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Chest Pain and Coronary Heart Disease Mortality Among Older Men and Women in Three Communities

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Angina pectoris is a manifestation of coronary heart disease, yet little is known from clinical or epidemiologic studies about its prognosis in older populations. We investigated the relation of uncomplicated angina symptoms to risk of coronary heart disease mortality within 3 years in a prospective study of 8,359 people aged 65 and older residing in three communities. From baseline (1981–1983) to the third year of follow-up (1984–1986), there were 245 deaths from coronary heart disease. Three classifications of chest pain were defined using the Rose Questionnaire: nonexertional chest pain, chest pain on exertion (including angina), and angina. Exertional chest pain was a strong, independent predictor of coronary heart disease death for older men and women. There were no differences in the prognostic implications of this symptom between the sexes; the relative risks being 2.4 (95% confidence interval, 1.4–4.4) in men and 2.7 (1.7–4.2) in women. The risk of coronary heart disease mortality for those reporting chest pain on exertion was at least as high as that for participants whose symptoms met the Rose Questionnaire criteria for angina. The association between exertional chest pain and coronary heart disease mortality was independent of other coronary risk factors. The relation was specific for deaths from coronary heart disease, as there was no association between exertional chest pain and noncoronary causes of death. Chest pain on exertion conveys important prognostic information about risk of coronary death in older populations, regardless of gender. (*Circulation* 1990;81:437–446)

Coronary heart disease is a leading cause of death among older Americans, accounting for nearly one half million fatalities among people aged 65 and older in 1985.¹ Angina pectoris is a manifestation of coronary heart disease, yet little is known from either clinical or epidemiologic studies about its prognosis in older populations. As originally described by Heberden,² classic angina is characterized by midsternal or left-sided chest pain provoked by exertion and relieved by rest. The perception and

importance of angina may differ in older populations for several reasons. First, perception of pain is thought by some to diminish with age,^{3,4} although experimental evidence for “presbyalgos” is currently inconclusive.⁵ Second, recall of angina symptoms may be influenced by age due to a greater prevalence in older people of memory losses and competing multiple bodily discomforts that may lessen the attention paid to chest pain.^{3,6} Third, silent myocardial infarction is thought to be common in the aged and may not be preceded by any recognized pain related to ischemia.⁷ Fourth, many older people become less physically active, particularly when limited by respiratory and musculoskeletal conditions, and may not exercise to the point of provoking angina.⁸ Finally, older people are thought to be more likely to experience atypical symptoms such as dyspnea, dizziness, and fatigue, rather than classic angina pectoris as a result of transient myocardial ischemia.^{3,8}

In epidemiologic studies, the classification of angina pectoris is often made on the basis of the London School of Hygiene Cardiovascular Questionnaire, a standardized instrument designed by Geoffrey Rose.⁹ The relation of angina as assessed by the

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Rose Questionnaire with fatal and nonfatal coronary heart disease events has been well established in middle-aged men.¹⁰⁻¹⁶ However, use of the Rose Questionnaire for predicting future coronary events in women of all ages remains unclear.^{12-13,15,17-19} Thus, the prognostic value of the Rose Questionnaire for predicting future coronary heart disease in older men and women is unknown. A prospective study of three community populations of people aged 65 and over provided the opportunity to investigate the relation of uncomplicated angina and other chest discomfort, as measured by the Rose Questionnaire, to risk of coronary heart disease mortality within 3 years.

Methods

Study Populations

The study populations include three prospective studies of community-dwelling older people that are part of the Established Populations for Epidemiologic Studies of the Elderly (EPESE). The studies began in 1981 and are located in East Boston, Massachusetts; New Haven, Connecticut; and Iowa and Washington counties, in rural Iowa. A fourth EPESE site located in Durham and surrounding counties in North Carolina began in 1985, but sufficient follow-up data are not yet available.

In baseline surveys conducted between 1981 and 1983, trained interviewers collected data on demographic characteristics, medical history and symptoms, prescription and nonprescription drug use, health habits, and health care utilization. Blood pressure and pulse measurements were also obtained. Surrogate or proxy informants were used for those few subjects unable to respond for themselves. The methods used in the baseline surveys are published elsewhere.^{20,21} Briefly, full community surveys of subjects aged 65 and older were conducted in East Boston and rural Iowa. In East Boston, of the 4,562 eligible, baseline interviews were obtained for 3,812 (84%). For Iowa, of the 4,601 eligible, 3,673 were interviewed (80%). The New Haven population was selected from a stratified random sample defined by three types of housing: public housing projects for the elderly with age and income restrictions, private housing projects for the elderly with age restrictions only, and other private community dwellings. Men were oversampled and of the 3,337 eligible, 2,812 were interviewed (82%).

We excluded subjects for whom proxy informants provided information, since chest pain questions were not asked (3.9% for East Boston and 2.0% for New Haven). In Iowa, 12.4% were excluded because, in addition to proxy interviews, telephone surveys conducted for persons too ill or too involved in farming operations to schedule in-person interviews did not include chest pain questions. In addition, the present study was restricted to subjects free from previous myocardial infarction at baseline, excluding 10.3%, 12.7%, and 11.2% of subjects in East Boston, New Haven, and Iowa, respectively. Of the remainder, less than 2% were missing data on chest pain.

The final analytic sample therefore included 8,359 participants (3,241 in East Boston, 2,371 in New Haven, and 2,747 in Iowa).

Data Collection

The London School of Hygiene Chest Pain, or Rose Angina, Questionnaire was administered by trained interviewers at baseline. The classification of angina by World Health Organization criteria is based on six characteristics elicited by this questionnaire²²: 1) the historical presence of any pain, discomfort, pressure, or heaviness; 2) present when hurrying, walking uphill, or at an ordinary pace on the level; 3) that requires the subject to stop, slow down, or take a nitroglycerin; 4) with subsequent relief; 5) occurring in 10 minutes or less; 6) located in the upper or middle sternum or the left anterior chest and left arm. Four chest pain classifications were derived from these criteria. Respondents who denied any history of chest pain as specified in the first criterion were classified as having "no chest pain." Respondents who reported history of chest pain satisfying the first criterion but not when hurrying, walking uphill, or on the level were classified as having "nonexertional chest pain." Respondents who reported a history of chest pain that occurred on exertion, that is, when hurrying, walking uphill, or on the level were classified as having "exertional chest pain." Respondents who reported a history of chest pain with characteristics satisfying all six of the Rose Angina Questionnaire criteria were classified as having "Rose angina." Those with Rose angina are a subset of the group reporting exertional chest pain.

Demographic information on age, sex, and race (New Haven only) as well as history of major chronic conditions diagnosed by a physician (or other health care provider for East Boston participants) including heart attack, diabetes, and high blood pressure was obtained. A definite "yes" was required for classification of a positive history for these conditions; suspect or possible diagnoses were not included. Use of nitrates within the last 2 weeks was determined by the interviewer from observation of all prescription drugs taken during the preceding 2 weeks. Drug names were recorded from the container labels and coded uniformly. Three blood pressures (two in Iowa) were taken with the participant seated according to the standard protocol used in the Hypertension Detection and Follow-up Program.²³ The average of two systolic blood pressure measurements (the last two in East Boston and New Haven) were used in this report. Respondents who answered "yes" to the question, "Do you smoke cigarettes regularly now?" at baseline were classified as current smokers. Those who indicated that they had been regular smokers but were not current smokers were classified as former smokers. Alcohol consumption per day during the previous month was calculated from a series of questions regarding frequency and amount of beer or ale, wine, and liquor consumption over the previous month. In the present study, subjects who consumed

TABLE 1. Age-Adjusted Prevalence of Chest Pain at Baseline and 3-Year Age-Adjusted Mortality Rates Among EPESE Participants

Community	Sex	Population at risk	Prevalence of chest pain			3-year mortality	
			Nonexertional chest pain	Chest pain on exertion	Rose angina*	Total mortality	CHD mortality
			Prevalence rate/100			Mortality rate/100	
East Boston	Men	1,195	13.8 (167)	6.7 (79)	4.2 (47)	16.4 (159)	3.7 (35)
	Women	2,046	14.2 (298)	9.4 (197)	5.8 (122)	9.6 (203)	2.2 (47)
New Haven	Men	936	18.0 (163)	6.3 (53)	4.0 (32)	19.3 (197)	4.3 (40)
	Women	1,435	18.6 (267)	8.8 (131)	5.5 (84)	11.4 (163)	2.6 (42)
Iowa	Men	936	16.0 (158)	4.9 (54)	3.0 (37)	11.7 (115)	3.9 (42)
	Women	1,811	16.5 (286)	6.9 (115)	4.2 (66)	6.6 (122)	2.3 (39)

CHD, coronary heart disease.

*Subjects with Rose Questionnaire angina are a subset of subjects with exertional chest pain.

Numbers in parentheses indicate cases of chest pain for prevalence rates and number of deaths for mortality rates.

at least 0.5 oz/day were compared with those who consumed lesser amounts of alcohol or none at all.

Vital status of all participants was ascertained by local surveillance mechanisms such as monitoring obituary notices and state vital statistics records, as well as by annual contacts with the participant or a proxy informant. During the first 3 years, follow-up was virtually complete in each location (less than 1% lost to follow-up in New Haven, no losses in East Boston and Iowa). Death certificates were obtained for all decedents and coded by a single nosologist using the *Ninth Revision of the International Classification of Diseases, Clinical Modification (ICD-9-CM)*. There were 362 deaths in East Boston participants, 360 in New Haven, and 237 in Iowa. Deaths with an underlying cause of coronary heart disease were coded as ICD-9-CM 410-414 for 245 eligible participants (82 in East Boston, 82 in New Haven, and 81 in Iowa).

Statistical Methods

Age-adjusted prevalence rates of the three types of chest pain (nonexertional, exertional, and Rose angina) and rates of total and coronary heart disease mortality were calculated using analysis of covariance techniques in conjunction with logistic regression models.²⁴ Rates were adjusted to the age distribution of the three cohorts combined. The relation of chest pain at baseline to standard coronary heart disease risk factors and use of nitrates was assessed separately for men and women in each community. Subjects reporting nonexertional chest pain, chest pain on exertion, and the subset with Rose angina were compared with those reporting no such symptoms. Statistical tests for means (*t* tests) and proportions (χ^2 tests) were performed.

Relative risks for coronary heart disease mortality comparing subjects with exertional chest pain to those with nonexertional chest pain and no chest pain were computed using Cox proportional hazards models. Relative risks (hazard ratios) and corresponding two-sided 95% confidence intervals (CI) were derived from models containing exertional chest pain (present vs. absent) alone, as well as in combination with age and other coronary risk

factors.²⁵ Models for the New Haven community contained terms for race (white vs. other) and housing stratum (public, private vs. community housing). Community-stratified summary estimates of relative risk were computed from Cox regression models that summarized across strata to provide an overall estimate adjusting for community.²⁶

Results

Age-adjusted prevalence rates of nonexertional chest pain were similar for men and women in each community and ranged between 14% and 19% (Table 1). In contrast, age-adjusted prevalence rates of exertional chest pain and Rose angina were higher for women than men. About 7–9% of the women reported exertional chest pain at baseline compared with 5–7% of the men. Prevalence rates of Rose angina ranged between 4% and 6% for women and 3% and 4% for men.

Men had higher age-adjusted rates of mortality from all causes and from coronary heart disease than women in each community after 3 years of follow-up (Table 1). In all three cohorts, men experienced mortality rates approximately 70% greater than those of women for both total and coronary heart disease mortality.

For analyses of the association between exertional chest pain and baseline characteristics, subjects with no chest pain and nonexertional chest pain were combined because in previous analyses, risk factor profiles were found to be similar in the two groups (Table 2). Risk factor profiles were also similar for those with exertional chest pain not meeting the Rose criteria and those with Rose angina; therefore, results are presented for the combined group with any exertional chest pain. The average age of those without exertional chest pain was slightly, but not significantly, higher than those with chest pain on exertion. History of diabetes was more common among those with exertional chest pain as compared with those without such chest pain, and this difference reached statistical significance for East Boston women (19.3% vs. 12.4% with diabetes, respectively; $p < 0.01$). The only exception was Iowa men, for

TABLE 2. The Relation of Exertional Chest Pain to Selected Characteristics at Baseline Among EPESE Participants

Baseline characteristic	Exertional chest pain					
	East Boston		New Haven		Iowa	
	Present	Absent	Present	Absent	Present	Absent
Men (sample size)	79	1,116	53	883	54	882
Age (mean years)	71.7	72.6	72.3	74.1	73.4	73.6
History of diabetes (%)	20.3	14.4	15.1	11.8	1.9	10.3*
History of hypertension (%)	31.7	31.7	43.4	35.8	46.3	31.9*
Antihypertensive use (%)	26.6	21.9	32.1	30.2	44.4	29.3*
Current smoking (%)	29.1	25.6	24.5	24.2	16.7	14.4
Former smoking (%)	50.6	45.7	52.8	43.5	48.2	42.1
Alcohol consumption (%) (≥0.5 oz/day)	41.6	40.6	30.2	30.1	17.0	21.1
Systolic blood pressure (mean mm Hg)	140.4	146.2*	142.6	144.6	132.0	137.7
Diastolic blood pressure (mean mm Hg)	76.6	80.3†	79.2	80.9	71.6	74.2
Nitrate use (%)	11.4	1.1‡	17.0	2.0‡	24.1	2.7‡
Women (sample size)	197	1,849	131	1,304	115	1,696
Age (mean years)	72.2	73.0	74.4	74.7	74.7	74.8
History of diabetes (%)	19.3	12.4†	17.6	12.0	11.3	8.1
History of hypertension (%)	51.3	46.1	63.4	48.0†	59.1	45.7†
Antihypertensive use (%)	34.2	36.7	59.2	43.7‡	57.9	43.9†
Current smoking (%)	16.8	16.8	24.4	17.6	10.5	5.5*
Former smoking (%)	20.8	14.8*	20.0	17.5	4.4	7.4
Alcohol consumption (%) (≥0.5 oz/day)	9.8	10.5	10.0	8.4	5.4	4.0
Systolic blood pressure (mean mm Hg)	140.3	144.9†	141.4	144.5	137.0	136.9
Diastolic blood pressure (mean mm Hg)	75.8	77.6*	77.0	78.8	71.7	71.9
Nitrate use (%)	19.3	1.8‡	25.2	3.0‡	19.1	1.0‡

* $p < 0.05$; † $p < 0.01$; ‡ $p < 0.001$.

whom the association was reversed and statistically significant ($p < 0.05$). History of hypertension and use of antihypertensives were generally higher among those with exertional chest pain as compared with those without such symptoms. These associations were statistically significant for New Haven women and Iowa men and women. Conversely, systolic and diastolic blood pressure were consistently inversely related to exertional chest pain. For example, among East Boston men and women, those without exertional chest pain had systolic blood pressure levels 4–6 mm Hg higher on average than those reporting exertional chest pain ($p < 0.05$ for men and women).

Few differences in the percent currently smoking were observed between those with and without exertional chest pain. Women in New Haven and Iowa with exertional chest pain were more likely to be current smokers. In contrast, proportions of former smokers were consistently higher among those with exertional chest pain. The only exception was Iowa women, for whom the reverse pattern was observed, and for whom the prevalence of current and former smoking was much lower than in the other commu-

nities. Finally, little difference was observed in the proportions consuming ≥ 0.5 oz/day of alcohol on average between those with and without exertional chest pain. However, alcohol consumption was generally lower among women than men and particularly low among Iowa women.

Approximately 20% of men and women with exertional chest pain had used nitrates (Table 2). The proportion of nitrate users among those with Rose angina did not differ from that observed among subjects with exertional chest pain. Those with no chest pain symptoms and nonexertional chest pain had a much lower proportion of nitrate users (3% or less).

In five of six groups stratified by community and sex, subjects with exertional chest pain had two to three times higher age-adjusted rates of coronary heart disease mortality than those with no chest pain (Figure 1). For example, Iowa women with exertional chest pain had a coronary heart disease mortality rate of 5.4% in contrast to 1.9% among those with no chest pain. Only among New Haven men were rates of coronary heart disease mortality similar. In gen-

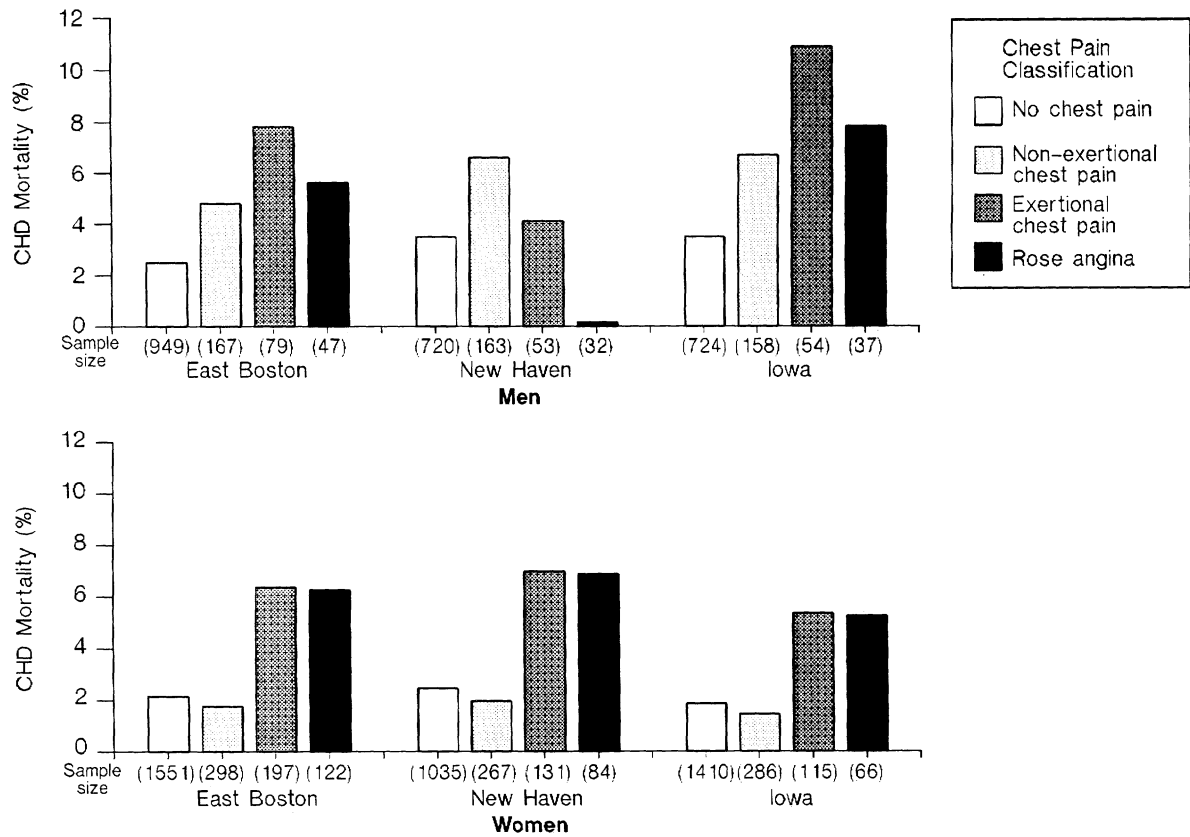


FIGURE 1. Bar graph of age-adjusted rates of coronary heart disease (CHD) mortality within 3 years (per 100) according to chest pain at baseline among EPESE participants in three communities.

eral, those with exertional chest pain had coronary heart disease mortality rates about the same, or higher, than the subset of subjects with Rose angina. The only exception was in New Haven men, for whom no coronary heart disease deaths occurred among those reporting Rose angina. Among all groups of women, coronary heart disease mortality rates for those with nonexertional chest pain were less than or about the same as mortality rates for those with no chest pain. Among men, coronary heart disease mortality rates in those with nonexertional chest pain were about twice as high as rates in men with no chest pain. In New Haven, rates for those with nonexertional chest pain were also 60% higher than rates in those with exertional chest pain.

Community-stratified summary relative risks from proportional hazards regression models showed that older men and women with exertional chest pain experienced two to three times the risk of coronary heart disease mortality within 3 years as subjects without such chest pain (Table 3). Age adjustment tended to increase the strength of association. The summary relative risks attained statistical significance, as did the relative risks in some subgroups (i.e., East Boston men and women and Iowa women).

Adjusting for age, history of diabetes, history of hypertension, current and former smoking, and systolic blood pressure yielded estimates similar to those adjusted for age alone (Table 3). Alcohol consump-

tion was not included because of its very low prevalence in women. Overall, the relative risks for exertional chest pain were 2.4 for men and 2.7 for women. These as well as several stratum-specific comparisons achieved statistical significance. For those aged 75 and older, the association of exertional chest pain with coronary heart disease mortality remained strong and statistically significant with relative risks of 2.2 (95% confidence interval 1.0–4.9) in men and 3.5 (95% CI, 2.0–6.0) in women (data not shown).

The relation of Rose angina to coronary mortality was compared with that of exertional chest pain not fulfilling the Rose criteria in similar multivariate survival models. In women, risk of coronary mortality was approximately equivalent in these two groups; the community-stratified relative risk for Rose angina was 2.7 (95% CI, 1.6–4.7), and for non-Rose exertional chest pain was 2.5 (95% CI, 1.3–5.0). In men, those with non-Rose angina were at higher risk for coronary death (community-stratified relative risk=4.2; 95% CI, 2.0–8.7) than men with Rose angina (community-stratified relative risk=1.4; 95% CI, 0.6–3.6). Therefore, the use of a simple measure of exertional chest pain (i.e., combining these two groups) was as good a predictor of coronary mortality as the full Rose Questionnaire in both sexes and perhaps a better predictor of coronary mortality in men.

The relations of risk factors to coronary heart disease mortality were reasonably consistent across

TABLE 3. Relative Risks Relating Exertional Chest Pain to Coronary Heart Disease Mortality During 3 Years of Follow-up Among EPESE Participants

Risk factor	Community-stratified summary relative risk* (95% CI)		
	Unadjusted	Age adjusted	Adjusted for standard coronary risk factors
Men			
Exertional chest pain	2.0 (1.1–3.6)	2.3 (1.3–4.1)	2.4 (1.4–4.4)
Age (10-year difference)		2.3 (1.8–2.9)	2.5 (2.0–3.2)
History of diabetes			1.8 (1.1–3.0)
History of hypertension			1.4 (0.9–2.0)
Current smoking			1.8 (1.1–2.9)
Former smoking			1.0 (0.7–1.6)
Systolic blood pressure (20 mm Hg difference)			1.0 (0.9–1.3)
Women			
Exertional chest pain	2.8 (1.8–4.3)	3.1 (2.0–4.8)	2.7 (1.7–4.2)
Age (10-year difference)		2.5 (2.0–3.1)	2.9 (2.3–3.8)
History of diabetes			2.4 (1.5–3.6)
History of hypertension			2.0 (1.4–2.9)
Current smoking			2.4 (1.4–3.9)
Former smoking			0.6 (0.3–1.3)
Systolic blood pressure (20 mm Hg difference)			1.1 (0.9–1.3)

CI, confidence interval.

*Relative risks obtained from Cox regression models stratified by community. Model provides an overall estimate of relative risk by summing over stratum-specific parameter estimates.

Community-specific results are available on request from Dr. LaCroix.

communities (data not shown) and for both sex groups (Table 3). Age, history of diabetes, and current (but not former) smoking were consistently related to higher risks of coronary heart disease mortality, with relative risks ranging between about 2 and 3. History of hypertension was a stronger and more consistent risk factor for women than men (relative risk [RR]=2.0 for women and 1.4 for men, overall). In separate analyses, exertional chest pain was excluded from these multivariate models, and the relative risk estimates for all other coronary risk factors shown in Table 3 were essentially unchanged (data not shown). In addition, we examined the same coronary risk factors in separate models for those with and without exertional chest pain and observed striking similarity in relative risk estimates between these groups (data not shown). Although comparable

in terms of the magnitude of the risk estimates, relative risks in the group with exertional chest pain were less statistically significant than in the group without this symptom, due to a much reduced sample size in the former group. The only marked difference was observed in men, for whom current smoking was a strong, positive risk factor in those without chest pain, but was not associated with coronary deaths among those with exertional chest pain.

We also determined whether exertional chest pain was a predictor of other causes of death (Table 4). Overall, the relative risk for total mortality associated with exertional chest pain was 1.5 for men and 1.4 for women, with lower 95% confidence bounds of 1.0 for both sexes. There was no evidence for an association of exertional chest pain with noncoronary causes of death; relative risks for noncoronary mortality were

TABLE 4. Relative Risks Relating Exertional Chest Pain to Total Mortality, Coronary Heart Disease Mortality, and Noncoronary Heart Disease Mortality During 3 Years of Follow-up Among EPESE Participants

	Community-stratified summary of relative risk* (95% CI)		
	Total mortality	Coronary heart disease mortality	Noncoronary heart disease mortality
Men	1.5 (1.0–2.1)	2.4 (1.4–4.4)	1.2 (0.7–1.8)
Women	1.4 (1.0–1.9)	2.7 (1.7–4.2)	1.0 (0.7–1.5)

CI, confidence interval.

*Relative risks obtained from Cox regression models stratified by community. Model provides an overall estimate of relative risk by summing over stratum-specific parameter estimates. All relative risks are adjusted for age, history of diabetes, history of hypertension, current smoking, former smoking, and systolic blood pressure. Subjects without exertional chest pain are the reference group.

Community-specific results are available on request from Dr. LaCroix.

weak and nonsignificant in all groups. Overall, the community-stratified summary relative risks for non-coronary mortality were 1.2 for men and 1.0 for women. In further analyses, no significant associations were observed between exertional chest pain and cardiovascular mortality excluding coronary heart disease deaths (i.e., 216 deaths coded as ICD-9-CM 390-448 excluding 410-414); the summary relative risks were 0.9 for men and 1.1 for women (data not shown). In addition, the inclusion of deaths from "arteriosclerotic cardiovascular disease" (i.e., 95 deaths coded as ICD-9-CM 429.2) with coronary heart disease deaths produced similar relative risks to those presented in Tables 3 and 4 (data not shown).

For New Haven and Iowa men, a history of non-exertional chest pain, versus no chest pain, was significantly associated with a twofold increased risk of coronary mortality after adjusting for other coronary risk factors, consistent with the crude coronary mortality rates presented by chest pain category in Figure 1 (data not shown). The association of non-exertional chest pain with coronary death was 1.9 for men overall (95% CI, 1.2–3.1). No significant associations for nonexertional chest pain were observed among women, for whom the overall relative risk was 0.8 (95% CI, 0.5–1.5). Relative risks for coronary heart disease mortality comparing subjects with exertional chest pain to those with no chest pain were similar for men and women in these models (RR=2.8 for men and 2.6 for women, overall).

Discussion

In this prospective study, exertional chest pain was a strong, independent predictor of coronary heart disease death within 3 years for older men and women. There were no differences in the prognostic implications of this symptom between the sexes, the relative risks being 2.4 in men and 2.7 in women. The risk of coronary heart disease mortality for those reporting chest pain on exertion was at least as high as the risk for participants whose chest pain met all the criteria of angina on the Rose Questionnaire. The association between exertional chest pain and coronary heart disease mortality was independent of other coronary risk factors. Furthermore, the association was specific for deaths from coronary heart disease, as there was no association between exertional chest pain and noncoronary causes of death.

These findings are similar to previous prospective studies in predominantly middle-aged populations that have shown an association between uncomplicated angina measured by questionnaire and cardiovascular mortality in men.^{10–13,15,16} Estimates of relative risk in these studies have ranged from 2 to 7. Although each of these studies considered age in their analysis, none had sufficient numbers of men over age 65 to examine this relation in older men. In contrast to men, past studies of younger and middle-aged women have been equivocal with some,^{12,17–19} but not all,^{13,15} reports supporting an association

between chest pain measured by questionnaire and cardiovascular mortality. Those studies demonstrating an increased risk of coronary mortality among women reporting chest pain have done so consistently for those aged 55 and older with relative risks ranging between 2 and 6. However, all these studies have included few women over the age of 65 at entry. Because risk of coronary heart disease mortality is so low among women before age 65, these studies have often been based on very few events.^{13,15,18} The findings of the present study suggest that older women with exertional chest pain have nearly three times the risk of coronary death within 3 years as their counterparts free of exertional chest pain, and the strength of this association was equal to that observed in older men. These results are consistent with earlier findings from the Framingham Study based on clinical diagnoses of angina in which lower survival compared with the general population was observed among women aged 60–69 with angina during an 8-year follow-up.²⁷ In that study, survival probabilities among older women with angina were comparable to those of men aged 50 and older with angina (60% alive at the end of follow-up).

In past studies, simple one-item measures of chest pain have predicted future risk of cardiovascular death.^{28,29} Among subjects aged 65 and older in the Alameda County study, the report of "pain in the heart or tightness or heaviness in the chest" was associated with 2.0 times the risk of coronary heart disease mortality in men and 1.9 times the risk in women during a 9-year follow-up.²⁹ These results are consistent with the present study in which a simplified measure of exertional chest pain was as strong a predictor of coronary heart disease as the full Rose Questionnaire in older people. The simple measure of exertional chest pain used in this study identified a group of older people at risk for coronary death that was 50–75% larger than those with positive Rose Questionnaire angina.

In the present study, the relation of exertional chest pain to risk of coronary mortality was independent of several coronary risk factors including age, history of diabetes, history of hypertension, current and former smoking, and systolic blood pressure. Several other studies have also observed that the relation of chest pain symptoms to coronary death persists after controlling for other risk factors either by matching,²⁸ stratification,^{10,16} or multivariate analysis.^{15,16,19,30} Chest pain on exertion may be a marker of coronary atherosclerosis and, therefore, could be considered an intermediate variable in the causal chain that occurs between traditional risk factors and coronary death. If so, then confounding of the chest pain–coronary mortality association by standard coronary risk factors would not be expected. The low prevalence of exertional chest pain in these cohorts, for whom the prevalence of atherosclerosis would be presumed high given the older age of all participants, suggests that if chest pain symptoms act as an intermediate variable, they do so only for a

minority of those at risk for coronary death. In this study, many older individuals at risk for coronary death by virtue of elevations in coronary risk factors did not have a history of chest pain at baseline. However, some may have developed chest pain between the baseline and their fatal coronary event.

In the present study, coronary risk factors increased risk of fatal coronary outcomes among individuals with chest pain on exertion as well as in those free of chest pain. There is some indirect evidence that this observation extends to serum cholesterol (which was not measured at baseline in the present study) from several other prospective studies.^{10,15,16,19} These findings imply that standard coronary risk factors have similar influence on future risk of coronary death among subjects with and without chest pain on exertion.

In this prospective study focused on older men and women, risk factors for coronary death were similar to those identified in middle-aged populations and included age, current smoking, history of diabetes, and history of hypertension. Although, among those with exertional chest pain, current smokers had similar risks of death from coronary heart disease as nonsmokers; this finding must be interpreted with caution. The number of men considered in this analysis was small ($n=182$), and they had a greater likelihood of quitting smoking before the baseline interview. The totality of evidence indicates that preventive measures aimed at risk factor reduction should be targeted to all older people regardless of their chest pain history.³¹

The specificity of the association of exertional chest pain with coronary heart disease mortality observed in the present study is also consistent with previous investigations of middle-aged populations.^{12,13,19} Each has shown no or only weak associations between angina as measured by the Rose Questionnaire and noncardiovascular mortality in the presence of strong, positive relations of angina with cardiovascular mortality. These findings support the conclusion that chest pain on exertion is a symptom that predicts future coronary heart disease death in elderly as well as in middle-aged populations.

The present study provides some evidence that risk of coronary heart disease death is increased for men (but not women) reporting atypical chest pain symptoms, identified in this study as nonexertional chest pain. One plausible explanation for the sex difference in this finding is that older men recall fewer details about their chest pain symptoms than older women. The accuracy and completeness of reporting medical conditions in health surveys has been shown to be higher among women than among men aged 65 and older.³² Overall, men with nonexertional chest pain were twice as likely to die of coronary heart disease within 3 years as those without this symptom. In a prospective study of British civil servants aged 40–64 followed for 5 years, Rose observed a small increased risk of coronary death among men reporting “other chest pain and discomfort”¹⁰ ($RR=1.4$ for men aged

60–64). A study of Finnish men aged 40–59 followed for 5 years also showed a weak association between “chest pain not related to effort” and coronary heart disease mortality¹³ ($RR=1.5$). A recent case-control study showed a relation of noncardiac chest pain symptomatology to short-term risk of first acute myocardial infarction among hypertensives without prior history of clinically diagnosed angina.³⁰ In that study, the group with noncardiac chest pain included subjects who presented for medical care with symptoms of syncope, dyspnea, or sensations of “pain, burning, tightness, heaviness, or discomfort originating anywhere between the jaw and the navel” without regard for onset with exertion. Our findings suggest that such symptoms are frequent in older populations (14–19%) and may have prognostic implications for older men. If such an association is confirmed in future studies, it will become important to characterize categories of patients with atypical chest pain so that its origin and influence on risk of coronary heart disease can be better understood.

As expected, use of nitrates among older people in these three cohorts was more common among those with chest pain on exertion. However, approximately 80% of subjects reporting exertional chest pain were not taking nitrates. It is possible that those with exertional chest pain may have taken other antianginal medications such as β -blockers, which are also prescribed for a variety of cardiovascular conditions other than angina. The inverse association of blood pressure with exertional chest pain observed in this study at baseline has been observed previously for men in a national cross-sectional study,³³ and may be due to greater use of antihypertensives (which was observed) or antianginal drugs, which are known to lower blood pressure. This finding is not likely to be a result of myocardial dysfunction secondary to past, recognized myocardial infarction, since participants with such a history were excluded from these analyses.

The present study was limited to a follow-up period of 3 years, so the conclusions are restricted to short-term coronary heart disease mortality. We were unable to consider nonfatal myocardial infarction as an endpoint due to the lack of an adequately validated surveillance system for its occurrence at this time. The measurement of angina symptoms was based solely on questionnaire responses, and we were unable to directly consider clinically diagnosed angina as an alternative method for classification of chest pain symptoms. On the other hand, our ability to perform this investigation in three cohorts is an obvious strength of the present study since the opportunity to replicate results from one community was immediately available. Although remarkable consistency was observed in the relation of chest pain and other risk factors to coronary mortality, the associations were, as expected, sometimes not uniformly present or of equal magnitude. This is likely to reflect the play of chance or perhaps even some heterogeneity of risk in older populations.

Taken together however, our findings support a strong, positive, independent association between exertional chest pain and risk of coronary heart disease death within 3 years in men and women aged 65 and older. Several aspects of this study may have implications for clinicians evaluating risks of mortality from coronary heart disease in older patients and for investigators designing, analyzing, and interpreting survey instruments for these populations. Among older people, the report of exertional chest pain conveys prognostic information regardless of the pain's duration, alleviation, or location, suggesting that risk of coronary heart disease death extends to a broader subgroup of older people than is encompassed by classic angina pectoris. In marked contrast to the epidemiologic evidence and clinical observations in middle-age that angina symptoms are less important for women than men, these findings indicate no difference in the magnitude of risk of death from coronary heart disease conveyed by chest pain on exertion for older women and men.

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