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Sex differences in survival after myocardial infarction in Sweden

Data from the Swedish National Acute Myocardial Infarction register

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Aims Women, particularly younger women, hospitalized with acute myocardial infarction have been found to have poorer prognosis than men. A large proportion of deaths due to myocardial infarction, however, occur in the pre-hospital phase. We set out to analyse age-specific sex differences in survival after myocardial infarction at different time intervals from the onset of acute myocardial infarction, including pre-hospital deaths and 1-year overall survival.

Methods and Results The National Acute Myocardial Infarction Register in Sweden was used to analyse age-specific sex differences in mortality outside hospital, 28-day mortality and 1-year mortality in 353 905 cases occurring between 1987 and 1995 in Swedish men and women aged 30 to 89 years. Overall, one in four of all myocardial infarction victims died outside hospital. At all ages, except in individuals younger than 50 years, men had higher pre-hospital mortality. The odds of dying within 28 days for women below 50 years of age, compared to men, was 1·84 (1·56–2·18) in hospitalized patients and 1·31 (1·18–1·46) in all infarction patients. Above the age of 65, in the total population with myocardial infarction, women had a better prognosis, with odds ratios ranging from 0·83 to 0·89. In patients surviving the first 28 days, 4·0% of the women and 2·9% of the men below the age of 50 were dead within a year after the infarction, odds ratio 1·37 (1·06–1·76). This excess mortality was mainly due to diabetes and non-cardiac causes. Only women younger than 50 years had a significantly poorer overall 1-year survival than men of the same age. At the age of 70 or more, women had a small survival advantage.

Conclusion In the total acute myocardial infarction population, only women under 50 years of age have a consistently worse prognosis than men. Much of the excess mortality in young women seems to be associated with diabetes.

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Key Words: Myocardial infarction, women, survival, population, diabetes.

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Introduction

In Sweden, as in most other Western countries, coronary heart disease is the leading cause of death, in women, as well as in men. However, women are affected later in life than men. Below 55 years of age the risk in men is four times that of women, and at any given age, the incidence of acute myocardial infarction in women is more or less the same as that of men 10 years younger[1]. With increasing age, the incidence of acute myocardial infarction increases markedly. However, even though the relative difference in women and men, with respect to risk of myocardial infarction and coronary death, decreases with age, incidence and mortality from myocardial infarction remain lower in women throughout life.

However, once a woman manifests coronary disease in the form of myocardial infarction, she loses her survival advantage, and fares no better, or worse, than men of the same age with myocardial infarction. The

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prognosis of women with myocardial infarction has been much debated over the last few years. In several papers[2–8], women have been found to have worse short-term prognosis than men, but in general, this has been partly attributed to differences in age and prior disease, mainly diabetes. New light was recently shed on this issue, with the publication by Vaccarino *et al*. who showed a significant interaction between sex and age, with younger, but not older, women having higher rates of death during hospitalization than men of the same age[9]. Among patients less than 50 years of age, the mortality rate for the women was twice that for the men. Differences in medical history, severity of the infarction and early management accounted only for about one third of the difference in risk.

The paper by Vaccarino *et al*.[9] was based on a massive database which included nearly 400 000 hospitalized patients. The sheer size of the sample, the detailed protocol and the careful validation of the methods, ensure the reliability of this study. However, the database only covered patients admitted alive, and no data were available with respect to post-hospital course. Two studies based on registries participating in the World Health Organization's Monitoring Trends and Determinants in Cardiovascular Disease (MONICA) Project have shown that a higher death rate during hospitalization in women is balanced by a higher rate of pre-hospital death in men[10,11]. These two studies, although covering more than 5000 patients each, included a limited number of younger women, particularly women under 50 years, and no data on outcome were available beyond 28 days. Also, there were no data in persons above the age of 64 years.

The present study uses data from more than 350 000 incident cases of acute myocardial infarction in Swedish men and women aged 30 to 89 years. In a recent publication from this register[12], gender differences in hospitalized patients were very similar to those reported by Vaccarino *et al*.[9]. The aim of the present study was to investigate the effect of age and gender on survival after myocardial infarction in the pre-hospital phase, after 28 days and after 1 year.

Methods

In Sweden all patients discharged from hospital are registered in the National Hospital Discharge Register. Virtually all patients with diagnosed acute myocardial infarction are hospitalized, and, with very few exceptions, in public hospitals, open to all. Subjects dying outside hospital, with a diagnosis of myocardial infarction are reported to the National Cause of Death Register. In this manner all serious cases of acute myocardial infarction will be covered either by the National Hospital Discharge Register or the Cause of Death Register. The National Acute Myocardial Infarction Register was established in 1996 by record linkage between the Hospital Discharge Register and the Cause of Death Register of all fatal and non-fatal cases of acute myocardial infarction occurring between 1987 and 1996, with complete data until 1995[1].

The present study uses data from the Acute Myocardial Infarction Register on men and women aged 30 to 89 years who died between 1987 and 1995, according to the Cause of Death Register, or who were discharged from hospital during the same period according to the Hospital Discharge Register, with acute myocardial infarction either as a principal or as a contributory diagnosis (code 410 according to the 9th revision of the International Classification of Diseases which was used in Sweden throughout the period).

Incident cases of acute myocardial infarction were identified as follows, by using the date of admission, and date of death if applicable:

- For each person entered in the Acute Myocardial Infarction Register, an acute myocardial infarction event was registered on the date of admission, or as death, for persons dying outside hospital, without previously having been treated in hospital.
- All further admissions or deaths within 28 days from the first admission were registered as referring to the same acute myocardial infarction event.
- Admissions or deaths occurring more than 28 days after the first admission were treated as new acute myocardial infarction events.
- Patients discharged from hospital with a diagnosis of acute myocardial infarction, and admitted to a rehabilitation or geriatric clinic the next day, at the latest, were not registered as a new incident case.

This method of classifying cases of acute myocardial infarction has been developed and evaluated in previous studies[13,14]. The Acute Myocardial Infarction Register has data on 353 905 incident cases diagnosed with acute myocardial infarction in men and women aged 30 to 89 from 1987 to 1995. Only persons with a formally correct Swedish 10 digit personal identification number are included in the Acute Myocardial Infarction Register. Of all admissions, 1544 (0·5%) did not have a correct 10-digit code, either because the patient was not a Swedish citizen, or because of a coding error. All subjects registered in the Cause of Death Register had a valid code.

In the Hospital Discharge Register 1·2% of all admissions lacked information on principal diagnosis. For medical admissions this figure was 0·8%. The diagnostic information of the Acute Myocardial Infarction Register has been evaluated, using a random sample of 2065 medical records, 1848 of which were possible to analyse, with a discharge diagnosis of either acute myocardial infarction (ICD code 410) or other ischaemic heart disease (ICD codes 411-414). For each subject, the registered diagnoses from the two national registries were compared with diagnoses from the medical records or the death certificate, and also with pre-defined criteria for myocardial infarction. According to these criteria, a definite acute myocardial infarction was considered to be present if there were signs of recent myocardial necrosis at autopsy, a new pathological Q wave on the

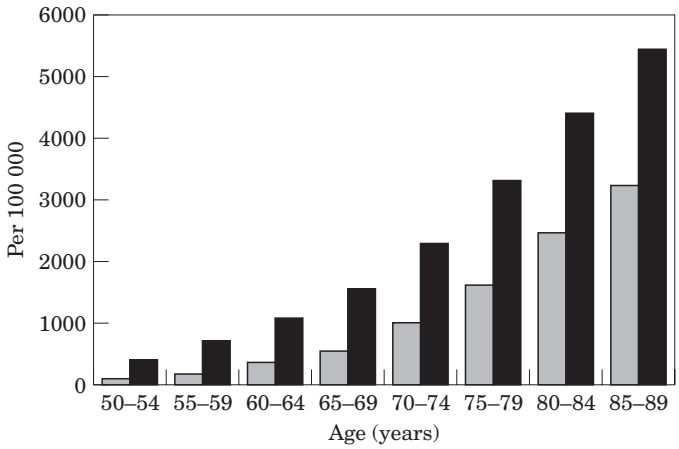

Figure 1 **Incidence of acute myocardial infarction in 1995 by age and sex among Swedish men (■) and women (□) aged 50 to 89 years.**

ECG, or typical symptoms or new ST elevation or T inversion on the ECG in combination with typical enzyme changes. In some cases, the criteria for a definite diagnosis of acute myocardial infarction were not fulfilled. These medical records were examined by an experienced cardiologist who classified the events into probable infarction or no infarction. Of the patients with a diagnosis of acute myocardial infarction in the Acute Myocardial Infarction Register, 89% fulfilled the pre-defined criteria, and another 7% were classified into the category of 'probable infarction'. Among hospitalized patients with an ischaemic heart disease diagnosis, but without a diagnosis of acute myocardial infarction at discharge, only 3% were found to fulfil the criteria. Coding errors occurred only very rarely. The fulfilment of the diagnostic criteria for acute myocardial infarction did not vary substantially by age or gender.

This analysis is restricted to all incident cases of acute myocardial infarction between the years 1987 and 1995. We only considered cases who were 30 to 89 years old at the time of the infarction. There were 132 515 incident cases of acute myocardial infarction or death from myocardial infarction in women and 221 390 cases in men, altogether 353 905 cases. The register covers deaths outside hospital, deaths in hospitalized patients from day 0 to 28, and deaths from day 29 to 365. Deaths after the 29th day are presented as due to ischaemic heart disease (ICD code 410-414, 9th revision of the ICD code), as due to diabetes (ICD code 250) or as due to any cause except ischaemic heart disease and diabetes.

Statistical methods

We used the SAS statistical package (version 6.12). Analyses were carried out in separate age strata. Relative risks are expressed as age-adjusted odds ratios, with 95% confidence intervals. The Breslow–Day test was used to assess whether there was an interaction between age and sex[15].

Results

Figure 1 shows the incidence of acute myocardial infarction in Swedish men and women in 1995. Although the relative difference between women and men decreases with age, the incidence continues to be considerably higher in men at advanced ages.

Below the age of 60, there was a strong preponderance of men with more than four times as many men, compared to women, in the register (Table 1). In men, 26% of all myocardial infarction cases occurred before the age of 65, as compared to only 11% in women. Up to age 80, the absolute number of acute myocardial infarction cases was higher in men; between age 80 and 84 there were about as many infarctions in women as in men. In the highest age stratum, due to more women than men surviving to advanced ages, there were more women with myocardial infarction.

The proportion of patients dying before reaching hospital increased from 13% and 14%, respectively, in men and women aged 30 to 49 years, to 36% and 33% among those aged 85 to 89 years (Table 2). The overall out-of-hospital mortality was 24% in women and 25% in men. At all ages, except below 50 years, a larger proportion of men, compared to women, died outside hospital. 28-day mortality in hospitalized patients ranged from 6% and 10% in men and women younger than 50 years to 43% and 40%, respectively, among the oldest patients.

Total 28-day mortality, including deaths outside hospital, was 18% and 23% in men and women below 50 years and increased to 64% and 60% in the oldest age group (Table 2). The odds ratio of dying within 28 days for women below 50 years of age, compared to men, was 1·84 (1·56–2·18) in hospitalized patients and 1·31 (1·18–1·46) in all acute myocardial infarction patients. In contrast, women aged 65 or more had odds ratios ranging from 0·83 to 0·89 compared to men if the total population above 65 years with myocardial infarction was considered. In the hospitalized population, only

Table 1 Number of acute myocardial infarction cases among Swedish men and women aged 30 to 89 years during 1987 to 1995

Age (years)	Women			Men			Ratio absolute number of cases women/men	Rate ratio, incidence women/men
	Number of MI cases	Per cent of all cases	Cumulative percentage	Number of MI cases	Per cent of all cases	Cumulative percentage		
<50	2416	1·8	1·8	10 947	4·9	4·9	0·22	0·23
50–54	2124	1·6	3·4	9892	4·5	9·4	0·21	0·22
55–59	3605	2·7	6·1	14 553	6·6	16·0	0·25	0·24
60–64	7001	5·3	11·4	22 056	10·0	25·9	0·32	0·30
65–69	12 981	9·8	21·2	32 576	14·7	40·7	0·40	0·35
70–74	21 386	16·1	37·4	40 753	18·4	59·1	0·52	0·43
75–79	29 716	22·4	59·8	42 195	19·1	78·1	0·70	0·52
80–84	31 650	23·9	83·7	32 524	14·7	92·8	0·97	0·59
85–89	21 636	16·3	100·0	15 894	7·2	100·0	1·36	0·66
	132 515			221 390				

women aged 75 years or more had a better prognosis than men. The overall age-adjusted odds ratio for dying outside hospital in women compared to men was 0·79 (0·78–0·80), and for all deaths during the first 28 days 0·86 (0·85–0·87).

In those patients surviving the first 28 days, 4·0% of the women and 2·9% of the men below the age of 50 years were dead within a year after the infarction (odds ratio 1·37 (1·06–1·76), Table 3). The proportion dying within the first year increased to 11% in men and women aged 65 to 69 years, with no difference between men and women. After the age of 69 years, women had a small survival advantage, with odds ratios, compared to men, of 0·91 to 0·94. There was a significant interaction between age and sex ($P<0·0001$).

In patients surviving the first 28 days there was no significant gender difference with respect to deaths due to ischaemic heart disease during the first year (Table 3). In contrast, there was a large difference in deaths attributed to diabetes. Almost a third of all deaths after the first 28 days in women with myocardial infarction below the age of 50 years were attributed to diabetes, but only 5% among the male deaths. The odds ratio for dying with a diagnosis of diabetes for women compared to men below 50 years after an infarction was 8·57 (4·33–17·0). Of the 75 deaths which occurred in women below the age of 50 years after the first 28 days, half or 37 death certificates gave diabetes as either the underlying or contributory cause of death, as opposed to about one in five of the men below 50 years.

Of the total number of female patients below the age of 50 years, altogether 26% died during the first year, with more than half the deaths occurring before hospitalization; the mortality after the first 28 days was comparatively low. In men below 50 years, 20·8% died during the first year (Table 4). Corresponding figures in men and women aged 85 to 89 years were 76·6 and 73·1%, respectively. After the age of 55 years, mortality due to ischaemic heart disease after the first 28 days was virtually identical in men and women. Non-ischaemic heart disease mortality was higher in younger women. Odds ratios for death within 1 year in the total and in the hospitalized population are shown in Fig 2. In the total population, only women younger than 50 years had poorer 1-year survival than men in the same age range. In the hospitalized population, women up to the age of 70 years continued to have higher mortality than men.

Discussion

In the present study, covering over 350 000 cases of non-fatal and fatal acute myocardial infarction in Swedish men and women, we found that younger, but not older, women, hospitalized with myocardial infarction, had a higher short-term, as well as long-term mortality, compared to men of the same age. However, a sizable proportion of deaths from myocardial infarction occurred suddenly, outside hospital and if pre-hospital deaths from myocardial infarction were included, there was little or no difference between women and men between 50 and 70 years of age. After the age of 70, women had better 28-day, as well as 1-year survival. Women below 50 years still had an increased 28-day, as well as 1-year mortality.

A large number of studies among hospitalized patients with myocardial infarction have found a worse prognosis in women compared to men[2–8] but there are exceptions[16–18]. Patient selection may account for some of the difference. Some studies have compared male and female patients eligible for trials with thrombolytic therapy[19,20]. As ST elevation is a pre-requisite in many of these trials and as women with myocardial infarction less often than men present with ST elevation[8], these studies may have selected patients who were more sick than the total population of female patients with myocardial infarction. Likewise, in studies of men and women admitted to a coronary care unit with a high proportion of patients with Q wave infarction[2,4], those women who were admitted may have had more serious infarctions than other women with myocardial

Table 2 Mortality in the first 28 days after registration for acute myocardial infarction in men and women aged 30 to 89 years

Age (years)	Women			Men			Odds ratio
	Cases registered with AMI	Died, n	Died, %	Cases registered with AMI	Died, n	Died, %	
Out-of-hospital							
30–49	2416	343	14·2	10 947	1470	13·4	1·07 (0·94–1·21)
50–54	2124	273	12·9	9892	1471	14·9	0·84 (0·74–0·97)
55–59	3605	508	14·1	14 553	2587	17·8	0·76 (0·68–0·84)
60–64	7001	1197	17·1	22 056	4556	20·7	0·79 (0·74–0·85)
65–69	12 981	2335	18·0	32 576	7393	22·7	0·75 (0·71–0·79)
70–74	21 386	4226	19·8	40 753	10 514	25·8	0·71 (0·68–0·74)
75–79	29 716	6659	22·4	42 195	11 561	27·4	0·77 (0·74–0·79)
80–84	31 650	8624	27·2	32 524	9969	30·7	0·85 (0·82–0·88)
85–89	21 636	7210	33·3	15 894	5761	36·2	0·88 (0·84–0·92)
Total	132 515	31 375	23·7	221 390	55 282	25·0	0·93 (0·92–0·95)
					Age-adjusted odds ratio		0·79 (0·78–0·80)
Hospitalized cases							
30–49	2073	209	10·1	9477	543	5·7	1·84 (1·56–2·18)
50–54	1851	187	10·1	8421	594	7·1	1·48 (1·25–1·76)
55–59	3097	366	11·8	11 966	1163	9·7	1·24 (1·10–1·41)
60–64	5804	886	15·3	17 500	2194	12·5	1·26 (1·16–1·37)
65–69	10 646	2032	19·1	25 183	4440	17·6	1·10 (1·04–1·17)
70–74	17 160	3988	23·2	30 239	6937	22·9	1·02 (0·97–1·06)
75–79	23 057	6541	28·4	30 634	9115	29·8	0·94 (0·90–0·97)
80–84	23 026	7777	33·8	22 555	8131	36·0	0·90 (0·87–0·94)
85–89	14 426	5793	40·2	10 133	4351	42·9	0·89 (0·85–0·94)
Total	101 140	27 779	27·5	166 108	37 468	22·6	1·30 (1·28–1·32)
					Age-adjusted odds ratio		0·98 (0·96–1·00)
All deaths day 0 to 28							
30–49	2416	552	22·8	10 947	2013	18·4	1·31 (1·18–1·46)
50–54	2124	460	21·7	9892	2065	20·9	1·05 (0·93–1·17)
55–59	3605	874	24·2	14 553	3750	25·8	0·92 (0·85–1·00)
60–64	7001	2083	29·8	22 056	6750	30·6	0·96 (0·91–1·02)
65–69	12 981	4367	33·6	32 576	11 833	36·3	0·89 (0·85–0·93)
70–74	21 386	8214	38·4	40 753	17 451	42·8	0·83 (0·80–0·86)
75–79	29 716	13 200	44·4	42 195	20 676	49·0	0·83 (0·81–0·86)
80–84	31 650	16 401	51·8	32 524	18 100	55·7	0·86 (0·83–0·88)
85–89	21 636	13 003	60·1	15 894	10 112	63·6	0·86 (0·83–0·90)
Total	132 515	59 154	44·6	221 390	92 750	41·9	1·12 (1·10–1·13)
					Age-adjusted odds ratio		0·86 (0·85–0·87)

infarction. Also, it has been pointed out[21,22] that the most marked differences in 28-day mortality have been found in countries with low event rates, suggesting that a large number of non-fatal episodes may not be recognized and reported. A study from Spain, where event rates for women are among the lowest in Europe[23], found that, after adjustment for age and co-morbidity, the odds ratio for death within 28 days was 1·7 in women compared to men[24].

In younger women, myocardial infarction is comparatively rare, even in countries where event rates are high, and may tend not to be recognized. In the Framingham study[25], myocardial infarction was more likely to be unrecognized in women than in men. An Icelandic study[26] found that the proportion of all infarctions that were unrecognized decreased from 40% in the youngest to 27% in the oldest women. Accordingly, comparatively higher hospital mortality in women compared to men could be a result of only more severe myocardial infarctions in younger women being recognized.

Age is a much more important determinant of mortality than gender in most studies. In the hospitalized population of the present study only 37% and 40% of men and women, respectively, among those aged 85 to 89 were alive after 1 year, whereas 92% of the men and 86% of the women below 50 survived the first year. However, the important finding in the study by Vaccarino *et al.*[9] was a significant interaction between age and sex, in that younger, but not older women, hospitalized with myocardial infarction had a poorer in-hospital prognosis compared to men. Similar findings have been reported earlier, in smaller studies[2,27–30]. One study in patients considered eligible for thrombolytic therapy reported higher mortality in women than men

Table 3 Mortality from ischaemic heart disease (IHD), diabetes and other causes 29 to 365 days after registration for acute myocardial infarction in men and women aged 30 to 89 years

Age	Women			Men			Odds ratio
	Cases registered with MI	Died, n	Died, %	Cases registered with MI	Died, n	Died, %	
IHD mortality*							
30–49	1864	32	1·7	8934	206	2·3	0·74 (0·51–1·08)
50–54	1664	40	2·4	7827	230	2·9	0·81 (0·58–1·14)
55–59	2731	113	4·1	10 803	431	4·0	1·04 (0·84–1·28)
60–64	4918	279	5·7	15 306	885	5·8	0·98 (0·85–1·13)
65–69	8614	694	8·1	20 743	1718	8·3	0·97 (0·89–1·06)
70–74	13 172	1419	10·8	23 302	2720	11·7	0·91 (0·85–0·98)
75–79	16 516	2507	15·2	21 519	3441	16·0	0·94 (0·89–0·99)
80–84	15 249	3010	19·7	14 424	2989	20·7	0·94 (0·89–1·00)
85–89	8633	1994	23·1	5782	1464	25·3	0·89 (0·82–0·96)
Deaths from diabetes†							
30–49	1864	23	1·2	8934	13	0·2	8·57 (4·33–17·0)
50–54	1664	13	0·8	7827	9	0·1	6·84 (2·92–16·0)
55–59	2731	13	0·5	10 803	19	0·2	2·71 (1·34–5·50)
60–64	4918	32	0·7	15 306	21	0·1	4·77 (2·75–8·27)
65–69	8614	34	0·4	20 743	65	0·3	1·26 (0·83–1·91)
70–74	13 172	74	0·6	23 302	91	0·4	1·44 (1·06–1·96)
75–79	16 516	93	0·6	21 519	114	0·5	1·06 (0·81–1·40)
80–84	15 249	83	0·5	14 424	56	0·4	1·40 (1·00–1·97)
85–89	8633	55	0·6	5782	23	0·4	1·61 (0·99–2·61)
Non-IHD, non-diabetes mortality							
30–49	1864	20	1·1	8934	44	0·5	2·19 (1·29–3·73)
50–54	1664	20	1·2	7827	49	0·6	1·93 (1·14–3·26)
55–59	2731	37	1·4	10 803	95	0·9	1·55 (1·06–2·27)
60–64	4918	91	1·9	15 306	227	1·5	1·25 (0·98–1·60)
65–69	8614	202	2·3	20 743	432	2·1	1·13 (0·95–1·34)
70–74	13 172	406	3·1	23 302	756	3·2	0·95 (0·84–1·07)
75–79	16 516	739	4·5	21 519	1083	5·0	0·88 (0·80–0·97)
80–84	15 249	934	6·1	14 424	1002	6·9	0·87 (0·80–0·96)
85–89	8633	757	8·8	5782	573	9·9	0·87 (0·78–0·98)
Total mortality							
30–49	1864	75	4·0	8934	263	2·9	1·37 (1·06–1·76)
50–54	1664	73	4·4	7827	288	3·7	1·19 (0·93–1·53)
55–59	2731	163	6·0	10 803	545	5·0	1·18 (1·00–1·40)
60–64	4918	402	8·2	15 306	1133	7·4	1·10 (0·99–1·23)
65–69	8614	930	10·8	20 743	2215	10·7	1·01 (0·94–1·09)
70–74	13 172	1899	14·4	23 302	3567	15·3	0·94 (0·89–0·99)
75–79	16 516	3339	20·2	21 519	4638	21·6	0·94 (0·90–0·98)
80–84	15 249	4027	26·4	14 424	4047	28·1	0·94 (0·91–0·98)
85–89	8633	2806	32·5	5782	2060	35·6	0·91 (0·87–0·96)

*Deaths from diagnoses ICD 410-414 (9th revision); †deaths with diabetes as underlying cause, according to the death certificate.

over 70 years of age[7]. Our figures for 28-day mortality are obviously higher than the in-hospital mortality (on average 5 days) reported by Vaccarino *et al.*[9], but otherwise our findings for the hospitalized population are remarkably similar, with 28-day mortality in the hospitalized population significantly higher for women than for men up to 70 years of age. Unlike Vaccarino *et al.* we found a slightly better prognosis in women, compared to men, over 75 years of age.

An added strength of the study by Vaccarino *et al.* was the careful characterization of the hospitalized population, which very clearly demonstrated that younger, but not older women with myocardial infarction, had more diabetes and congestive heart failure, and that women of all ages had more hypertension. The higher prevalence of diabetes in female myocardial infarction patients has been noted in other studies[2,4,8,17,19,20,24,27]. Women have also been found to have a more complicated hospital course[8,9] and fewer interventions[9,31,32]. We had no data on background variables, but in the study by Vaccarino *et al.*, differences in medical history, hospital course and management accounted only for about one third of the difference in the risk. In the present study, diabetes alone accounted for a substantial proportion of deaths in women younger than 50 years. Of the 75 deaths which

Table 4 Mortality at different intervals after acute myocardial infarction in men and women registered in the Swedish Acute Myocardial Infarction Register 1987–1995

Age	All registered cases	Outside hospital %	Day 1 to 28 %	IHD deaths day 29–365 %	Non-IHD deaths day 29–365 %	Total deaths during the first year %
Women						
30–49	2416	14·2	8·7	1·3	1·8	26·0
50–54	2124	12·9	8·8	1·9	1·6	25·1
55–59	3605	14·1	10·2	3·1	1·4	28·8
60–64	7001	17·1	12·7	4·0	1·8	35·5
65–69	12 981	18·0	15·7	5·3	1·8	40·8
70–74	21 386	19·8	18·6	6·6	2·2	47·3
75–79	29 716	22·4	22·0	8·4	2·8	55·7
80–84	31 650	27·2	24·6	9·5	3·2	64·5
85–89	21 636	33·3	26·8	9·2	3·8	73·1
Men						
30–49	10 947	13·4	5·0	1·9	0·5	20·8
50–54	9892	14·9	6·0	2·3	0·6	23·8
55–59	14 553	17·8	8·0	3·0	0·8	29·5
60–64	22 056	20·7	9·9	4·0	1·1	35·7
65–69	32 576	22·7	13·6	5·3	1·5	43·1
70–74	40 753	25·8	17·0	6·7	2·1	51·6
75–79	42 195	27·4	21·6	8·2	2·8	60·0
80–84	32 524	30·7	25·0	9·2	3·3	68·1
85–89	15 894	36·2	27·4	9·2	3·7	76·6

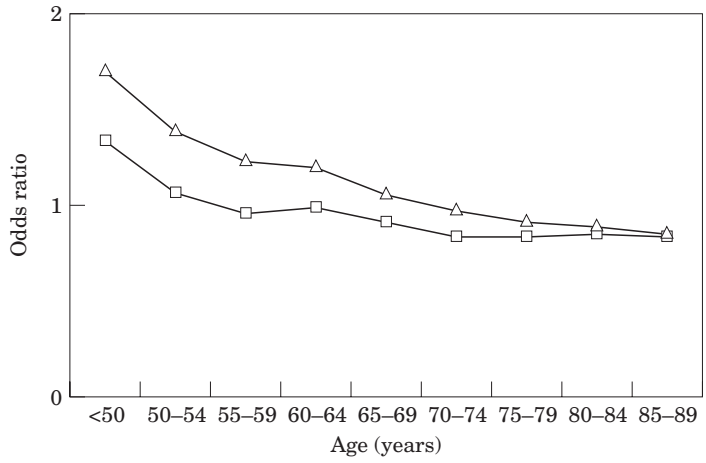

Figure 2 **Odds ratios by age for 1-year mortality after acute myocardial infarction in women compared to men in the hospitalized (△) and total population (□) population in Sweden, 1987 to 1995.**

occurred in women below 50 years after the first 28 days, half stated diabetes as the principal or contributory cause of death, as opposed to about one in five among the men.

The more benign course in the older women, as opposed to the older men, is more difficult to explain. One study showed a small female advantage over the next 2 years in 30-day survivors, after an initial higher 30-day mortality in women[18]. In a population-based study of men and women admitted to hospital with any form of coronary heart disease, women had a better long-term prognosis, but after myocardial infarction, the prognosis was the same after surviving the first 30 days, regardless of sex[17]. It may be that the later onset of coronary disease in women plays a role, with less extensive disease and fewer women than men with previous myocardial infarction, as has been shown in other studies[3,10,33,34].

When analysing mortality from myocardial infarction it is not enough to analyse hospital mortality. A considerable proportion of deaths from acute myocardial infarction occur outside hospital. In our study over 60%

of the 28-day mortality in women below 50 years, and more than 70% in men of the same age, occurred in non-hospitalized persons. The proportion of out-of-hospital deaths decreased slightly at higher ages, more so in men than in women. Similar or higher proportions have been reported in those comparatively few other studies that have reported out-of-hospital events[10,11,22,35]. Most of the cited studies have found that women had lower case fatality before admission, due to the fact that men seemed to die earlier in the attack. The largest study reported from 29 MONICA populations covering almost 80 000 events in men and women aged 35 to 64 years, found that 42% to 75% (median 64%) of all deaths within 28 days occurred before reaching hospital in women, and 58% to 80% (median 70%) in men[22] and that this percentage was lower for women than for men in 22 of the 29 populations. Accordingly, the higher in-hospital death rate in women could be due to the fact that more severely ill women survive until they are hospitalized. We found that women under the age of 50 years had a similar out-of-hospital mortality to men, and that after adding these deaths, women under 50 still had a significantly higher 28-day case fatality than men of the same age, a disadvantage that was maintained over the first year after the event. At all other ages women had a lower risk of dying in the pre-hospital phase than men, and at ages above 65 years, total 28-day survival, as well as total 1-year survival was slightly better than in men.

Gender differences in autopsy rates could lead to fatal cases being more readily diagnosed as myocardial infarction in men, particularly at younger ages. However, in cases below 50 years of age dying outside hospital, a very high proportion, 76% of the men and 79% of the women were autopsied. Autopsy rates declined in the higher age groups but remained over 50% at ages below 65 years. The autopsies revealed no differences between men and women at any age. Even so, some of the small excess mortality in older men outside hospital may have been due to a greater tendency to diagnose myocardial infarction in men. However, this should not affect total mortality after the first 28 days, which was still higher in men. Another limitation of the present study is that the data were collected for other purposes and consequently the criteria for defining an event could not be as rigidly standardized, as for instance in the MONICA study[10]. However, in the validation which was carried out against medical records, the fulfilment of the diagnostic criteria for myocardial infarction were not found to vary substantially by age or gender and any resulting misclassification would therefore probably have been non-differential.

The implications of these findings vary according to point of view. From a population perspective, less than 1% of all infarctions occur in women aged below 50 years and only a very small fraction of deaths from myocardial infarction. If 28-day mortality had been the same for women as for men below 50 years, fewer than 10 deaths per year in this age category would have been avoided, representing only a tiny fraction of 1% of all deaths due to myocardial infarction in Sweden. From a public health perspective major emphasis should be on prevention. In Sweden, the incidence in women aged below 65 years decreases at a lower rate than for men of the same age[1]. This, more than the overall poorer prognosis in young women with myocardial infarction, should be a public health issue, and should lead to preventive action, particularly with respect to smoking. As a majority of deaths occur before reaching hospital, opportunities for reducing coronary deaths in young women by improving medical care are limited. However, from the perspective of the cardiologist, dealing with hospitalized patients, the poorer prognosis in women below the age of 70 years should be a major concern, whatever the cause. Finally, from the point of view of the young woman at hospital with a myocardial infarction, not only is her risk of dying within the first month almost twice that of a male patient of the same age, but her overall chance of survival, compared to women without myocardial infarction, is more compromised than for a man with myocardial infarction, compared to healthy men.

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