

Morbidity and Mortality of Myocardial Infarction in the MONICA Study Area Augsburg in 1985

Hannelore Löwel^{1,4}, Ulrich Keil^{1,3}, Wolfgang Koenig², Allmut Hörmann¹, Michael Lewis⁴, Heinz-Dieter Bolte⁴, Johannes Gostomzyk⁵

¹ GSF-Medis-Institut, Neuherberg, ² Universitätsklinik Ulm, ³ Ruhr-Universität Bochum, ⁴ Zentralklinikum Augsburg, ⁵ Gesundheitsamt Augsburg

Introduction

The main objective of the WHO MONICA ('Multinational Monitoring of trends and determinants in cardiovascular diseases') project is the analysis of the trends in cardiovascular mortality, morbidity and case fatality over 10 years in defined populations and the 'explanation' of these trends. The main hypotheses are: Changes in cardiovascular mortality may be caused by 1. a change in incidence, 2. a change in case fatality or 3. a change in incidence and case fatality. Changes in incidence might be mediated by changes in risk factor levels. Changes in case fatality should be related to changes in (acute) medical care. The testing of the main hypotheses of the global MONICA project requires the pooling of the data from the 40 participating centers in Europe, North America, Asia, Australia and New Zealand and the joint analysis of the pooled data. The MONICA project Augsburg contributes to this data pool [1].

Four basic sources of information are to be utilized in each MONICA center over a period of ten years, three involving special studies:

1. Routinely available demographic data on the study population (denominator data).
2. Investigation of medically recognized coronary events, coronary deaths (ICD 410–414) and non-fatal acute myocardial infarctions (ICD 410, 411), using medical and medico-legal sources, and validating the original diagnoses, using MONICA criteria (= coronary event register study).
3. Periodic assessment of the acute care of coronary events.
4. Population surveys to monitor levels of risk factors

and health related behaviour in the study area from which the coronary events derived. Centers are expected to carry out surveys in the beginning, in the middle, and at the end of the 10 year period.

Figure 1 shows the time table for event registration and the three cross-sectional studies of the MONICA Augsburg project.

The 1984/85 survey forms the basis for the MONICA Augsburg cohort study. This paper is confined to results from the coronary event register study.

Methods

The Augsburg MONICA region covers the city of Augsburg and the counties of Augsburg and Aichach-Friedberg with a total population of 532,000 in 1985. There are 156,489 men and 171,093 women, age 25–74, in the study region.

Since October 1, 1984, all fatal and non-fatal coronary events occurring in 25–74 year old residents of the study region and fulfilling the MONICA selection criteria for acute myocardial infarction (AMI) and coronary death have been registered. The MONICA Augsburg Manual [2] describes the procedures for event registration. External quality controls are performed by the WHO quality control center for event registration in Dundee.

Data sources for event registration are 26 hospitals, inside and adjacent to the study area, three health departments, and over 300 practicing physicians.

Patients hospitalized for AMI are reported to the registration team by physicians and nurses of 13 hospitals within the study area and 13 further hospitals in areas adjacent to the study area. Two nurses of the registration team are continuously monitoring the 26 hospitals for AMI patients. Hospital patients who have survived the first days of AMI are interviewed by trained nurses with a standardized questionnaire. They are asked about their medical history, their use of medical facilities and the circumstances of their coronary event. Data concerning in hospital treatment are transferred from the medical records into standardized data forms after the patient is discharged. Electrocardiogram (ECG) changes are evaluated by coding four ECGs, if available, applying the Minnesota code. Where possible, ECGs from the 1st, 2nd and 3rd day of hospitalization and the discharge ECG are coded.

The major treatment center of the study area for

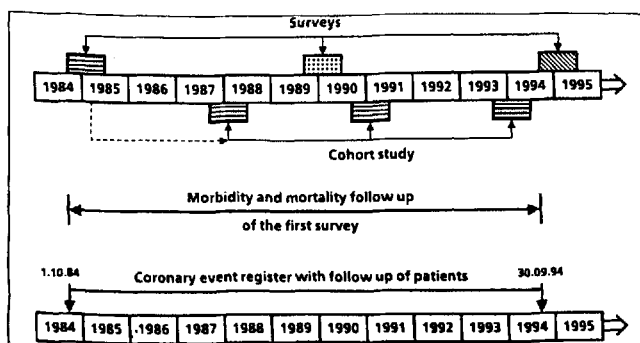


Fig. 1. Time-table, MONICA Project Augsburg.

patients with AMI is the Zentralklinikum Augsburg, a large hospital with 1405 beds, which provides services to the area since 1982. The registration shows that about 75% of all hospitalized myocardial infarction patients in the study area are treated in this hospital.

Information on fatal events in the study population which have occurred within the study area is obtained from death certificates provided by the three health departments. According to the MONICA Manual [1] the following death certificate diagnoses or codes of the 9th revision of the International Classification of Diseases (ICD) must be screened for event registration: Diabetes (250), hyperlipidaemia (272), obesity (278) hypertensive heart disease (401-405), ischaemic heart disease (410-414), other heart disease (420-429), stroke (430-438), diseases of arteries, etc. (440-447), other ill-defined causes of death, etc. (797-799).

The information on the death certificate is validated by sending a questionnaire to the coroner and the last treating physician. The coroner is asked to provide information on the events leading to death, including the probable survival time after the onset of symptoms. The last treating physician is asked for the cardiovascular history of the deceased, including medication prior to death. All non-fatal AMI and coronary deaths are classified by MONICA diagnostic categories (MD) derived from the MONICA diagnostic criteria by a special algorithm [1]. To define the MD of a registered event, information about four data items must be collected: acute symptoms, cardiac enzymes, ECG change code, and necropsy findings in fatal cases. The MDs read as follows:

- 1 = definite acute myocardial infarction
- 2 = possible acute myocardial infarction or coronary death
- 3 = ischaemic cardiac arrest with successful resuscitation not fulfilling criteria for definite or possible myocardial infarction
- 4 = no acute myocardial infarction or coronary death
- 9 = fatal events with insufficient data. (Only in the Augsburg study, persons with non-fatal events who refused to give written consent to participate in the study are given MD 9.)

To avoid underestimating the risk of myocardial

Tab. 1. Distribution of surviving and deceased 25- to 74-year-old patients with a coronary event (n = 998) in the MONICA diagnostic categories (MD). MONICA Project Augsburg, Coronary Event Register 1985.

Coronary event (MD)	non-fatal		fatal	
	n	%	n	%
Definite (1)	283	68	47	8
Possible (2)	96	24	348	60
Cardiac arrest with successful resuscitation (3)	4	1	-	-
No acute myocardial infarction (4)	18	4	49	8
Insufficient data (9)	14	3	139	24
Total	415	100	583	100

Tab. 2. Incidence, attack and death rates of coronary events in men (n = 695) and women (n = 236) per 100,000 by age and MONICA diagnostic categories (MD). MONICA Project Augsburg, Coronary Event Register 1985.

Age	Incidence rate		Attack rate		Death rate	
	MD 1, 2, 3	MD 1, 2, 3, 9	MD 1, 2, 3	MD 1, 2, 3, 9	MD 1, 2	MD 1, 2, 9
Men						
25-34	0	3	3	5	0	3
35-44	53	68	69	84	19	32
45-54	206	260	253	314	74	124
55-64	531	651	773	915	311	434
65-74	927	1108	1643	1873	1030	1249
25-64	167	207	229	276	82	122
25-74	247	302	378	444	182	241
Women						
25-34	3	3	3	3	0	0
35-44	3	6	3	6	0	3
45-54	17	23	20	25	17	23
55-64	96	136	109	152	56	97
65-74	393	495	514	627	310	419
25-64	29	40	32	45	17	29
25-74	87	113	109	138	64	92

infarction and coronary death in the population of the study area, the event rates are calculated separately for MDs 1, 2, 3 and MDs 1, 2, 3, 9 without MD 4 events. The event rates are defined as follows:

Incidence rate = the non-fatal and fatal events for whom no history of previous myocardial infarction could be established divided by the midyear population.

Tab. 3. 28-day case fatality (%) in men (n = 695) and women (n = 236) by age and MONICA diagnostic category groups (MD). MONICA Project Augsburg, Coronary Event Register 1985.

Age	MD 1, 2, 3			MD 1, 2, 3, 9		
	events n	deaths n	28-day case fatality (%)	events n	deaths n	28-day case fatality (%)
Men						
25-34	1	-	0.0*	2	1	50.0*
35-44	26	7	26.9*	32	12	37.5*
45-54	92	27	29.3	114	45	39.5
55-64	201	81	40.3	238	113	47.5
65-74	271	170	62.7	309	206	66.7
25-64	320	115	35.9	386	171	44.3
25-74	591	285	48.2	695	377	54.2
Women						
25-34	1	-	0.0*	1	-	0.0*
35-44	1	-	0.0*	2	1	50.0*
45-54	7	6	85.7*	9	8	88.9*
55-64	37	19	51.4*	52	33	63.5
65-74	141	85	60.3	172	115	66.9
25-64	46	25	54.3	64	42	65.6
25-74	187	110	58.8	236	157	66.5

* Values are based on a small number of events.

Tab. 4. 28-day case fatality (%) in first and recurrent events by age and sex (MONICA diagnostic categories 1, 2, 3, 9). MONICA Project Augsburg. Coronary Event Register 1985.

Age group	Men		Women	
	First Event (n = 472)	Recurrent Event (n = 223)	First Event (n = 193)	Recurrent Event (n = 43)
25-34	-	0*	0*	-
35-44	34	51*	0*	-
45-54	35	61	88*	100*
55-64	39	68	63*	66*
65-74	64	70	65	72*
25-64	38	65	65	72*
25-74	48	68	65	73

* Values are based on a small number of events (see Table 3).

Attack rate = all first and recurrent fatal and non-fatal events divided by the midyear population.

Coronary death rate = all first and recurrent fatal events divided by the midyear population.

Case fatality (%) = all fatal events divided by all fatal and nonfatal events multiplied by 100.

Results

In 1985, 998 coronary events, 734 in men and 264 in women, were registered among the 25-74 year old residents of the study area. These events were fatal within 28 days for 403 men and 180 women.

There is a great discrepancy in the structure of the MDs between non-fatal and fatal cases (Table 1). For non-fatal cases, the results show a definite AMI (MD 1) in 68% and a possible AMI (MD2) in 24%. In contrast to this, only 8% of the fatal cases were classified as definite, and 60% as possible AMI. This is due to the low autopsy rate of 6.3% and the large proportion of cases deceased outside the hospital. Every 4th fatal case lacked sufficient data for diagnostic classification, even though in 95% of fatal cases the official

cause of death was validated by statements of the last treating physician or coroner. According to the physicians, 123 (37%) of the 334 out of hospital fatal cases were found dead, so that not even information about possible symptoms of pain could be obtained. Enzyme levels and ECGs were available for only 8% of the out of hospital fatal cases, but for 96% of the non-fatal cases. These differences in the MD structure are the reason for grouping the Augsburg event rates separately in MD 1, 2, 3 and MD 1, 2, 3, 9. Naturally, all 39 male and 28 female events which are classified as MD 4 were excluded from the calculation of the rates.

In both men and women, the incidence, attack and death rates for myocardial infarction increase with age (Table 2). The event rates for men in the age group 25-64 are about five times higher than the respective rates for women. These differences are smaller in the higher age groups. About two thirds of the events are first events. The higher proportion of first events in women is associated with a higher age at the time of the first event.

Case fatality is defined as the percentage of events which are fatal within 28 days (Table 3). The case fatality increases with age and is higher in female than in male cases up to age 64. Although incidence and attack rates are lower in women than in men in the age range monitored, women run a higher risk of death than men, once they have suffered a coronary event.

The case fatality for first events is lower than for recurrent events, both for male and female patients (Table 4). Table 5 shows the case fatality in the age range 25-74 years relative to the stages of medical care. The 28-day case fatality is highest if all coronary events are included in the calculation. If only the in-hospital cases are considered, the case fatality is reduced by half. Those who reached the hospital and survived 24 hours have a case fatality of 11.9% (men) and 6.0% (women). This analysis shows that the major risk of death occurs in the pre-hospital and early hospital phase.

Tab. 5. Coronary events by stages of medical care. Number of deaths and 28-day case fatality (%) before the subsequent stage of medical care in men and women, age 25-74. MONICA diagnostic categories 1, 2, 3, 9. MONICA Project Augsburg. Coronary Event Register 1985.

Stages of medical care	No. of coronary events	No. of deaths before the next stage	No. of deaths within 28 days	28-days case fatality (%)
Men				
1. All coronary events	695	217	377	54.2
2. Those who reached the emergency room	478	19	160	33.5
3. Those who reached the ICU and/or general ward ≤ 24 hours	459	98	141	30.7
4. Those who survived > 24 hours after admission to hospital	361	43	43	11.9
Alive after 28 days	318	-	-	-
Women				
1. All coronary events	236	103	157	66.5
2. Those who reached the emergency room	133	6	54	40.6
3. Those who reached the ICU and/or general ward ≤ 24 hours	127	43	48	37.8
4. Those who survived > 24 hours after admission to hospital	84	5	5	6.0
Alive after 28 days	79	-	-	-

Tab. 6. Coronary deaths (ICD 9th Rev.: 410–414) according to official mortality statistics and coronary event register by age, sex and MONICA diagnostic categories (MD). MONICA Project Augsburg. Coronary Event Register 1985.

Age	Off. mort. statistics n	Men event-register		Off. mort. statistics n	Women event-register	
		MD 1,2 n	MD 1,2,9 n		MD 1,2 n	MD 1,2,9 n
25–34	–	–	1	–	–	–
35–44	9	7	12	–	–	1
45–54	34	27	45	11	6	8
55–64	106	81	113	26	19	33
65–74	183	170	206	98	85	115
25–64	149	115	171	37	25	42
25–74	332	285	377	135	110	157

Discussion

Before evaluating the coronary event rates, the possible sources of bias in data acquisition inherent in our registration process must be considered.

For non-fatal events, the case finding procedure virtually guarantees the complete obtainment of all AMI events in the 13 hospitals of the study region. The treatment of study region residents with AMI in hospitals adjacent to the study region is the exception (8 cases in 1985). If initial treatment occurred in other hospitals within or outside the FRG, only those patients transferred for further treatment to a hospital within or adjacent to the study region can be registered (9 cases in 1985). Questionnaires sent to 264 practicing physicians (response 93%) of the study region in 1984 showed that 25–74 year old patients with a diagnosed AMI are always hospitalized for medico-legal and ethical reasons [3]. The maximum figure for non-fatal events occurring and being exclusively treated outside the study region does not exceed 5%.

It seems evident that coronary event registers in regions with a low autopsy rate like Augsburg (6.3%) will tend to underestimate the risk of myocardial infarction, if the fatal cases with insufficient data (MD 9) are not taken into account. Regions with higher autopsy rates will have more cases of MD 1 and MD 2 (possible) or MD 4 (no myocardial infarction) and less cases with insufficient data than regions with low autopsy rates. For this reason, the coronary event rates are calculated separately for cases comprising MD 1, 2, 3 and cases comprising MD 1, 2, 3, 9 to establish a lower (MD 1, 2, 3) and an upper (MD 1, 2, 3, 9) limit of event rates. Table 6 shows that the absolute number of coronary deaths (ICD 410–414) in the official mortality statistics are within the range of coronary deaths established by MD 1, 2, and MD 1, 2, 9. This finding supports the validity of the register data.

The MONICA Data Center in Helsinki has furnished the 1984 age-standardized official mortality data for the age group 35–64 of 32 centers [4]. With 800 male and 332 female deaths of all causes per 100,000 the study region of Augsburg is in the mid range of all MONICA centers. The official coronary death rate for 1984 in Augsburg, 173 per 100,000 men and 30 per 100,000 women, is in the lower third of the MONICA centers.

Age-standardized results of AMI morbidity are not yet available for the MONICA centers. The findings from various other coronary event register studies presented in Table 7 therefore permit only a limited comparison with the Augsburg data, and only guarded conclusions are possible. The results from the DAN MONICA [5] provide the best comparison, because all coronary event rates could be age standardized. The attack rate for Auckland, New Zealand could also be age standardized [6]. The results from Karl-Marx-Stadt [7] are

Tab. 7. Comparison of rates of myocardial infarction (AMI) in 25- to 64-year-olds reported by various Coronary Event Registers from 1981 to 1985.

Coronary Event Register	Attack rate per 10 ⁵		Death rate per 10 ⁵		28-day-case fatality rate in %		Necropsy rate in %	Comments
	men	women	men	women	men	women		
MONICA-Augsburg, FRG, 1985 (139,990 men, 143,645 women)	278	38	123	25	44.2	65.8	6.3	age standardized by FRG population 1980 MONICA-diag. 1, 2, 3, 9
DAN-MONICA, DK, 1982 (90,408 men, 91,946 women)	499	124	136	35	27.3	28.2	40.0	age standardized by FRG population 1980 MONICA-diag. 1, 2
Karl-Marx-Stadt, GDR, 1984 (79,000 men, 88,000 women)	321	66	100*	24*	31.0	36.2	41.4	not standardized by age; definite, possible AMI + death with insufficient data; *calculated: attack rate × case fatality: 100
Auckland, NZ, 1981 (199,000 men, 206,000 women)	433	103	–	–	21.6**	27.3**	31.4	attack rates are age standardized by FRG population 1980, only definite AMI; ** 35- to 69-year-old cases

unstandardized averages and can only be compared with caution. The comparison of these four centers as well as the coronary event rates published by WHO for the year 1971 [8] permit the conclusion that morbidity and mortality of coronary events for the 25–64 year old population in Augsburg are comparatively low. The case fatality, however, is relatively high in the study area.

In summary, the Monica Augsburg data necessitates a continuous review of possible sources of bias which affect the registration process and the interpretation of event rates. A crude method to control for completeness of case obtainment using the official mortality statistics was presented.

A first, careful comparison of coronary event register results showed the existence of differences in event rates between the centers. The analysis of the trends of coronary heart disease morbidity and mortality within the 40 participating centers of the international MONICA project may also shed more light on the factors responsible for those regional differences.

Summary

In the year 1985, 998 (734 men, 264 women) cases of acute coronary events were registered among the 25-74 year-old residents of the study area (151,489 men and 171,093 women) of whom 583 (403 men, 180 women) died within 28 days (case fatality). Both AMI as a clinical diagnosis and AMI as a cause of death are validated by defined MONICA diagnostic criteria (acute symptoms, enzyme level, ECG, autopsy diagnosis). The AMI-risk (MONICA diagnostic categories 1, 2, 3, 9) in the study area Augsburg is relatively low (incidence: men 302, women 113; attack rate: men 444, women 138; death rate: men 241, women 92; all per 100,000 for each group). The 28-day case fatality is comparatively high (men 54%, women 67%). A comparison of the Augsburg rates with those of three other centers shows that the Augsburg figures are in the lower range.

Zusammenfassung

Morbidität und Mortalität an akutem Herzinfarkt in der MONICA-Studienregion Augsburg im Jahre 1985

Im Jahre 1985 wurden 998 (734 Männer, 264 Frauen) Herzinfarkterkrankungsfälle bei 25- bis 74jährigen Einwohnern der Studienregion (151489 Männer und 171093 Frauen) registriert, von denen 583 Personen (403 Männer und 180 Frauen) innerhalb von 28 Tagen verstarben. Die klinische Diagnose Herzinfarkt und auch die Todesursache «Koronare Herzkrankheit» wurden anhand der MONICA-Diagnose-Kriterien (akute Symptomatik, Enzymhöhe, EKG-Verlauf und bei Verstorbenen das Autopsieergebnis) validiert und nach MONICA-Diagnose-Kategorien eingeteilt. Ein erster Vergleich mit 3 weiteren MONICA-Zentren zeigt deutlich regionale Differenzen bei den «attack-rates» und der 28-Tage-Letalität, während die Herzinfarktmortalität weniger differiert. Die Herzinfarkterkrankungs- und -sterbehäufigkeit der 25- bis 74jährigen Studienbevölkerung ist relativ niedrig (Erstinfarkthäufigkeit: 302 für Männer, 113 für Frauen; Fallhäufigkeit: 444 für Männer, 138 für Frauen; Sterberate: 241 für Männer, 92 für Frauen; jeweils je 100000 der Bevölkerung gleichen Geschlechts). Die 28-Tage-Letalität ist mit 54% der männlichen und 67% der weiblichen Herzinfarkterkrankten vergleichsweise hoch.

Résumé

Morbidité et mortalité par l'infarctus du myocarde dans la région MONICA d'Augsburg en 1985

Chez les habitants de la région augsbourgeoise âgés de 25 à 74 ans (151489 hommes et 171093 femmes), 998 cas (734 hommes, 264 femmes) de malades de l'infarctus du myocarde ont été recensés, dont 583 (403 hommes et 180 femmes) sont décédés en 28 jours. Le diagnostic clinique de l'infarctus du myocarde aussi bien que la cause du décès par «cardiopathie coronaire» ont été évalués et classés à l'aide de catégories diagnostiques MONICA (symptômes aigus, taux d'enzyme, tracés-électrocardiographe et les résultats de l'autopsie des décédés). Une première comparaison avec trois autres centres MONICA présente une différence régionale nette en ce qui concerne la fréquence des crises cardiaques et la létalité de 28 jours, tandis qu'elle est moins prononcée quant à la mortalité par infarctus du myocarde. La maladie de l'infarctus et les décès qui en résultent sont relativement peu fréquents dans une population âgée de 25 à 74 ans (fréquence du premier infarctus: 302 hommes, 113 femmes; fréquence de cas: 444 hommes, 138 femmes; Taux de décès par infarctus du myocarde: 241 hommes, 92 femmes; sur 100000 respectivement d'une population du même sexe). La létalité de 28 jours représente un taux relativement élevé avec 54% des hommes et 67% des femmes malades de l'infarctus.

References

- [1] World Health Organisation: MONICA Manual, Version 1.1., Genf, 1986.
- [2] Keil U, Koenig W, Löwel H, Judt I, Lukitsch D, Gall W, Schurer B, Huss W, Nonnenmacher G, Hörmann A, Kaup U. MONICA-Project, Region Augsburg; Manual of Operations – Myocardial Infarction Register, Gesellschaft für Strahlen- und Umweltforschung, Bericht 21, München 1985.
- [3] Löwel H, Koenig W, Hörmann A, Roos G, Gostomzyk J, Keil U. MONICA-Projekt, Region Augsburg; Herzinfarkt-Register – Pilotstudie 1983/84, Gesellschaft für Strahlen- und Umweltforschung, Bericht 28, München 1985.
- [4] The principal investigators of the MONICA-Project: Wld hlth statist. quart. 40 1987: 171–184.
- [5] Schroll M, Kirchhoff M, Sjol A, Schnack H, Henriksen S, Kirby H, Madsen M. Monitoring of trends and determinants in cardiovascular disease, DAN-MONICA, Glostrup, Denmark, 1982–1992. CVD Epidemiology Newsletter, American Heart Association, October 1985; 40: 54–55.
- [6] Beaglehole R, Stewart A, Bonita R, Jackson R, Sharpe DN. Myocardial infarction and sudden death in Auckland. NZ Med J 1984; 97: 715–8.
- [7] Quieitzsch D, Voigt G, Bock M, Glös J, Jung U, Maaz B. Vergleichsstudie der Letalität des akuten Myokardinfarktes in der 25- bis 64jährigen Bevölkerung einer Industriegrossstadt der DDR zwischen den Herzinfarktregistern 1974/75 und 1984. Z Klin Med 42, 1987; 11: 981–984.
- [8] World Health Organisation. WHO Public Health in Europe. Myocardial infarction community registers – Results of a WHO International Collaborative Study coordinated by the Regional Office for Europe. WHO, Regional Office for Europe, Copenhagen; 1977.

Address for correspondence:
 Hannelore Löwel
 Zentralklinikum Augsburg
 Stenglin Strasse 2
 D-8900 Augsburg