting and classifying end points an unlikely explanation for the difference in outcome.

In summary, several possible explanations for the absence of an association between Type A behavior and risk of coronary heart disease in MRFIT have been identified, but more data are needed to evaluate these possibilities. Uncertainty in the definition of the global Type A behavior pattern itself may be an important part of the problem. Jenkins (21) has noted that “the best current measures, including the structured interview, are only approximations of clearly real but not totally specified complexes of behavior.” In her detailed review, Matthews (22) has pointed out that “the psychological dimensions underlying Type A behavior have not been identified,” and that “the environmental factors that elicit Type A behavior in the susceptible individual have not been examined in a systematic manner.” Reviews of these issues and of the general body of evidence regarding Type A behavior pattern and coronary heart disease have been published elsewhere (4–6, 22).

Clearly, many questions remain to be investigated, and it would be unwarranted to conclude that the Type A behavior pattern, or some aspects of it, has no association with risk of coronary disease. The present study involved a highly selected sample of men who had volunteered to participate in a clinical trial involving change in diet, cessation of cigarette smoking, and treatment of high blood pressure. Extending these results to other populations should be attempted very cautiously, if at all. Nonetheless, failure to find an association between Type A behavior and risk of coronary heart disease in this sample raises questions regarding the robustness of the Type A hypothesis in its present form. Further studies are needed to investigate these questions. In addition, the validity of procedures used to assess behavior patterns should be a focus for further research.

REFERENCES

15. Kalbfleisch JD, Prentice RL. The statistical anal-