Fire Fighting and Coronary Heart Disease

ELAINE DIBBS, M.A., H. EMERSON THOMAS, JR., M.D., SCOTT T. WEISS, M.D., AND DAVID SPARROW, M.S.

SUMMARY Some studies suggest that fire fighters are at a higher risk of developing coronary heart disease than are males in the general population. We followed 1646 men for 10 years to determine the incidence of coronary heart disease. Subjects were participants of the Normative Aging Study, a longitudinal study of aging. Comparison of fire fighters (n = 171) and non–fire fighters (n = 1475) showed no significant difference in the incidence rates of coronary heart disease. Comparison of the groups regarding baseline risk factors revealed no material difference. These data suggest that fire fighters do not have an excess risk of coronary heart disease.

MANY FACTORS might influence risk of developing coronary heart disease. Cigarette smoking, high blood pressure, elevated serum cholesterol, and low levels of high-density lipoprotein cholesterol are important contributors to coronary disease risk. Other factors, such as occupation, have not been examined as extensively.

Barnard and Weber stated that fire fighters are at a higher risk of coronary heart disease than are males in the general population. This conclusion is based in part on U.S. census data and on results of electrocardiographic stress testing. It has been suggested fire fighters' excess risk is due to high occupational exposure to smoke or to carbon monoxide.

We studied the findings in 1646 participants of the Normative Aging Study, followed for 10 years to determine the incidence of coronary heart disease, to test the hypothesis that fire fighters have a greater incidence of coronary heart disease than non–fire fighters.

Methods

The Normative Aging Study is a longitudinal study of aging initiated in 1963 and located at the Veterans Administration Outpatient Clinic in Boston. The original 2078 white male participants of the Normative Aging Study were carefully screened at entry according to health criteria, and were free of known chronic conditions at the outset. This first examination included a history, physical examination, ECG, chest x-ray, and a variety of biochemical laboratory tests. Serum cholesterol was measured with the colorimetric method of Sperry. Systolic blood pressure and fifth-phase diastolic blood pressure were measured in both arms with the participants seated. The average systolic and diastolic pressures in both arms were used for analysis. Cigarette smoking status was determined by a trained interviewer. Smokers were defined as men who smoked one or more cigarettes a day; all others were considered nonsmokers. Weight and height were measured with the subjects wearing only stockings and undershorts. Body mass index (weight/height²) was then calculated.

Similar examinations were repeated every 5 years on the average. The data were supplemented by information on cardiovascular illness obtained from hospital records. The data presented here were obtained from the first three examinations.

The diagnostic categories of coronary heart disease under consideration include myocardial infarction, angina pectoris and death from coronary heart disease. The criteria for myocardial infarction and angina pectoris were those used in the Framingham Heart Study. The records of all possible cases of myocardial infarction were reviewed by a cardiologist. Myocardial infarction was diagnosed only when documented by unequivocal electrocardiographic changes (i.e., pathologic Q waves), by a diagnostic elevation of serum enzymes (SGOT and lactic dehydrogenase) accompanying chest discomfort consistent with myocardial infarction, or by autopsy. Angina pectoris was diagnosed when the subject reported recurrent chest discomfort that lasted up to 15 minutes, was distinctly related to exertion or excitement and was relieved by rest or nitroglycerin. The diagnosis was rejected when another explanation was possible or if discomfort also occurred as often at rest. Death from coronary heart disease was designated when a death certificate (coded according to the eighth revision of the International Classification of Diseases) indicated an underlying cause of death coded to rubric 410 or 412.

The subjects in the current study were a subgroup of the Normative Aging Study population. These 1646 subjects (171 fire fighters and 1475 non–fire fighters) had three complete medical examinations or a diagnosis of coronary heart disease by the third examination. Sixteen men with missing baseline measures of coronary risk factors and 416 others who did not have three complete medical examinations were excluded. The proportions of fire fighters and non–fire fighters were similar in excluded and included subjects (X² = 1.26, p = 0.74). Subjects excluded because of missing examinations (fire fighters and non–fire fighters) were similar to included subjects with respect to age, cholesterol, blood pressure and body mass index, but the excluded subjects had higher rates of cigarette smoking (table 1).

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TABLE 1. Baseline Characteristics for Fire Fighters and Non–Fire Fighters

<table>
<thead>
<tr>
<th></th>
<th>Excluded subjects</th>
<th>Included subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firefighters</td>
<td>Non–firefighters</td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>40.6 ± 6.9</td>
<td>40.4 ± 10.6</td>
</tr>
<tr>
<td>Mean serum cholesterol (mg/dl)</td>
<td>196.9 ± 42.6</td>
<td>199.0 ± 42.9</td>
</tr>
<tr>
<td>Mean systolic blood pressure (mm Hg)</td>
<td>123.7 ± 10.9</td>
<td>123.5 ± 13.3</td>
</tr>
<tr>
<td>Mean diastolic blood pressure (mm Hg)</td>
<td>76.8 ± 7.9</td>
<td>76.9 ± 8.0</td>
</tr>
<tr>
<td>Mean body mass index (kg/m²)</td>
<td>25.8 ± 2.4</td>
<td>25.6 ± 3.1</td>
</tr>
<tr>
<td>Cigarette smokers (%)</td>
<td>61.1</td>
<td>49.2</td>
</tr>
</tbody>
</table>

Values are mean ± SD.

Fire fighters and non–fire fighters were compared with regard to the 10-year incidence of coronary heart disease. We estimated the rate ratio of coronary heart disease using a maximal likelihood procedure. The statistical significance was calculated using the Mantel-Haenszel test for combining 2 × 2 tables. The 95% confidence interval around the rate ratio was calculated according to the method described by Miettinen.

Results

The baseline characteristics were similar in fire fighters and non–fire fighters included in the study (table 1).

The 10-year incidence of all categories of coronary heart disease (myocardial infarction, angina pectoris, or death from coronary heart disease) in fire fighters and non–fire fighters is shown in table 2. The incidence rates were somewhat lower than those from other prospective studies (e.g., The Framingham Heart Study), but this probably reflects the health criteria for acceptance into the Normative Aging Study. Only four of the 171 fire fighters (2.3%) developed coronary heart disease, compared with 71 of the non–fire fighters (4.8%). Although the mean ages of fire fighters and non–fire fighters were comparable (table 1), a greater proportion of non–fire fighters were older than age 50 years (table 2). We therefore controlled for age using the three age strata shown in table 2. The overall rate ratio estimate, controlled for age, was 0.5; that is, the rate for fire fighters was only 50% that of non–fire fighters. The 95% confidence interval included 1, and the Mantel-Haenszel test yielded a two-tail p value of 0.9.

The 10-year incidence of myocardial infarction for the fire fighters and non–fire fighters is shown in table 3. Two fire fighters (1.2%) and 37 non–fire fighters (2.5%) had a myocardial infarction. The estimated rate ratio was 0.5, which indicates a lower rate of disease among fire fighters than among non–fire fighters. The relatively large 95% confidence interval (0.1–1.9) reflected the small number of cases among fire fighters. The Mantel-Haenszel test yielded a two-tail p value of 0.31.

Discussion

Earlier studies suggested an increased risk of coronary heart disease among fire fighters. However, these investigations appear to have some methodologic limitations. For instance, a study based on the 1950 U.S. census reported that of all occupations considered, fire fighters had the highest mortality from atherosclerotic heart disease. However, the occupations of decedents and survivors were obtained from different sources, which might have inflated the fire fighters' rate. In addition, no adjustment was made for differences in known risk factors between the occupational groups. Finally, because the statistics in the 1950 U.S. census study dealt only with deaths, they were not necessarily an accurate gauge of the incidence of nonfatal coronary attacks or of coronary

TABLE 2. Ten-year Incidence of Coronary Heart Disease* Among Fire Fighters and Non–Fire Fighters

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Firefighters</th>
<th>Non–firefighters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. cases</td>
<td>No. at risk</td>
</tr>
<tr>
<td>Total</td>
<td>171</td>
<td>4</td>
</tr>
<tr>
<td>20–39</td>
<td>67</td>
<td>1</td>
</tr>
<tr>
<td>40–49</td>
<td>87</td>
<td>3</td>
</tr>
<tr>
<td>50+</td>
<td>17</td>
<td>0</td>
</tr>
</tbody>
</table>

*Myocardial infarction, angina pectoris or coronary heart disease death.
†Computed by the Mantel-Haenszel test for combining 2 × 2 tables.
disease in general. Improved medical care may lower fatalities, even though the number of people suffering from coronary attacks or other heart conditions may be relatively high.

Barnard et al.11 administered a near-maximal treadmill test to 90 fire fighters and compared the results with those reported several years earlier on 232 similarly tested insurance underwriters. Nine of the fire fighters (10%) had ischemic ECG changes, compared with 18 of the insurance underwriters (8%). The results were not evaluated statistically. When we compared their reported rates among fire fighters and underwriters, the 95% confidence limits of the crude rate ratio included the null value (1.0). Consequently, the rates of the two groups are not significantly different.

Barnard et al.21 performed cardiac catheterization and angiography on six of the nine fire fighters who had an ischemic response to stress testing. Only two of the six had evidence for obstruction or significant narrowing of coronary vasculature, indicating a low predictive value (33%) for stress testing. This study and other studies22,23 demonstrate the limitations of stress testing for detecting significant coronary heart disease.

Felton24 evaluated fire fighters and other Los Angeles safety personnel with bicycle ergometry. There was a suggestion that fire fighters had higher rates of ischemic ECG changes than other workers, but no statistical evaluation was performed and no information on age or other coronary risk factors was provided for the occupational groups considered.

The Normative Aging Study offers an opportunity to observe the natural history of coronary heart disease in a relatively unbiased manner. Occupational status was determined before the onset of disease, without knowledge of the subjects in whom the disease would subsequently develop and with all subjects in the study having an equal opportunity for diagnosis. Adult males were followed 10 years for the development of nonfatal and fatal coronary heart disease. The data suggest that male fire fighters did not have an excess incidence of coronary heart disease. Thus, the results from our study place some doubt on the hypothesis that fire fighters are at greater risk of coronary heart disease. Based on the available small sample, we can rule out, with 95% confidence, an increased relative risk for fire fighters of greater than 1.4 for coronary heart disease and greater than 1.9 for myocardial infarction.

### Table 3. Ten-year Incidence of Myocardial Infarction Among Fire Fighters and Non–Fire Fighters

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Fire fighters</th>
<th>Non–fire fighters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. at risk</td>
<td>No. of cases</td>
</tr>
<tr>
<td>Total</td>
<td>170</td>
<td>2</td>
</tr>
<tr>
<td>20–39</td>
<td>67</td>
<td>1</td>
</tr>
<tr>
<td>40–49</td>
<td>86</td>
<td>1</td>
</tr>
<tr>
<td>50+</td>
<td>17</td>
<td>0</td>
</tr>
</tbody>
</table>

*Computed by the Mantel-Haenszel test for combining 2 × 2 tables.

### References

19. Miettinen OS: Estimability and estimation in case-referent
Long-term Effects of a Blood Pressure Survey on Patient Treatment in a Community

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SUMMARY  The influence of a systematic survey and follow-up of blood pressure in a population sample was assessed by a subsequent survey performed an average of 40 months later. A subsample of 764 men, originally ages 35–57 years, was randomly selected for telephone follow-up, while blood pressure was remeasured in 133 (17% of the subsample). These were drawn from 6779 men who had a diastolic blood pressure (DBP) ≥ 90 mm Hg, the average of the second two measurements of three at the initial survey.

Ninety percent of the men in the telephone survey reported they had visited their physician or medical-care source. Of these visits, 70% were for consideration of blood pressure, and in 36% this visit was directly attributed to the screen. At follow-up, 52.8% were taking antihypertensive medication and in 61% of this group the medication was started after the initial screen. Follow-up revealed DBP reduced by 8.7% in the group not treated with antihypertensive agents either before or after the initial survey, by 13.4% in the group on treatment before the survey and by 17.7% in the group started on therapy after the survey. Although lack of a suitable comparison group is a limitation, these findings in a population-based cohort strongly suggest that systematic blood pressure screening, combined with effective immediate referral, may be associated with an important effect on blood pressure control in the community.

THE DETECTION and control of hypertension in the community appears to be improving. More people with hypertension are detected and a greater proportion are receiving adequate treatment. Mass blood pressure screening may be one of the reasons for this improvement. However, the effectiveness of screening programs has been questioned. Unsystematic, sporadic screening efforts appear to attract primarily a self-selected population of the elderly and health-conscious, or those previously detected and under care. Those not screened are at a higher risk and less likely to be detected by casual screening methods. Moreover, many screening programs have not provided adequate follow-up or liaison with medical facilities.

In the course of recruitment for a large primary prevention trial, approximately 31,000 middle-aged men were surveyed from a population base by a door-to-door method. High participation was achieved: 96.9% of households were contacted and 80.9% of age-eligible men were examined. This systematic process was combined with a standardized and prompt follow-up procedure for men found to have an average DBP ≥ 90 mm Hg. In the present study, the effect of the initial screening survey is evaluated by follow-up of a random sample of those with elevated blood pressure, 3–5 years after the initial contact. We sought to determine the influence of this survey, the equivalent of a systematic screening and referral effort on hypertension control.

Methods

Recruitment for the Multiple Risk Factor Intervention Trial (MRFIT), sponsored by the National Heart, Lung, and Blood Institute, formed the basis for this study. It involved all households in specified census tracts of Minneapolis-St. Paul. The recruitment was continuous from January 1974 to September 1975.

A letter was first mailed to individual homes in the selected census tracts informing the occupants of an upcoming home visit, as well as describing the nature...
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