Relation of socioeconomic position to the case fatality, prognosis and treatment of myocardial infarction events; the FINMONICA MI Register Study

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Abstract

***Objective*—To examine socioeconomic differences in case fatality and prognosis of myocardial infarction (MI) events, and to estimate the contributions of incidence and case fatality to socioeconomic differences in coronary heart disease (CHD) mortality.**

***Design*—A population-based MI register study.**

***Methods*—The FINMONICA MI Register recorded all MI events among persons aged 35–64 years in three areas of Finland during 1983–1992. A record linkage of the MI Register data with the files of Statistics Finland was performed to obtain information on socioeconomic indicators for each individual registered. First MI events (n=8427) were included in the analyses.**

***Main results*—The adjusted risk ratio of prehospital coronary death was 2.11 (95% CI 1.82, 2.46) among men and 1.68 (1.14, 2.48) among women with low income compared with those with high income. Even among persons hospitalised alive the risk of death during the next 12 months was markedly higher in the low income group than in the high income group. Case fatality explained 51% of the CHD mortality difference between the low and the high income groups among men and 38% among women. Incidence contributed 49% and 62%, respectively.**

***Conclusions*—Considerable socioeconomic differences were observed in the case fatality of first coronary events both before hospitalisation and among patients hospitalised alive. Case fatality explained a half of the CHD mortality difference between the low and the high income groups among men and more than a third among women.**

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The association of low socioeconomic position with high coronary heart disease (CHD) mortality has been a consistent feature in many countries with different health care systems.[1–4] Reduction of these socioeconomic differences has been a central aim of health policy in several countries, including Finland.[5] As CHD is the most common cause of death and contributes much to general health inequity, it would be important to learn more about the reasons for CHD mortality differences between socioeconomic categories. So far, our knowledge on potential causes of the differences and factors associated with them, has been insufficient. The existing information is mainly based on analyses of routine mortality statistics with very little information on components of mortality—that is, incidence and case fatality. Furthermore, the association of socioeconomic position with treatment practice patterns of acute myocardial infarction (MI) and chronic CHD is poorly known. More detailed data are needed for effective prevention of excess CHD mortality among persons with low socioeconomic position.

We have carried out a record linkage of the FINMONICA MI Register[6 7] data for the 10 year period 1983–1992 with indicators of socioeconomic position, such as taxable income and years of education, obtained from Statistics Finland. On the basis of these data, we have analysed the relation of socioeconomic position to the case fatality, one year prognosis, and treatment of first ever MI events in Finland. Mortality and morbidity trends by socioeconomic position have been recently reported.[8] Combining all these data we have now calculated relative contributions of differences in incidence and case fatality to the CHD mortality difference between persons with low income and those with high income.

Methods

The FINMONICA MI Register Study was a Finnish contribution to the WHO MONICA Project (Multinational *Moni*toring of trends and determinants of *Ca*rdiovascular disease).[9 10] It registered all suspected MI events, including out of hospital deaths, among men and women aged 35–64 years in three geographical areas of Finland during the 10 year period 1983–1992. Monitored areas were the provinces of North Karelia and Kuopio in eastern Finland and the Turku/Loimaa area in south western Finland. In the middle of the registration period, 1988, the combined population of these areas within the age range of registration was 119 871 men and 120 134 women. Annual population counts were obtained from Statistics Finland and used for the analyses.

The organisation of health care services in the FINMONICA areas has been described.[11]

The province of North Karelia has one specialised central hospital, which treated about two thirds of the MI patients in this area. The rest were treated in four community health centre hospitals. In the Kuopio Province, about half of the MI patients were treated in the Kuopio University Hospital. Two smaller district hospitals treated about 25%, and the rest were treated in 14 community health centre hospitals. In the Turku-Loimaa area, about 80% of the patients with a coronary event were treated in Turku University Central Hospital. Almost all the rest of the patients in this area were treated in the district hospital in Loimaa.

The registration was carried out following a standardised protocol and under rigorous quality control. Both the registration protocol and quality control results for each participating centre of the WHO MONICA MI registers are available on the internet.[12 13] Methods and main findings of the FINMONICA MI Register Study have been described in detail in our previous papers.[6 7 11] The main sources for case finding were hospital admission diagnoses and death certificates of the area. At the National Public Health Institute data were further cross checked with the National Causes of Death Register and the National Hospital Discharge Register for completeness. Suspected coronary events were classified on the basis of symptoms, serial Minnesota coding of ECGs, cardiac enzymes and, in fatal cases, necropsy findings and history of CHD. Fatal definite and fatal possible MIs and coronary deaths as well as non-fatal definite and non-fatal possible MIs (according to the FINMONICA criteria) were included in this study. Diagnostic criteria for these categories have been published.[7 14] The diagnostic classification was carried out without knowing the socioeconomic position of the patient.

Questions on thrombolysis, time between the onset of symptoms and medical presence, angiography, revascularisation, and the presence of diabetes were added to the FINMONICA MI Register form in the middle of the study period. Therefore, we have data on these variables for the latter five years (1988–1992) only. Data on medications originate from the acute coronary care surveys of the MI Register,[11] which covered all consecutive events during three four-month periods, from 1 September to 31 December in 1986, 1989 and 1992. In these surveys, all cardiac medications were recorded that (a) the patients were taking before the event; (b) the patients received in hospital during the event; and (c) were prescribed to the patients at discharge from the hospital.

In this study, we focused on incident (=first clinically recognised) MI events (n=8427). The exception was the medication usage data from the acute coronary care surveys, where we included also recurrent events to increase the statistical power. Information on whether the MI was first or recurrent was obtained by asking the patient, checking the hospital records, and sometimes by interviewing a family member. Of the events registered during the 10 year period, 64% were first and 36% recurrent. Case fatality—that is, the proportion of events that ended fatally, was analysed at four time points: (1) prehospital case fatality; (2) in hospital, but < 1 day since the beginning of symptoms; (3) 0–27 days case fatality; (4) 0–365 days case fatality. To assess the roles of hospital treatment and secondary prevention, we calculated also risk ratios of dying during days 2–27 and days 28–365 since the beginning of symptoms. The FINMONICA MI Register data covered 28 days since the beginning of symptoms and the one year survival status as well as coronary deaths (ICD 410–414) during the one year follow up were obtained by record linkage with the National Causes of Death Register.

Data on socioeconomic position were obtained by record linkage of the MI register with files of Statistics Finland on the basis of personal identification number, unique to every resident of Finland. Taxable income and education level were available for the years 1980, 1985 and 1990, for each person. The closest income and education record before the first MI event were used as the indicators of socioeconomic position. For statistical analyses the income data were grouped into three categories: low, middle, and high. Cut off limits of the income categories were adjusted as necessary for the 1985 and 1990 data to take the inflation into account and to keep the relative size of each category constant during the whole 10 year study period. On average, 26.2% of men belonged to the low income group, 31.9% to the middle income group, and 41.9% to the high income group. Among women, the corresponding proportions were 38.9%, 21.4% and 39.7%. Education was used as a dichotomous variable: basic, corresponding to <9 years of full time education, and secondary or higher, corresponding to at least 10 years of full time education. Similar data were obtained on the income and education distributions in the populations of the study areas and used as the denominators in the analyses.

STATISTICAL METHODS

Case fatality proportions were age standardised with the direct method using five year age groups and the distribution of MONICA events as the standard.[9 10] The 95% confidence intervals (CI) were calculated on the basis of normal approximation of the binomial distribution. Mantel-Haenszel χ^2 tests were used to examine linear trends in medication usage across the income categories. Survival differences between the socioeconomic groups were analysed with Kaplan-Meier curves and log rank tests. Risk ratios of total and CHD death were calculated with Cox's proportional hazards regression using the highest income or education category as the reference. Relative contributions of incidence and case fatality to the difference in mortality between persons with low and high income were calculated on the basis of the formula: $M=I \times F$, where M= mortality from incident MI events, I= incidence and F= case fatality. For the comparison between the two income groups this can be written: $M'/M=I'/I \times F'/F$, where M' and M are the mortality rates in the groups compared, I' and I incidence rates in the same groups, and

Table 1 Age standardised case fatality (%) of first myocardial infarction events by income and education among men and women aged 35–64 years in the FINMONICA Myocardial Infarction Register Study during 1983–1992

	Case fatality (95% confidence intervals)				
	Number	*Prehospital*	*≤1 day*	*0–27 day*	*0–365 day*
Men					
Income					
Low	2429	35.5 (33.5, 37.4)	38.0 (36.0, 39.9)	43.6 (41.7, 45.6)	48.5 46.5, 50.5
Middle	2630	23.0 (21.4, 24.7)	25.7 (24.0, 27.4)	30.3 (28.5, 32.1)	34.3 (32.5, 36.2)
High	1426	17.6 (15.3, 19.8)	19.5 (17.1, 21.8)	24.0 (21.4, 26.5)	26.6 (24.0, 29.3)
Education					
Basic	4856	28.0 (26.8, 29.3)	30.6 (29.3, 31.9)	35.7 (34.3, 37.0)	39.8 (38.4, 41.1)
Middle or high	1629	21.0 (18.8, 23.2)	22.8 (20.5, 25.1)	27.6 (25.2, 30.0)	31.4 (28.9, 33.9)
Women					
Income					
Low	1275	16.7 (14.2, 19.2)	19.6 (16.9, 22.3)	25.9 (23.0, 28.8)	29.9 (26.9, 32.9)
Middle	357	13.4 (9.7, 17.0)	15.3 (11.5, 19.2)	21.0 (16.6, 25.3)	25.1 (20.5, 29.7)
High	310	10.2 (6.6, 13.7)	13.4 (9.4, 17.4)	18.3 (13.8, 22.9)	20.0 (15.3, 24.7)
Education					
Basic	1563	16.7 (14.4, 18.9)	19.4 (17.0, 21.7)	25.1 (22.6, 27.6)	28.8 (26.2, 31.4)
Middle or high	379	9.3 (6.4, 12.2)	11.7 (8.5, 15.0)	17.3 (13.5, 21.1)	20.6 (16.5, 24.7)

F' and F case fatalities in these groups. After log transformation this takes the form log(M'/M)=log(I'/I)+log(F'/F). This formula gives a possibility to partition the mortality rate ratio to the relative contributions of incidence rate ratio and case-fatality rate ratio. Mortality and incidence rates for this calculation were taken from our earlier paper.[8] The statistical analyses were carried out using SAS.[15]

Results

There were 6485 first MI events among men and 1942 among women. Their distribution by income and education category is shown in table 1. The relation of socioeconomic position to the case fatality was similar in all three geographical areas as well as in the urban and rural areas. Therefore, the data are presented as combined. The age standardised case fatality among men differed significantly between the low, middle, and high income groups at all four time points examined (table 1). One year after the event almost half of the patients had died in the low income group, whereas in the high income group approximately a quarter of the patients had died. The difference between the two education categories was also significant, although less than the difference between the low and high income groups.

Among women, the case fatality was lower than among men (table 1). Marked differences were nevertheless observed between the low and high income groups as well as between the basic education group and the middle or higher education group at all time points examined. One year after the onset of the event 30% of the low income women had died. In the high income group this proportion was 20%.

The proportion of prehospital deaths of all one year deaths among men was 71% in the low income group and 66% both in the middle and the high income groups. Among women, the proportion of prehospital deaths was lower than among men. However, also among women the highest proportion of prehospital deaths, 52%, was observed in the low income group. For the middle and high income groups these proportions were 51% and 44%, respectively. In Kaplan-Meier survival curves (fig 1), most of the difference between the income groups arose during the first day, but separate examination of first day survivors revealed that the curves continued deviating during the whole one year follow up.

The adjusted risk ratio of death comparing low income category with the high income category among men was 2.11 for prehospital

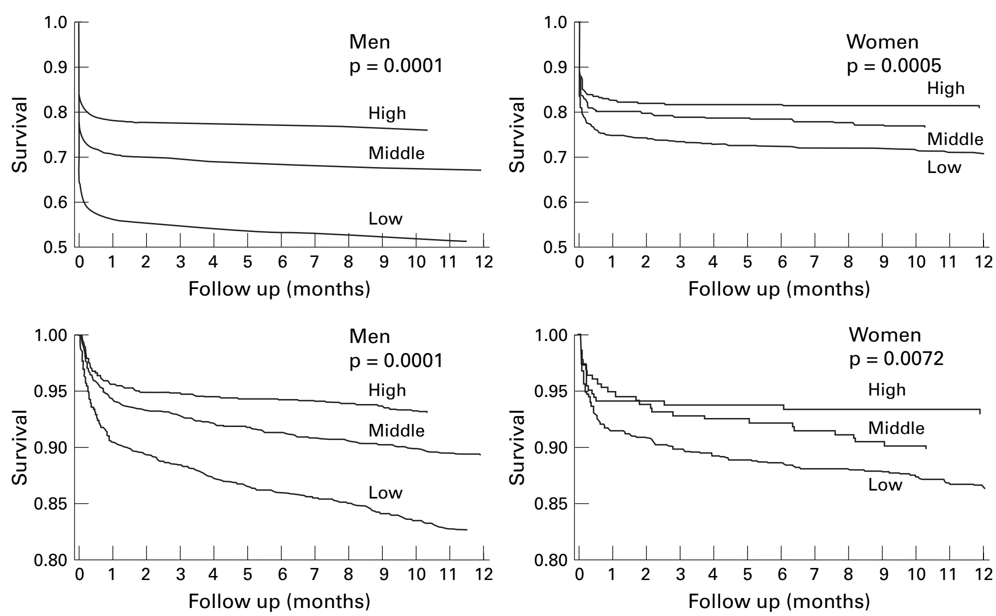

Figure 1 Kaplan-Meier one year survival curves by income group for all patients aged 35–64 years with their first MI event (upper panel, n=6485 for men and n=1942 for women) and for patients who have survived >1 day since the beginning of symptoms of their first MI (lower panel, n=4647 for men and n=1617 for women) in the FINMONICA MI Register Study. The p values are based on log rank tests for the difference between the income groups.

Table 2 Adjusted risk ratios (95% confidence intervals) of death by income and education among men and women aged 35–64 years with their first myocardial infarction event; the FINMONICA Myocardial Infarction Register Study, 1983–1992*

	Time of death			
	Prehospital	*In hospital ≤1 day*	*2–27 days*	*28–365 days*
Men				
Income				
Low	2.11 (1.82, 2.46)	1.79 (1.09, 2.93)	2.01 (1.45, 2.80)	2.68 (1.78, 4.04)
Middle	1.35 (1.16, 1.58)	1.63 (1.02, 2.62)	1.26 (0.90, 1.76)	1.81 (1.20, 2.71)
High	1	1	1	1
Education				
Basic	1.33 (1.18, 1.51)	1.61 (1.05, 2.46)	1.25 (0.95, 1.65)	1.23 (0.91, 1.68)
Middle or high	1	1	1	1
Women				
Income				
Low	1.68 (1.14, 2.48)	1.05 (0.49, 2.27)	1.62 (0.90, 2.91)	3.08 (1.21, 7.88)
Middle	1.32 (0.83, 2.08)	0.72 (0.27, 1.94)	1.12 (0.55, 2.26)	2.33 (0.83, 6.57)
High	1	1	1	1
Education				
Basic	1.69 (1.18, 2.42)	1.14 (0.55, 2.37)	1.22 (0.75, 1.99)	1.30 (0.69, 2.44)
Middle or high	1	1	1	1

*Adjusted for age, study area, urban/rural residence, and study period (two 5 year periods).

deaths (table 2). Interestingly, also among men who were hospitalised alive and stayed alive for more than one day after the onset of symptoms, the risk of death during the one year follow up was two times higher in the low income group than in the high income group. Furthermore, among men who were alive at day 28 after their first MI event, the risk of death was 2.68 times higher in the low income group than in the high income group. The corresponding risk of coronary death was only slightly lower, 2.46 (95% CI 1.55, 3.89). Also among women the adjusted risk of prehospital death was significantly higher in the low income group than in the high income group. For deaths during days 2–27 and 28–365 the findings among women were consistent with those among men, but the 95% CIs around the odds ratios were wide and only the latter did not include one. Marked differences in the risk of death were also found between the education groups, although not quite as steep as the differences between the income groups.

To assess, whether the size of MI differed by socioeconomic position, we examined peak creatinine phosphokinase (CK) values in persons who were hospitalised alive and stayed alive >1 day since the beginning of symptoms. No differences were observed. Among men, the medians of highest CK values were 738, 809, and 809 U/l in the low, middle and high income groups, respectively. Among women, the corresponding values were 334, 256 and 304 U/l. Among men who survived the event, the ECG changes were classified as definite on the basis of serial Minnesota coding in 33.1% of the cases in the low income group, 39.7% in the middle income group, and 39.4% in the high income group. Among women, the corresponding numbers were 28.0%, 28.0% and 28.5%. Among men, the diagnostic category for the event was definite MI significantly more often in the high income group than in the low income group (table 3). No such difference was seen among women.

To find out whether comorbidity differs by socioeconomic position, we examined the prevalence of diabetes by the income group. Among men the prevalence of diabetes was 14.3% (95% CI 12.2, 16.4%), 15.0% (12.8, 17.2%), and 14.6% (11.7, 17.5%) in the low, middle, and high income groups, respectively. Among women, however, the prevalence of diabetes was 24.7% (20.3, 29.1%) in the low income group, 13.3% (7.7, 18.9%) in the middle income group and 8.7% (4.3, 13.1%) in the high income group.

Men with high income were significantly more often treated in a specialist hospital than men with low income and similar tendency was seen also among women (table 3). Stratification by urban/rural residence revealed that these differences originated from rural areas, where patients with low income were referred to a specialist hospital less often than patients with middle or high income (among men 72%, 76%, and 79%; among women 69%, 77%, and 74%, respectively). The patients from urban areas were almost all treated at a specialist hospital independently of income. Delay from the onset of the symptoms to medical presence tended to be shorter in men with high income than in men with low income. This trend was similar both among urban and rural men.

Table 3 Age standardised clinical characteristics, treatments, and diagnostic procedures (%) by income among men and women aged 35–64 years with their first myocardial infarction who were hospitalised alive during 1983–1992; the FINMONICA Myocardial Infarction Register Study

	Definite MI	*Delay >4 hours**	*Treatment at specialist hospital*	*Thrombolysis**	*Angiography* during 28 days*	*Revascularisation* during 0–365 days*
Men (n = 4799)						
Income						
Low	64.9 (62.5, 67.3)	46.8 (43.0, 50.6)	80.0 (78.0, 82.0)	20.9 (17.8, 24.0)	3.3 (1.9, 4.7)	10.2 (7.9, 12.5)
Middle	67.8 (65.7, 69.9)	43.4 (40.0, 46.8)	86.0 (84.4, 87.6)	19.2 (16.5, 21.9)	5.5 (4.0, 7.0)	15.8 (13.3, 18.3)
High	71.1 (68.2, 74.0)	41.8 (37.6, 46.0)	90.6 (88.7, 92.5)	25.2 (21.5, 28.9)	8.5 (6.2, 10.8)	20.0 (16.7, 23.3)
Women (n = 1669)						
Income						
Low	52.9 (49.4, 56.4)	47.2 (42.2, 52.7)	81.5 (79.0, 84.0)	14.3 (10.4, 18.2)	6.6 (4.1, 9.1)	12.6 (8.8, 16.4)
Middle	46.0 (40.3, 51.7)	54.6 (46.4, 62.8)	89.1 (85.7, 92.5)	11.1 (5.7, 16.5)	11.6 (5.5, 17.7)	18.5 (11.2, 25.8)
High	50.0 (44.2, 55.8)	49.1 (41.2, 57.0)	87.0 (82.9, 91.1)	12.6 (7.3, 17.9)	7.6 (3.8, 11.4)	10.6 (6.1, 15.1)

*Data are for the years 1988–1992 only, n=2204 for men and 746 for women.

Table 4 Age standardised proportions (%, 95% CI) of medications prescribed at discharge from hospital after the MI event by the income level. Men aged 35–64 years (n = 734). The FINMONICA MI Register Study

	β blockers	*Antiplatelet agents*	*Hypolipidaemic medications**
Income			
Low	67.7 (62, 73.4)	56.2 (50.0, 62.4)	6.1 (2.1, 10.1)
Middle	80.1 (75.5, 84.7)	58.8. (53.3, 64.3)	8.8 (4.7, 12.9)
High	77.1 (70.4, 83.8)	66.4 (59.0, 73.8)	10.7 (5.0, 16.4)
p for trend†	0.02	0.03	0.12

*Data for years 1988–1992 only, n = 450. †Mantel-Haenszel χ^2 test for linear trend across the income groups.

Among women, no clear gradient was seen. Thrombolysis was given to 25.2% of men in the high income group and 20.9% in the low income group. Among women, the corresponding numbers were 12.6% and 14.3%. During 28 days, angiography was significantly more often performed on men of the high income group than men of the low income group. During one year after the event, revascularisation was performed on 20% of the men in the high income group and 10% of the men in the low income group. Among women, the frequency of angiography and revascularisation did not differ by income group.

At discharge, β blocking agents were prescribed to 67.7% of the men in the low income group and to 77.1% in the high income group (table 4). There was a significant increasing trend (p=0.02) in β blocker prescriptions with increasing income. Antiplatelet agents, mainly acetylsalicylic acid, were prescribed to 56.2% of the men in the low income group and to 66.4% in the high income group. A significant increasing trend (p=0.03) was observed also in the prescriptions of antiplatelet agents with increasing income. Similar tendency towards more active treatment in the high income group was observed for hypolipidaemic medications. Even though we included also recurrent coronary events in these analyses, the 95% CIs of these proportions among women were wide and did not allow much conclusions. The general direction of the findings among women was, however, consistent with that in men.

Incidence and case fatality contributed almost equally to the one year mortality difference between the low and high income groups among men: 51% was attributable to the case fatality 49% was attributable to the incidence (table 5). Among women, 62% of the one year mortality difference was attributable to the higher incidence and 38% to the higher case fatality in the low income group than in the high income group.

Table 5 Age standardised incidence and one year mortality*† rates of first coronary events in the low and high income groups (per 100 000 persons), and the proportion‡ of mortality difference between the income groups attributable to the difference in case fatality and difference in incidence*

Sex and income group	*Incidence*	*Mortality*	*Proportion (%) attributable to* case fatality	*Proportion (%) attributable to* incidence
Men			51	49
Low	648	310		
High	370	96		
Women			38	62
Low	177	52		
High	86	18		

*Adopted from Salomaa *et al.*[8] †Mortality within one year after the onset of the event. ‡Calculated as described in the Methods.

Discussion

Finland has a predominantly public health care system. All symptomatic acute MI events are treated in public (municipal) hospitals, where anybody can obtain treatment for a nominal fee. Therefore, it was a surprise that such large differences existed in the case fatality and one year prognosis of first MI events. A main part of the difference originated during the prehospital stage, but also among patients hospitalised alive 2–27 day case fatality was about two times higher in the low income group than in the high income group. Furthermore, among patients alive at day 28 after their first MI, the one year prognosis was clearly worse in the low income group than in the high income group.

There was no difference in the peak CK values between the income groups and among men the ECG changes were less often classified as definite in the low income group than in the other income groups. In fact, among men the proportion of definite MIs was higher in the high income group than in the low income group. Thus, there was no evidence for larger infarcts in the low income group that could explain their higher case fatality. There was, however, some evidence that the delay between the onset of symptoms and medical presence was longer in male patients with low income than in those with high income. This trend was observed both in urban and in rural areas. It may have had an impact on prehospital case fatality and, together with more equivocal ECG findings, also on the administration of thrombolytic treatment, which tended to be less common among men with low income. Another relevant feature was that in rural areas people with low income were more often treated in health centre wards, whereas people with high income were referred to specialist hospitals. A recent report from the USA indicated that large hospitals, where many MI patients are treated, achieve better resuls than smaller hospitals, where doctors and nurses have less experience.[16]

After day 28, the one year prognosis was clearly worse in persons with low than in those with high socioeconomic position suggesting less efficient secondary prevention. This finding is in agreement with published studies from Sweden,[17] England,[18] and from the USA.[19] Medications with proven effect in secondary prevention, such as β blockers, antiplatelet agents, and hypolidaemic agents, were after the MI less often prescribed for men with low income than men with high income. A similar finding has been recently described from the USA.[20] Even though all differences were not statistically significant because of the small size of the FINMONICA acute coronary care survey, it is probable that they have been of prognostic significance. In Finland, the patient pays only 25% of the costs of medications prescribed for the treatment of chronic CHD. Thus, the economic obstacles for obtaining necessary medications should be small. It is nevertheless possible that differences in compliance may have increased the differences in prescriptions. Furthermore, the twofold difference in revascularisations during the year after MI has probably also contributed to the differences in one year prognosis. It is known from earlier studies that the access to bypass surgery was not equal in Finland during the 1980s.[21] The need for such operations substantially exceeded the capacity in public hospitals and the costs in private hospitals may have been too high for people with low socioeconomic position.

Besides differences in the use of medications and invasive procedures, a number of psychosocial factors may have played a part in the prognosis of MI patients after the acute stage. In the β-Blocker Heart Attack Trial (BHAT) the patients classified as being socially isolated and having a high degree of life stress had more than four times greater risk of death three years post-MI than men with low levels of both stress and isolation.[22] High levels of stress and social isolation were more common among the least educated men and less common among the best educated. An inverse association of education with mortality in the BHAT Study reflected the gradient in these psychosocial characteristics. We had no data on psychosocial factors in the present study, but there is no reason to believe that their significance would be different in the Finnish population than it was in the BHAT Study population.

Another potential explanation for the higher case fatality and worse prognosis of patients with low socioeconomic position could be comorbidity. It is probable that diseases other than than CHD may accumulate among persons with low socioeconomic position and influence on their case fatality and prognosis after MI. The prevalence of diabetes did not, however, differ by the income group among men, but among women it was clearly more common in the low income group than in the middle and high income groups. It is well established that diabetic MI patients have higher case fatality than the non-diabetic ones.[23] Accordingly, the greater prevalence of diabetes may have contributed to the high case fatality of women with low income. We had no data on other comorbidities in the FINMONICA MI register, but as our study population was less than 65 years old, it seems reasonable to assume that they have not played a substantial part.

The majority of the case fatality differences originated at the prehospital stage. Interestingly, the proportion of prehospital deaths of all one year deaths was somewhat higher in the low income group than in the other income groups. Even these deaths are not beyond the influence of the health care system. In the FINMONICA MI Register data, 36% of persons who died out of hospital had had a previous MI and a further 25% had symptomatic CHD.[7] Thus, the majority of these persons have been in contact with physicians and received treatment and counselling. Therefore, both secondary and primary prevention can play a part in preventing excess prehospital deaths among persons with low socioeconomic position.

KEY POINTS

- There are considerable socioeconomic differences in the case fatality of first coronary events in Finland.
- Significant socioeconomic case fatality differences were observed also among patients hospitalised alive.
- Medications for secondary prevention were prescribed less often to patients with low socioeconomic position than to patients with high socioeconomic position.
- Among men, case fatality explained a half of the CHD mortality difference between the socioeconomic groups, while incidence explained the other half.
- Among women, case fatality explained a third of the CHD mortality difference between the socioeconomic groups, while the incidence explained two thirds.

Only a limited amount of information exists on the relation of socioeconomic position to the case fatality of MI. Recently, however, three MONICA centres, Scotland,[24] France,[25] and northern Sweden,[26] have reported the relation of socioeconomic position to the case fatality of MI in their populations. In agreement with our results, they all found higher case fatality in persons with low socioeconomic position. Scottish and Swedish investigators have reported the prehospital case fatality separately and, analogously to our results, found it to be higher in persons with low socioeconomic position. However, among hospitalised patients the case fatality in Scotland showed no strong socioeconomic pattern[24] and in northern Sweden only the professional category "not classified"—that is, retired and unemployed people—had higher inhospital case fatality than the other professional groups.[26] Our study suggests that the situation is different in Finland, as we found a substantial socioeconomic difference also in the case fatality of patients hospitalised alive. The one year case fatality of MI differed by socioeconomic position in northern Sweden similarly to Finland, but the Swedish investigators did not report separately the one year prognosis for patients who had survived the acute stage.

It is commonly assumed that the incidence of MI is mainly determined by the risk factor levels in a population and predominantly influenced by the primary prevention methods, whereas the case fatality is mainly determined by the treatment. To our knowledge, this study is the first one to estimate the relative contributions of incidence and case fatality to the socioeconomic differences in CHD mortality. We found that approximately half of the mortality difference between the low and high income groups among men was attributable to the incidence and another half attributable to case fatality. Among women, the case fatality difference played a somewhat smaller part.

Interestingly, several investigators have previously concluded that approximately half of the socioeconomic differences in CHD mortality can be explained by the differences in classic risk factors and another half has remained unexplained.[27–29] Our present and earlier[30] results suggest that differences in treatment and in seeking the treatment may explain a substantial proportion of the other half.

Besides the large size and detailed nature of the FINMONICA MI Register data, a major strength of this study was the possibility for record linkage with the files of Statistics Finland. This gave us accurate information on taxable income and education level for each person before their first MI event. Most other studies have used surrogate indicators of socioeconomic position, such as the zip code of the area of residence, which inevitably leads to some misclassification and may bias the results towards the null.[1 31] The accurate information on socioeconomic position may in part explain why our estimates on socioeconomic differences are larger than in many other studies. A limitation was that we did not have family income, which may have led to some misclassification, particularly among women. Findings on education were, however, consistent with those on income also among women suggesting that the lack of information on family income does not distort our findings. Another limitation was the small size of the acute coronary care survey, which covered only three four-month periods during the FINMONICA registration. This led to low statistical power to detect differences between the socioeconomic groups in the use of medications. Nevertheless, the numbers were sufficiently large to indicate significant trends in prescription patterns among men.

In conclusion, we found marked socioeconomic differences in the case fatality of first MI events. Significant differences were observed at the prehospital stage, but also among patients who reached the hospital alive as well as in one year prognosis of patients who were alive at day 28 after the onset of the event. Half of the socioeconomic difference in CHD mortality is attributable to the difference in case fatality among men, and more than one third among women. Data suggested that the use of medications with proven efficacy was not equal in different socioeconomic groups. In part this was attributable to the longer delay with seeking medical help in the low socioeconomic groups and to the difference in the type of hospital, where the treatment was given. Correcting the differences in treatment and reducing the delay to seek help should be the first steps towards the reduction of excess case fatality in persons with low socioeconomic position.

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1 Davey Smith G, Neaton JD, Wentworth D, *et al.* Socioeconomic differentials in mortality risk among men screened for the multiple risk factor intervention trial: I. White men. *Am J Public Health* 1996;**86**:486–96.
2 Kunst AE, Groenhof F, Mackenbach JP, and the EU Working Group on Socioeconomic Inequalities in Health. Occupational class and cause specific mortality in middle aged men in 11 European countries: comparison of population based studies. *BMJ* 1998;**316**:1636–42.
3 Koskenvuo M, Kaprio J, Romo M, *et al.* Incidence and prognosis of ischaemic heart disease with respect to marital status and social class. *J Epidemiol Community Health* 1981; **35**:192–6.
4 Mackenbach JP, Cavelaars AEJM, Kunst AE, *et al*, and the EU Working Group on Socioeconomic Inequalities in Health. Socioeconomic inequalities in cardiovascular disease mortality. An International study. *Eur Heart J* 2000;**21**:1141–51. *5Health for all by the year 2000. The Finnish National Strategy*. 2nd ed. Helsinki: Ministry of Social Affairs and Health, 1985.
6 Tuomilehto J, Arstila M, Kaarsalo E, *et al*. Acute myocardial infarction (AMI) in Finland—baseline data from the FINMONICA AMI register in 1983–1985. *Eur Heart J* 1992;**13**:577–87.
7 Salomaa V, Miettinen H, Kuulasmaa K, *et al*. Decline of coronary heart disease mortality in Finland during 1983 to 1992: roles of incidence, recurrence, and case-fatality. The FINMONICA MI register study. *Circulation* 1996;**94**: 3130–7.
8 Salomaa V, Niemelä M, Miettinen H, *et al*. The relationship of socioeconomic status to the incidence, mortality, and one-year prognosis of acute coronary events in the FINMONICA myocardial infarction register study. *Circulation* 2000;**101**:1913–18 .
9 Tunstall-Pedoe H, Kuulasmaa K, Amoyel P, *et al*. Myocardial infarction and coronary deaths in the World Health Organization MONICA project: registration procedures, event rates, and case-fatality rates in 38 populations from 21 countries in four continents. *Circulation* 1994;**90**:583–612.
10 Tunstall-Pedoe H, Kuulasmaa K, Mähönen M, *et al*, for the WHO MONICA (monitoring trends and determinants in cardiovascular disease) Project. Contribution of trends in survival and coronary-event rates to changes in coronary heart disease mortality: 10-year results from 37 WHO MONICA Project populations. *Lancet* 1999;**353**:1547–57.
11 Miettinen H, Salomaa V, Ketonen M, *et al*, on behalf of the FINMONICA Myocardial Infarction Register Group. Trends in the treatment of patients with myocardial infarction and coronary revascularization procedures in Finland during 1986–92: the FINMONICA Myocardial Infarction Register Study. *J Intern Med* 1999;**245**:11–20.
12 WHO MONICA Project. MONICA Manual (1998–1999). Available from URL:http://www.ktl.fi/publications/monica/manual/index.htm, URN:NBN:fi-fe19981146.
13 Mähönen M, Tolonen H, Kuulasmaa K, *et al,* for the WHO MONICA Project. Quality assessment of coronary event registration data in the WHO MONICA Project (January 1999). Available from URL:http://www.ktl.fi/publications/monica/coreqa/coreqa.htm, URN:NBN:fi-fe19991072.
14 Palomäki P, Miettinen H, Mustaniemi H, *et al*. Diagnosis of acute myocardial infarction by MONICA and FINMONICA diagnostic criteria in comparison with hospital discharge diagnosis. *J Clin Epidemiol* 1994;**47**:659–66.
15 SAS Institute Inc. *Users guide, statistics: version 6, volume 2*. 4th ed. Cary, NC: SAS Institute, 1989:17.
16 Thieman DR, Coresh J, Oetgen WJ, *et al*. The association between hospital volume and survival after acute myocardial infarction in elderly patients. *N Engl J Med* 1999;**340**: 1640–8.
17 Wilhelmsen L, Rosengren A. Are there socio-economic differences in survival after acute myocardial infarction? *Eur Heart J* 1996;**17**:1619–23.
18 Greenwood D, Packham C, Muir K, *et al*. How do economic status and social support influence survival after initial recovery from acute myocardial infarction? *Soc Sci Med* 1995;**40**:639–47.
19 Ickovics JR, Viscoli CM, Horwitz RI. Functional recovery after myocardial infarction in men: the independent effects of social class. *Ann Intern Med* 1997;**127**:518–25.
20 Rathore SS, Berger AK, Weinfurt KP, *et al.* Race, sex, poverty, and the medical treatment of acute myocardial infarction in the elderly. *Circulation* 2000;**102**:642–8.
21 Keskimäki I, Koskinen S, Salinto M, *et al*. Socioeconomic and gender inequities in access to coronary artery bypass grafting in Finland. *Eur J Public Health* 1997;7:392–7.
22 Ruberman W, Weinblatt E, Goldberg JD, *et al.*. Psychosocial influences on mortality after myocardial infarction. *N Engl J Med* 1984;**311**:552–9.
23 Miettinen H, Lehto S, Salomaa V, *et al.* Impact of diabetes on mortality after the first myocardial infarction. The FINMONICA Myoccardial Infarction Register Study Group. *Diabetes Care* 1998;**21**:69–75.
24 Morrison C, Woodward M, Leslie W, *et al.* Effect of socioeconomic group on incidence of, management of, and survival after myocardial infarction and coronary death: analysis of community coronary event register. *BMJ* 1997; **314**:541–6.

25 Lang T, Ducimetiere P, Arveiler D, *et al*. Incidence, case fatality, risk factors of acute coronary heart disease and occupational categories in men aged 30–59 in France. *Int J Epidemiol* 1997;**26**:47–57.
26 Peltonen M, Rosén M, Lundberg V, *et al*. Social patterning of myocardial infarction and stroke in Sweden: incidence and survival. *Am J Epidemiol* 2000;**151**:283–92.
27 Rose G, Marmot MG. Social class and coronary heart disease. *Br Heart J* 1981;**45**:13–19.
28 Lynch JW, Kaplan GA, Cohen RD, *et al*. Do cardiovascular risk factors explain the relation between socioeconomic status, risk of all-cause mortality, cardiovascular mortality, and acute myocardial infarction? *Am J Epidemiol* 1996;**144**:934–42.
29 Pekkanen J, Tuomilehto J, Uutela A, *et al*. Social class, health behaviour, and mortality among men and women in eastern Finland. *BMJ* 1995;**311**:589–93.
30 Vartiainen E, Pekkanen J, Koskinen S, *et al*. Do changes in cardiovascular risk factors explain the increasing socioeconomic difference in mortality from ischaemic heart disease in Finland? *J Epidemiol Community Health* 1998;**52**:416–19.
31 McLoone P, Ellaway A. Postcodes don't indicate individuals' social class. [Letter.] *BMJ* 1999;**319**:1003.