Introduction

It is well documented that those with low income have an increased mortality from cardiovascular disease (CVD).1–3 Even though cardiovascular mortality has decreased during the last 30 years, the socioeconomic differences seen in the Western world in mortality from cardiovascular disease still persist.1,4 Studies from France and Scotland as part of the MONICA-project have shown that socioeconomically disadvantaged groups have a higher incidence and case fatality after an AMI.5,6 In these studies, the socioeconomic variations in short-term case fatality were mainly attributed to large differences in pre-hospital deaths. Such differences could partly depend on the health care system of a country. Sweden is an equity-oriented country with a well-developed social security system and has a public health care system where ambulance transport is free of charge and emergency hospital care is available at a very low cost.7 All symptomatic AMI events are treated in public hospitals, where anybody can obtain treatment for a nominal fee (about 10 euros per 24-h period at the hospital covering medications, examinations and treatments during in-hospital care). Thus, the availability of emergency hospital care should not vary by SEP. However, earlier Swedish studies8,9 as well as studies from other countries with similar health care systems such as Canada10 and Finland11 have shown an association between low SEP and increased short-term case fatality after an AMI.

Methods

Study population

The study population of this prospective cohort study consisted of all men (N = 33 723) and women (N = 35 500) born between 1926 and 1950 and living in the city of Malmö in 31 December 1990. All subjects had complete data on income. Subjects with a history of AMI (i.e. 345 men and 115 women, respectively) registered in the regional or national AMI registers during 1987–90 were excluded. The project was approved by the regional ethical committee.

Retrieval and classification of events

Information on morbidity and mortality was obtained by record linkage with the National Inpatient Register (Swedish Board on Health and Welfare), the Swedish Causes of Death Register,13 and the Malmö Myocardial Infarction Register.14 Underlying causes of death and hospitalization diagnosis, respectively, were coded in accordance with the 9th and 10th...
version of the International Classification of Diseases. Myocardial infarction was defined according to the International Classification of Diseases (ICD) 9th edition code 410 or (ICD) 10th edition code I21 according to the diagnosis criteria used in the Nation-wide Swedish Statistics of Acute Myocardial Infarction. Each individual was followed until 31 December 2003, date of first AMI or death. Three categories of outcome after the first AMI were used: pre-hospital death (i.e. deaths among those who did not reach the hospital alive), death within 28 days and survival more than 28 days.

**Income variable**

We used information obtained from the 1990 Swedish census on individual income (including all income from service, wealth and enterprise) as an indicator of SEP. The information on income in the Swedish censuses was register-based and collected from the Swedish register of individual income and wealth at Statistics Sweden. Income was classified into four groups by quartiles: low (1), medium to low (2), medium to high (3) and high (4). We used the low income group as a reference in the comparisons. The absolute income levels for men in each of the quartiles were: first quartile <13200 Euros, second quartile 13200–17830 euros, third quartile 17830–23220 euros and fourth quartile >23220 euros. The corresponding figures for women were: first quartile <9130 euros, second quartile 9130–13440 euros, third quartile 13440–17000 euros and fourth quartile >17000 euros.

**Statistical methods**

Follow-up (in years) was calculated as the time between 1 January 1991 and the first AMI, until death or until 31 December 2003. Sex-specific Cox proportional hazards models were used to estimate the ratios of hazard rates of incident AMI between different levels of income. Hazard ratios (HR) were first estimated for income level in relation to incident AMI. The HRs were presented as age-adjusted ratios (HR) were first estimated for income level in relation to incident AMI. Hazard ratios were calculated and adjusted for age and time to event by means of logistic regression analyses, with the lowest income quartile group as the reference group.

**Results**

**Incidence of myocardial infarction in relation to income**

As seen in table 1, the total number of first events among those aged 40–64 years at baseline during the study period 1991–2003 was 2435 (70.5%) among men and 1017 (29.5%) among women. The incidence rates decreased with increasing income in both men and women, with the lowest incidence rates in the highest income group (444/100000 for men and 120/100000 for women). The age-adjusted hazard ratios of first AMI from Cox proportional hazards model by measures of income in 1990 showed a graded relation with incident AMI, with the lowest HR in the high income groups (HR = 0.7, 95% CI 0.6–0.8) for men and (HR = 0.5, 95% CI 0.4–0.6) for women (data not shown).

**Table 1 Incidence of first acute myocardial infarction and median age at onset by income quartiles in Swedish men and women, aged 40–64 years in 1990**

<table>
<thead>
<tr>
<th>Income*</th>
<th>n</th>
<th>%</th>
<th>Median income 1990 (Euros)</th>
<th>Median age (years)</th>
<th>Incidence per 100 000 person-years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First quartile</td>
<td>686</td>
<td>28.2</td>
<td>8000</td>
<td>62.1</td>
<td>649</td>
</tr>
<tr>
<td>Second quartile</td>
<td>711</td>
<td>29.2</td>
<td>16000</td>
<td>63.7</td>
<td>676</td>
</tr>
<tr>
<td>Third quartile</td>
<td>564</td>
<td>23.2</td>
<td>20400</td>
<td>62.5</td>
<td>531</td>
</tr>
<tr>
<td>Fourth quartile</td>
<td>474</td>
<td>19.5</td>
<td>29400</td>
<td>62.3</td>
<td>444</td>
</tr>
<tr>
<td>Total</td>
<td>2435</td>
<td>100</td>
<td>18100</td>
<td>63.0</td>
<td>574</td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First quartile</td>
<td>357</td>
<td>36.1</td>
<td>6400</td>
<td>67.1</td>
<td>321</td>
</tr>
<tr>
<td>Second quartile</td>
<td>287</td>
<td>28.2</td>
<td>11700</td>
<td>65.7</td>
<td>252</td>
</tr>
<tr>
<td>Third quartile</td>
<td>225</td>
<td>22.1</td>
<td>15200</td>
<td>64.5</td>
<td>197</td>
</tr>
<tr>
<td>Fourth quartile</td>
<td>138</td>
<td>13.6</td>
<td>20500</td>
<td>66.9</td>
<td>120</td>
</tr>
<tr>
<td>Total</td>
<td>1017</td>
<td>100</td>
<td>13700</td>
<td>66.0</td>
<td>229</td>
</tr>
</tbody>
</table>


**Prognosis after the first AMI in relation to sociodemographic characteristics**

Among men, 16.1% (n = 393) died a pre-hospital death, i.e. without reaching the hospital, 7.6% (n = 186) died within 28 days, and 76.2% (n = 1856) survived more than 28 days after the first AMI. A similar distribution was seen in women with the corresponding figures of 14.3% (n = 145), 9.3% (n = 94) and 76.5% (n = 778). Most of all deaths within 28 days after the first AMI were pre-hospital deaths, 68% among men and 61% among women.

Those who died without reaching the hospital were generally older, more often had low income and were more often singles compared to those who survived 28 days or more after the event (all P < 0.05, data not shown) in both men and women. A similar pattern was observed among those who reached the hospital alive, but died within 28 days after the first AMI, with the exception of a lower prevalence of women being singles. There were no differences in prognosis after the first AMI with regard to country of birth defined as born in Sweden or born abroad.

**Pre-hospital death after the first AMI**

A total of 393 (16.1%) men and 145 (14.3%) women died a pre-hospital death due to the AMI. Dying without reaching the hospital was more common among men in lower income groups, 20.6%, than in higher income groups, 12.2%. The corresponding percentages for women were 20.4 and 5.8%, respectively (table 2). Table 2 also shows the odds ratios (OR) of case fatality for pre-hospital death in relation to income after adjustment for age and time-to-event. The odds of dying before reaching the hospital after suffering an AMI were lower for those with the highest compared to the lowest income in both men (OR 0.5; 95% CI 0.4–0.8) and women (OR 0.3; 95% CI 0.1–0.6).

Out of those who died a pre-hospital death after the AMI, 76% had during the last year paid one or more visits to the doctors or nurses attached to the medical care system in Malmö or in the municipalities in the same district and 65% had done so during the last 3 months (data not shown). One third of the patients made their last visit in primary health care (33%) and 21% to a medical clinic at the hospital. Another 16% had visited the emergency clinic, 6% the eye clinic, 4% the surgical clinic,
4% the orthopedic clinic, 3% the ear clinic and 2% the oncological clinic. While 72% of those in the lowest two income groups had paid a visit to the medical services at least once the last three months before their death, only 59% had done so in the two highest income groups \( (P < 0.05; \) after adjustment for age and sex). There were only small differences in the nature of the last visits into medical care and these differences were not statistically significant. For example, 30% of the patients in high income groups and 34% of patients from low income groups made their last visit in primary health care. While 15% of patients from high income groups made their last visit to the emergency clinic, 16% did so among low income groups.

**Twenty-eight days case fatality among those reaching the hospital alive**

In all, 186 of the 2042 men (9.1%) and 94 of the 872 women (10.8%) who reached the hospital alive died within 28 days.

Table 3 shows the age- and time-to-event-adjusted OR of death within 28 days after the AMI among those reaching the hospital alive. There is a similar, but weaker, pattern of association as seen for pre-hospital death. As compared with the lowest income group, the highest income group seemed to have a lower odds for death within 28 days in both men \( (OR = 0.6; 95\% CI 0.4–0.9) \) and women \( (OR = 0.7; 95\% CI 0.3–1.3). \)

**Twenty-eight days case fatality overall**

The overall 28 days case fatality was 23.8% (579/2435) among men and 23.5% (239/1017) among women. Table 4 shows the OR of overall 28 days case fatality in relation to income after adjustment for age and time-to-event. As compared with the lowest income group, the highest income group had lower odds for death within 28 days after the AMI in both

### Table 2

Numbers, percentages and age- and time to event-adjusted OR and 95% CI of pre-hospital death after the first myocardial infarction by income quartiles in the whole population of Malmö, Sweden, ages 40–64 years in 1990

<table>
<thead>
<tr>
<th>Income*</th>
<th>Men</th>
<th></th>
<th></th>
<th></th>
<th>Women</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
<td>OR</td>
<td>95% CI</td>
<td>Number</td>
<td>%</td>
<td>OR</td>
<td>95% CI</td>
</tr>
<tr>
<td>First quartile</td>
<td>141</td>
<td>20.6</td>
<td>1.0</td>
<td>–</td>
<td>75</td>
<td>20.4</td>
<td>1.0</td>
<td>–</td>
</tr>
<tr>
<td>Second quartile</td>
<td>113</td>
<td>15.9</td>
<td>0.7</td>
<td>0.5, 0.9</td>
<td>41</td>
<td>14.3</td>
<td>0.7</td>
<td>0.5, 1.1</td>
</tr>
<tr>
<td>Third quartile</td>
<td>81</td>
<td>14.4</td>
<td>0.6</td>
<td>0.5, 0.9</td>
<td>21</td>
<td>9.3</td>
<td>0.4</td>
<td>0.3, 0.7</td>
</tr>
<tr>
<td>Fourth quartile</td>
<td>58</td>
<td>12.2</td>
<td>0.5</td>
<td>0.4, 0.8</td>
<td>8</td>
<td>5.8</td>
<td>0.3</td>
<td>0.1, 0.6</td>
</tr>
<tr>
<td>Total</td>
<td>393</td>
<td>16.1</td>
<td>–</td>
<td>–</td>
<td>145</td>
<td>14.3</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>


b: OR = Odds ratios; CI = confidence interval.

### Table 3

Numbers, percentages and age- and time to event-adjusted OR and 95% CI of death within 28 days after the first myocardial infarction among those reaching the hospital alive by income quartiles in the whole population of Malmö, Sweden, ages 40–64 years in 1990

<table>
<thead>
<tr>
<th>Income*</th>
<th>Men</th>
<th></th>
<th></th>
<th></th>
<th>Women</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
<td>OR</td>
<td>95% CI</td>
<td>Number</td>
<td>%</td>
<td>OR</td>
<td>95% CI</td>
</tr>
<tr>
<td>First quartile</td>
<td>207</td>
<td>30.2</td>
<td>1.0</td>
<td>–</td>
<td>120</td>
<td>32.7</td>
<td>1.0</td>
<td>–</td>
</tr>
<tr>
<td>Second quartile</td>
<td>164</td>
<td>23.1</td>
<td>0.7</td>
<td>0.5, 0.8</td>
<td>64</td>
<td>22.3</td>
<td>0.6</td>
<td>0.4, 0.9</td>
</tr>
<tr>
<td>Third quartile</td>
<td>120</td>
<td>21.3</td>
<td>0.6</td>
<td>0.5, 0.8</td>
<td>34</td>
<td>15.1</td>
<td>0.4</td>
<td>0.3, 0.6</td>
</tr>
<tr>
<td>Fourth quartile</td>
<td>88</td>
<td>18.6</td>
<td>0.5</td>
<td>0.4, 0.7</td>
<td>21</td>
<td>15.2</td>
<td>0.4</td>
<td>0.2, 0.7</td>
</tr>
<tr>
<td>Total</td>
<td>579</td>
<td>23.8</td>
<td>–</td>
<td>–</td>
<td>239</td>
<td>23.5</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>


b: OR = Odds ratios; CI = confidence interval.
men (OR = 0.5; 95% CI 0.4–0.7) and women (OR = 0.4; 95% CI 0.2–0.7).

DISCUSSION

The results from the present study showed that both incidence of first AMI and short term case fatality were inversely related to income in middle-aged men and women. The largest relative mortality differences were seen in the proportion of people dying without reaching hospital. Poor socioeconomic circumstances thus increases the risk of having an AMI, decreases the chance of reaching hospital alive, and increases the risk of dying from the event.

It has been estimated that about 30–40% of patients having an AMI die suddenly before reaching hospital.16 In the present study investigating a middle-aged population, 14–16% died pre-hospitaly, i.e. these individuals never reached the hospital alive. These deaths constituted about 60–70% of all deaths within 28 days after the first AMI. While 90–95% of the AMI patients in higher income groups reached the hospital alive and could take advantage of the medications and treatments available, only about 80% did so in lower income groups. There might be different explanations for the socioeconomic differences seen. Presence of other diseases such as for example diabetes, respiratory diseases, other cardiovascular diseases more common among low SEP groups might affect survival after an AMI. Furthermore, low SEP groups have been shown to have a more unfavourable risk factor pattern,4–17 which in turn might affect survival. It could also be that individuals in lower SEP have larger infarctions and therefore a worse prognosis. There are studies showing an association between low SEP and the size of the infarction;10,19 however, there are also studies where no such associations were found.11 Furthermore, even though low income is related to greater distances to hospitals, this explanation seems less likely in Malmö as the emergency unit can be reached from any part of the city within minutes. Differences in access and availability of social support may also be of importance. Social support is known to be inversely associated with SEP12,15 and has been shown to be associated with a lowered incidence of AMI10,12,21 and also to enhance survival after a cardiac event.8,20,22 A further hypothesis would be that low SEP patients seek medical care too late which might affect survival after an AMI. Earlier studies have shown that delays in seeking medical care seem to be associated with low SEP,12,23 even though this finding is not consistent.24 Finally, there is also a possibility that differences in medical care prior to the AMI may be of importance. Information on visits to medical care before death is important in that it can give indications of potential differences in the ability of the health care system to identify and treat patients at higher risk of MI. One hypothesis of the higher pre-hospital mortality among low SEP groups might be that low SEP groups have lower access to medical care and are therefore more often unidentified as coronary risk patients. In our study, two thirds of the patients who died outside hospital had been in contact with the medical services within the last three months. These figures might be somewhat higher since private out-patient clinics are not included in the register on visits in the medical services. It should be mentioned though that in Malmö, private out-patient care with regard to heart disease is small and there are no private hospitals. However, it was more common in low than in high income groups to have visited the medical services during the months before the AMI. Another hypothesis might be that low SEP groups make fewer visits to specialists and are therefore not optimally treated. However, this hypothesis was not supported by our data. Finally, it might be that those from low SEP groups were less often identified as risk individuals for future coronary death than those from high SEP groups. Even though our data showed more visits in medical care during the months before death among low SEP groups and no socioeconomic differences in the nature of the visits, there is still a possibility that some of these patients might not have been identified as potential risk individuals regarding future coronary death. About one third of the patients made their last visit to specialties that not normally handle coronary symptoms.

Also among those reaching the hospital alive, there were socioeconomic differences in 28-day case fatality, with higher rates in lower income groups. Some of these differences might be attributed to differences in the aggressiveness of treatment after the AMI. Earlier studies have shown differences in echocardiography, medication and timely revascularization by SEP.3,10,11,25–30 Differences in co-morbidity and risk factor load are other potential explanations of these differences.

Our results of an inverse association between SEP and case fatality after an AMI are in line with the findings from other Swedish studies. In a recent Swedish study using a large 27-year longitudinal cohort defined in the Scania region, incident cases of AMI and immediately fatal AMIs markedly increased with neighborhood deprivation.8 Furthermore, there was a markedly higher 1-day case-fatality and shorter survival time after MI among neighborhoods with a high versus low residential instability. In a study by Peltonen et al.9 performed within the framework of the population-based WHO MONICA project on all first AMI events in the age group 25–64 years in northern Sweden during the period 1985–94, there was a lower early survival after an AMI among male workers and self-employed non-professionals than among male professionals. However, there were no statistically significant socioeconomic differences in case fatality among women. In a Swedish register-based study using ecological data on all 5533 patients who were admitted during 1986–1995 for a first acute MI at Malmö University Hospital, patients from areas with low SES had the highest 28-day case fatality rate. However, after stratifying for age and gender this relationship remained statistically significant only in men <75 years.8

Some methodological issues should be considered. First, in Sweden, all symptomatic AMI events in Sweden are treated in public hospitals, where nobody can obtain treatment for a nominal fee. There is only one hospital in Malmö taking care of all patients with AMI and no private hospitals. Thus, differences related to inter-hospital variations in treatment cannot explain the socioeconomic differences in case fatality. Second, one limitation of the present study is that there was no information on risk factors at baseline preventing us from investigating the mediating mechanisms of the association between income and coronary incidence and case fatality, respectively. Third, another limitation of our study is that we have no data on cardiac investigations or procedures before the event. Invasive cardiac revascularization increase survival32,33 and it has been shown that high SEP groups receive such procedures more often than low SEP groups.3,10,11,25–30 Fourth, during follow-up some subjects reach the age of retirement which could lead to a reduced income. However, there is no obvious reason to believe that this would differ by SEP. Fifth, the criteria used to define a MI was more narrow than the international criteria for MI, which could lead to poorer comparability with the results from international studies. The choice of using this more narrow criteria stem from the fact that the use of these specific codes in the criteria of a MI has been validated nationally, where the results showed that 86% of the patients coded as having a MI.
that the data on cause of death are generally more accurate in cases biased the results. The quality of the data on cause of mortality register encompass 97% of all deaths in Sweden, similar or even widening relative social inequalities over time. The Swedish Public Health Report 2001, showed that while the relative socioeconomic differences in coronary mortality have been increasing over time (with data from the mid-80s), there had been a decline in coronary mortality in all socioeconomic groups over time. The strength of our study is that our data covers the total general population in Malmö, which minimized the risk for selection bias. The validity of the diagnosis for nonfatal AMI has been estimated to be very high, i.e. 90–95%. The mortality register encompass 97% of all deaths in Sweden, while census participation rates range between 97% and 99%. Thus, there is no reason to believe that incomplete retrieval of cases biased the results. The quality of the data on cause of death also depends on the accuracy of the physician’s completion of the death certificate and it is widely known that the data on cause of death are generally more accurate in younger than in older people. To reduce the potential effect of such bias we have chosen to focus on middle-aged individuals in this study. However, there is no obvious reason to believe that this kind of potential misclassification would differ by SEP in a country like Sweden with a well-developed social security system.

In conclusion, the results showed that even in an equity-oriented health care system like in Sweden with a well-developed social security system, poor socioeconomic circumstances increases the risk of having an AMI, decreases the chance of reaching hospital alive, and increases the risk of dying from the event. Most of the short-term case fatality after the first AMI was due to pre-hospital deaths, i.e. these individuals never reached the hospital alive, and here we also found the greatest socioeconomic mortality differences. Of the pre-hospital deaths, the proportion who had visited the medical services during the three months preceding their AMI was higher among those from lower income groups. However, many of those suffering a pre-hospital death had visited clinics that normally do not treat coronary symptoms. If more patients were identified at an earlier stage this might increase the number of patients reaching hospital alive, giving an opportunity for emergency care as well as for secondary preventive activities to influence coronary survival.

Acknowledgements

This study was financed by grants from the Labour Market Insurance Company, the Swedish Council for Social Research, the National Institute of Public Health, the Swedish Research Council, the Swedish Cancer Society, the Swedish Heart and Lung foundation (Gunnar Engström, Bo Hedblad) and by an ALF Government Grant Dnr M:B 39 1026/2006 (Maria Rosvall). We also wish to express our sincere gratitude to late Professor Lars Janzon, Head of the Epidemiology Research Group, Lund University, who contributed to the initiation and drafting of this article.

Conflicts of interest: None declared.

Key points

- Even in an equity-oriented health care system like in Sweden, poor socioeconomic circumstances increases the risk of having an AMI, decreases the chance of reaching hospital alive, and increases the risk of dying from the event.
- In all, 60–70% of all deaths within 28 days after the AMI were pre-hospital deaths.
- Out of patients with pre-hospital deaths after their AMI, a higher proportion of those with low income had paid a visit to the medical services during the last three months before death as against those with high income.
- About one third of those suffering a pre-hospital death after their AMI had paid their last visit to the medical services into clinics that normally do not treat coronary symptoms.
- If more patients were identified at an earlier stage this might increase the number of patients reaching hospital alive, giving an opportunity for emergency care as well as for secondary preventive activities to influence coronary survival.

References


Received 30 November 2007, accepted 9 June 2008