Gender differences in the decline of mortality rates of acute myocardial infarction in West Germany*

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In Germany in 1994, 86,915 people died from acute myocardial infarction; 56.3% of these cases were male. The corresponding mortality rates per 100,000 were 1161 in men and 879 in women. The male–female mortality ratio in 1994 was most pronounced for males aged 45–54 years with a relative risk of 5.7 (95% CI, 5.2 to 6.2). The mean age of death was 70.5 years in men and 78.6 years in women, reflecting a difference of 8.1 years.

In both genders, mortality rates of acute myocardial infarction in the former Federal Republic of Germany (West Germany) started to decline in 1980. This decline summed up to −37.8% (95% CI, −38.9 to −36.8) in men and −25.7% (95% CI, −27.1 to −24.3) in women until 1994. The difference in gender-specific decline was significant. The steepest decline was achieved for men in the 25–44 year age group and for middle-aged women of 45–64 years. An increase could be observed for both genders over 85 years. The mean age of death from myocardial infarction, however, increased in the same time period by 2 years in men and 4 years in women.

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Key Words: Acute myocardial infarction, mortality, gender difference.

Introduction

Substantial differences in health care support between men and women have been reported in the literature. Recent data suggest that female patients suffering from angina-like pain are less often referred to intensive care units than men[1]. There is evidence that women are less frequently referred to coronary arteriography than male patients[2,3] when admitted to a coronary care unit with a coronary diagnosis. There are also data to suggest that women undergo fewer diagnostic procedures than men after myocardial infarction[4]. Women might also benefit less from progress in coronary therapy. Several studies have shown that they are not treated as aggressively as male patients[4,5]; an under-treatment with thrombolytic agents in women with myocardial infarction has been observed[6,7]. The proportion of female candidates for bypass surgery is extremely low[8,9].

Focusing on the situation in Germany, data indicate an increasing trend in the prevalence of coronary risk factors among females. The prevalence of smoking among younger females increased during the 1980s[10].

The present study set out to analyse the possible impact of these unfavourable circumstances on the trend in mortality rates from coronary heart disease in females in comparison to male heart disease victims. To this end, we examined the trends in coronary heart disease mortality in Germany for the period 1980 to 1994 for different age cohorts, particularly focusing on changes between men and women.

Methods and statistics

The study was based on information recorded on death certificates in all age groups, for the period 1980 to 1994. These data were extracted from annual reports of the German bureau of statistics[11]. The definition of ischaemic heart disease corresponded to the International Classification of Diseases, 9th revision (ICD-9;
There is a steady increase in mortality for both sexes, groups taking in the younger age groups with a very low To demonstrate the differences between the gender mortality in females is quantified in Fig. 2, which ranged for males 70 to 74 years and for females 80 to 84.

410-414). The present study focused on the condition of fatal acute myocardial infarction coded as ICD-9 410.

In the former German Democratic Republic, death certificates of patients dying from acute myocardial infarction were sometimes not coded in accordance with ICD rules. After reunification, consistent validity in coding of acute myocardial infarction death certificates was achieved, apart from 1993, for both parts of Germany. Therefore, 1994 mortality data with respect to acute myocardial infarction will be reported in the present paper for Germany as a whole, while trend analyses from 1980 to 1994 are restricted to the former Federal Republic of Germany (West Germany).

The age-specific mortality rates and their 95% confidence intervals (95% CI) have been constructed through the standard method of logarithmic transformation. The change of mortality rates over the observation period is based upon rates which were standardized to the mean of the census year 1987 age distribution of the German population.

Table 1  Male-female mortality ratio for acute myocardial infarction (ICD 410) in the year 1994 for 10-year age groups (relative risks and 95% confidence intervals)

<table>
<thead>
<tr>
<th>Age groups</th>
<th>RR</th>
<th>LCL</th>
<th>to</th>
<th>UCL</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-34</td>
<td>4.09</td>
<td>2.90</td>
<td>to</td>
<td>5.76</td>
</tr>
<tr>
<td>35-44</td>
<td>5.67</td>
<td>4.85</td>
<td>to</td>
<td>6.64</td>
</tr>
<tr>
<td>45-54</td>
<td>5.68</td>
<td>5.22</td>
<td>to</td>
<td>6.18</td>
</tr>
<tr>
<td>55-64</td>
<td>4.03</td>
<td>3.86</td>
<td>to</td>
<td>4.21</td>
</tr>
<tr>
<td>65-74</td>
<td>2.70</td>
<td>2.63</td>
<td>to</td>
<td>2.77</td>
</tr>
<tr>
<td>75-84</td>
<td>1.93</td>
<td>1.89</td>
<td>to</td>
<td>1.98</td>
</tr>
<tr>
<td>&gt;85</td>
<td>1.50</td>
<td>1.45</td>
<td>to</td>
<td>1.55</td>
</tr>
</tbody>
</table>

LCL/UCL = lower and upper confidence limits.

represents the cumulative acute myocardial infarction mortality in the year 1994 for both genders, again stratified in 5-year age groups. As can be seen, the sum percent curve for women is constantly shifted to the right for all age groups. The mean age of death by acute myocardial infarction was 70.5 years for men and 78.6 for women, reflecting a difference of 8.1 years. The male–female mortality ratio for 1994 as relative risks (RR) and its 95% confidence intervals for 10-year age groups is presented in Table 1. The mortality ratio for men is significantly higher in all age groups; however it is most significant in the 45–54 year age group, where the male–female mortality ratio culminated in a risk of 5.7 (CI 5.2 to 6.2).

Trend analysis 1980 to 1994

In 1980, acute myocardial infarction mortality rates in both genders started to decline in the former Federal Republic of Germany. Figure 3 presents the time course of the decline, apart from that year, for both genders. This decline was more pronounced in men than in women and reached 37.8% (95% CI, 38.9 to 36.8) in men and 25.7% (95% CI, 24.7 to 26.3) in women until the year 1994. However, the mean age of death increased in the same time period by 4 years in women and 2 years in men.

A stratification of the decline into four age groups (25-44, 45-64, 65-84 and >85) reveals a reduction in acute myocardial infarction mortality rates in both genders for all age groups except for the very old (> = 85 years, Table 2). The steepest decline was achieved for men in the 25-44 year age group and for middle-aged women aged 45-64 years. In those aged 65 to 84 years, progress was lowest for both sexes in the first half of the observation period. Most of the reduction, especially for women, was only achieved after 1987.

Discussion

The absolute acute myocardial infarction mortality rate in women was lower than in men, whereas the mean age

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Figure 2 Cumulative mortality from acute myocardial infarction in the year 1994, for both genders, stratified in 5-year age groups. --- = men; ---- = women.

Figure 3 Decline in mortality rates from acute myocardial infarction for both genders from 1980. --- = men; ---- = women.

of manifestation was significantly higher. The number of women who suffer a lethal myocardial infarction is generally thought to be about one fourth of that of men[2,30]. The present study revealed that this is true only for the age groups up to 70 years. The overall difference in absolute figures of acute myocardial infarction mortality added up only to 13% for male patients in 1994.

Patterns of decline
There has been a major decline in mortality from coronary heart disease over the past three decades in nearly all technologically advanced nations of the world[13,14]. Compared to other highly industrialised countries, the decline started with a considerable delay in the Federal Republic of Germany. For both sexes, coronary heart disease mortality rates did not peak before 1980[15].

The present study revealed that apart from 1980, mortality rates declined in both sexes with measurable overall trend differences in the decline in acute myocardial infarction mortality between males and females. Women were significantly less advantaged than men. Gender differences in trend developments have also occurred elsewhere; studies, however, yielded inconsistent results. Sempos et al.[16] reported that the rate of decline in coronary mortality among females in the U.S. had decreased relative to males since the mid 1970s. This observation was confirmed in an analysis of the Minnesota Heart Survey data which further revealed that the average annual percentage decline among females levelled off during the 1980s[17]. Recent data analysis from Framingham[18], however, indicates a more favourable trend for women than for men.

Kriiger et al.[19] concluded from their findings in Norway, that the rate of decline in coronary heart disease mortality for women seemed to stagnate during the latter part of their study period (1986-89). Except for rural areas, there was even a slight mortality increase for women in the age group 60–69 years between 1981–85 and 1986–89. Recently, Wilson and Siskind[20] revealed, in contrast to these findings, a possible reversal of the decline in mortality in the youngest male cohorts in Australia. In Sweden, mortality due to myocardial infarction in women remained virtually constant during the period 1969–1986[21,22].

Causes for decline
The favourable trends in mortality rates of acute myocardial infarction over the observed time may be due to
a decline in disease incidence, reflecting a success of primary prevention and/or in fatality rates. This primarily points to advances in the management of coronary artery disease. Vital statistics data alone cannot decide this.

**Risk factor modification**

Relating morbidity figures and risk factor data to the observed mortality trends, most researchers assume that life style changes leading to risk factor reduction account considerably for the decline\(^2\). Calculations of that kind have to be handled with caution as up to 13% for males and +18% for females was highly significant, but was not associated with changes in risk factor distribution\(^2\). The decline in coronary heart disease mortality since 1980 does not mirror national trends in risk factor developments over the observed period. It is therefore likely that unfavourable changes in risk factor distribution are, in part, compensated for by improved survival among patients with coronary artery disease conditions. This improved survival is closely tied to advances in medical care of coronary artery disease patients.

Overall, obesity has increased relative to the decreased prevalence of smoking between the male cohorts. A similar trend, concerning women, has been observed in Sweden. Falkeborn et al.\(^2\) found a dramatic increase in smoking among Swedish women, but concluded that cohort effects may not be noticeable yet, as this increase has occurred fairly recently. However, mean blood pressure levels and the prevalence of hypertension among middle-aged Swedish women have also decreased over time\(^2\). For Australia, a decrease in smoking and an increase in treatment of high blood pressure have been reported\(^2\). In Germany however, there were no similar positive reductions in primary risks. Hoffmeiser et al.\(^2\) have shown that during the second half of the 1980s there were alarming increases in some of the major coronary heart disease risk factors. Total serum cholesterol levels are high in Germany and are still increasing, as are body mass index values. Moreover, there is a significant increase in smoking in women in that period. Register-based data in the period 1985 to 1992 from the southern part of Germany confirm a marked reduction in the incidence of fatal and non-fatal acute myocardial infarction events in 25- to 74-year-old males, but an increase in women in the same age stratum. This trend with -13% for males and +18% for females was highly significant, but was not associated with changes in risk factor distribution\(^2\).

These findings mean that changes in risk factor contribution in the index population are not linked to cardiovascular disease mortality trends. There is a paucity of valid data on the epidemic burden of cardiovascular risk factors in the German population in the 1970s or even before. Data published in that period indicate, however, that the prevalence of hypertension and hypercholesterolaemia was significantly higher than in later years\(^2\). Thus, it cannot be ruled out that long-term effects of population-based risk factor modifications may take a considerable time to influence mortality patterns.

**Disease management**

The decline in coronary heart disease mortality since 1980 does not mirror national trends in risk factor developments over the observed period. It is therefore likely that unfavourable changes in risk factor distribution are, in part, compensated for by improved survival among patients with coronary artery disease conditions. This improved survival is closely tied to advances in medical care of coronary artery disease patients.

Major advances have undoubtedly occurred in the management of acute myocardial infarction in industrialised nations. Recent data from a university medical school in Detroit (U.S.A.) suggest a 50% reduction of in-hospital mortality (14.7% vs 7.4%). Nine hundred and eighty-two consecutive patients hospitalized in a coronary care unit in the beginning of the 1980s were compared with 816 consecutive patients 10 years later\(^2\). Population studies have attributed evidence that

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**Table 2 Decline of AMI mortality (ICD 410) between 1980 and 1994 in the former FRG, stratified for sex and four age groups**

<table>
<thead>
<tr>
<th>Age groups</th>
<th>% change 1980-87</th>
<th>% change 1980-94</th>
<th>LCL to UCL 1980-94</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-44</td>
<td>Men -36.6</td>
<td>-52.0</td>
<td>-55.8 to -47.8</td>
</tr>
<tr>
<td></td>
<td>Women -34.4</td>
<td>-36.0</td>
<td>-47.9 to -21.4</td>
</tr>
<tr>
<td>45-64</td>
<td>Men -23.6</td>
<td>-45.0</td>
<td>-46.4 to -43.6</td>
</tr>
<tr>
<td></td>
<td>Women -14.4</td>
<td>-39.0</td>
<td>-42.1 to -35.7</td>
</tr>
<tr>
<td>65-84</td>
<td>Men -8.1</td>
<td>-36.0</td>
<td>-37.0 to -34.8</td>
</tr>
<tr>
<td></td>
<td>Women -1.0</td>
<td>-25.9</td>
<td>-27.3 to -24.5</td>
</tr>
<tr>
<td>&gt; =85</td>
<td>Men +14.8</td>
<td>+4.6</td>
<td>-0.8 to +1.02</td>
</tr>
<tr>
<td></td>
<td>Women +8.5</td>
<td>+5.5</td>
<td>+1.5 to +9.6</td>
</tr>
<tr>
<td>All ages*</td>
<td>Men -15.2</td>
<td>-37.8</td>
<td>-38.9 to -36.8</td>
</tr>
<tr>
<td></td>
<td>Women -6.7</td>
<td>-25.7</td>
<td>-27.1 to -24.3</td>
</tr>
</tbody>
</table>

*Calculation of the all ages row is based on age-standardized figures. LCL/UCL = lower and upper confidence limits.
the percentage of patients with non-Q wave acute myocardial infarction has increased\cite{28} and that the incidence of cardiogenic shock and pulmonary congestion may have declined as well\cite{29}.

The present study confirmed that women in comparison to men have been significantly less advantaged by the decline in mortality in all age groups. This finding may be due to a relative under-consumption of cardiac treatment in women. Whether changes in fatality rates have contributed to total decline and its gender differences is still debated. Wilson and Siskind\cite{20} suggested that changes in fatality rates have contributed only a small amount to total decline. For Germany, Herman et al.\cite{30} found a decline in in-hospital acute myocardial infarction mortality in Bremen for males, but not for females. Löwel et al.\cite{26} analysed data from the Augsburg Myocardial Infarction Register, which is situated in the southern part of Germany, and did not find any such trends in the same period.

McGovern and co-workers\cite{31} studied coronary heart disease mortality between 1985 and 1990 in a metropolitan area of the U.S.A. and identified a 25% decline in mortality in both sexes in the age group 30 to 74 years. Survival among patients hospitalized for AMI increased substantially for men, a trend that had an important role in the continued decline due to coronary heart disease. The 41% decline of in-hospital mortality exceeded the decline of out-of-hospital mortality (17%) among men significantly. Tunstall-Pedoe et al.\cite{32} also identified a higher 28-day-fatality rate for women than for men below age 65 years hospitalized with myocardial infarction in Glasgow. In line with these findings is a recent study of Wilkinson et al.\cite{33} in London who followed 216 women and 607 men with acute myocardial infarction admitted to a coronary care unit. They confirmed that women with acute myocardial infarction had a worse prognosis than men but the excess risk was confined to the first 30 days.

McGovern et al.\cite{31} suggest that one quarter of the improvements in short-term survival after acute myocardial infarction may be attributable to more frequent use of thrombolytic therapy, which has been shown to be applied less in women. More recently, a significant increase in treatment with thrombolytics has been observed in Augsburg, Germany\cite{26} in the time interval from 1985 to 1992 (men from 16% to 38%; women from 45% to 71%) as well as in similar countries\cite{31}, suggesting that prior treatment imbalances may have been corrected recently, leading to a further decline in female mortality rates.

The age pattern of decline in the present study revealed most pronounced advantages for both genders in the younger and middle-aged groups, indicating a favourable allocation of resources and attention in the most prevalent target group. Also, the mean age of death has risen in the older age group. However, there is concern about acute myocardial infarction manifestation in the youngest female age groups where almost no further decline was observed, apart from 1987.

**Limitations of the study**

Interpreting and comparing cause-specific mortality by vital statistics data should be considered with caution. Differences or changes in death certification practices can introduce biases and disturb the validity of observed differences\cite{37,38}. An analysis of mortality patterns with the presence of death of more than one serious condition would be conceptually more appropriate especially among the elderly\cite{39,40,41}. In earlier studies, the change in disease categories between the 8th and 9th revisions of the ICD has been shown to be a major source of invalidity\cite{42}. This can be ruled out in the present study, as there were no changes in disease category definitions during the study period.

**References**

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