



# Maternal mortality in Bavaria between 1983 and 2000

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## KEY WORDS

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**Objective:** This study was undertaken to identify the main causes of maternal mortality within a developed country to refocus and enhance the delivery of obstetric services.

**Study design:** From January 1, 1983, to December 31, 2000, 309 maternal deaths occurring in Bavaria were documented and classified in a prospective observational study. The data sources were the civil registry, confidential reports by members of the Bavarian Society of Obstetrics and Gynecology, and public information. Direct obstetric death, indirect obstetric death, and coincidental death account for 164, 67, and 78 cases, respectively. They were expressed as the maternal mortality ratio (MMR: maternal deaths/100,000 live births) over the 18-year study period divided into three 6-year intervals 1983 to 1988, 1989 to 1994, and 1995 to 2000.

**Results:** The direct obstetric mortality ratio (DOMR: direct obstetric deaths/100,000 live births) decreased from 11.3 in the study period 1983 to 1988 to 5.4 in the study period 1995 to 2000 ( $P < .0005$ ), mainly because of a reduction in antepartum and intrapartum deaths. The main cause of direct obstetric death was thromboembolism, including amniotic fluid embolism, which remained unchanged over the study period; other causes of direct obstetric death decreased markedly but not significantly.

**Conclusion:** Careful analysis of the Bavarian maternal mortality data identified postpartum maternal deaths to be unchanged during the study period. In particular, effective prevention and treatment of thromboembolism should be a prior focus for obstetric care.

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The maternal mortality ratio (MMR), expressed as maternal deaths per 100,000 live births over a given period, is a major measure of obstetric care quality. According to World Health Organization (WHO) estimates, it varies up to 100-fold worldwide, from approximately 10 in developed countries to approximately

1,000 in the least developed.<sup>1,2</sup> However, even in countries with complete civil registers and active cause-of-death attribution guidelines, there is underreporting and misclassification<sup>3-8</sup> and therefore the need for scientific endeavour for complete documentation and correct classification. A complete register requires cross-checking against, and supplementation by information from multiple additional sources before trends can be identified with sufficient reliability to inform recommendations for future obstetric care. Thus, the 1995 Report on Confidential Enquiries into Maternal Deaths (CEMD) included the recommendations of the Royal

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**Table I** Comparison of data sources for maternal deaths

	1983-1988	1989-1994	1995-2000
Death certificate			
Obstetric deaths	97	67	63
Coincidental deaths	9	23	28
Total	106	90	91
All sources combined			
Obstetric deaths	96	63	72
Coincidental deaths	18	34	26
Total	114	97	98
Underreporting [ <i>n</i> (%)]	8 (7.0)	7 (7.2)	7 (7.1)

College of Obstetricians and Gynaecologists (RCOG) on the prophylactic use of heparinoids, which markedly reduced thrombosis-related deaths after cesarean section, as documented in the recent CEMD.<sup>7</sup> In this study we aim for the presentation of the leading causes of maternal mortality at the end of the 20th century in a well-defined region in central Europe and derive recommendations for further enhancing the quality of obstetric care.

## Data sources

The Bavarian Society of Obstetrics and Gynaecology launched a confidential enquiry into maternal deaths in Bavaria on January 1, 1983. The database was built from the civil register and death certificates, cross-checked, and supplemented with the Bavarian perinatal database (BPE), which documents 90.7% of deliveries in Bavaria. The database was extended by confidential reports from physicians, social institutions, lay persons, and a press search. The compilation of these information by the Board of the Bavarian Society of Obstetrics and Gynaecology made all maternal deaths in pregnancy, or within 42 days of its termination, irrespective of duration or site, available (International Classification of Diseases and Related Health Problems [ICD] 9 and 10), including direct and indirect obstetric deaths, and the accidental or coincidental deaths. Our definition is equivalent to the CEMD definitions.<sup>7</sup> Late maternal deaths, ie, those occurring more than 42 days after but within 1 year of the termination of pregnancy, were not documented, as they were not included in German civil registers during the study period. Therefore, our data are not comparable with the pregnancy-related mortality ratios that are based on the Centers for Disease Control and Prevention—American College of Obstetricians and Gynecologists (CDC-ACOG) definitions.<sup>6</sup>

Nationality of the deceased was documented and classified in German and non-German.

Statistical comparisons were performed with odds ratios.

**Table II** Pattern of direct/indirect maternal deaths 1983-2000

	1983-1988	1989-1994	1995-2000
Live births	699,663	793,222	756,426
Deaths			
Obstetric:			
Direct [ <i>n</i> (DOMR)]	79 (11.3)	44 (5.5)*	41 (5.4)*
Indirect [ <i>n</i> (MMR)]	17 (2.4)	19 (2.4)	31 (4.1)
Direct/indirect	4.6	2.3	1.3
Coincidental	18	34	26
Total	114	97	98

\*  $P < .01$  vs 1983-1988.

**Table III** Timing of maternal deaths in relation to delivery

	1983-1988	1989-1994	1995-2000
Live births	699,663	793,222	756,426
MMR	13.7	7.9	9.5
Time of death			
Antepartum	20 (18)	19 (7)*	15 (3)
Intrapartum	10 (10)	2 (2)*	3 (3) <sup>†</sup>
Postpartum	66 (51)	42 (35)	54 (35)
Total	96 (79)	63 (44)	72 (41)

Direct obstetric deaths are shown in parentheses.

\*  $P < .02$ ;

<sup>†</sup>  $P < .07$  vs 1983-1988.

## Review methods

Over the 18-year study period to 2000, the death certificate information yielded a total of 287 deaths, of which 227 were obstetric and 60 coincidental. However, the extended database, individually analyzed by Dr Welsch, yielded figures of 309, 231, and 78, equivalent to an underreporting of approximately 7% that remained constant throughout the study period (Table I). Dr Welsch is member of the Mothers' Mortality and Severe Morbidity (MOMS) group and classified all maternal deaths according to the rules of this international panel.<sup>9</sup> In 150 of these 231 obstetric cases (64.9%), the cause of maternal death was documented by autopsy.

With the use of the medical documentation, available in 300 of the 309 cases (97.1%), Dr Welsch reclassified the deaths as direct obstetric, indirect obstetric, and coincidental, dividing the study period into three 6-year intervals to facilitate the analysis of change with time (the remaining 9 cases were classified by using the death certificate information only). Misclassification—in particular, 9 deaths classified as coincidental on the basis of the death certificate information versus 18 on the basis of the extended database, and 23 versus 34—was most marked in the periods 1983 to 1988 and 1989 to 1994, respectively (Table I).

**Table IV** Maternal mortality in relation to maternal age

	Age group (y)						
	≤19	20-24	25-29	30-34	35-39	40-44	≥45
Births 1983-1988	23,272	178,559	279,907	156,758	51,456	9,038	671
Direct deaths	3	12	21	27	12	3	1
Indirect deaths	0	5	7	4	1	0	0
Total [ <i>n</i> (MMR)]	3 (12.9)	17 (9.5)	28 (10.0)	31 (19.8)	13 (25.3*)	3 (33.2)	1 (149.0)
Births 1989-1994	18,702	143,712	321,162	227,007	70,496	11,624	519
Direct deaths	1	5	16	12	7	3	0
Indirect deaths	2	1	5	2	4	4	1
Total [ <i>n</i> (MMR)]	3 (16.0)	6 (4.2)	21 (6.5)	14 (6.2)	11 (15.6*)	7 (60.2)	1 (192.7)
Births 1995-2000	15,767	102,890	252,364	268,862	101,055	14,941	546
Direct deaths	0	2	8	16	13	2	0
Indirect deaths	1	3	15	5	6	1	0
Total [ <i>n</i> (MMR)]	1 (6.34)	5 (4.86)	23 (9.11)	21 (7.81)	19 (18.80*)	3 (20.08)	0 (0.0)

\*  $P = .01$  vs 20-24 y.

## Results

The pattern of maternal deaths over the study period showed a marked reduction in direct obstetric deaths in 1989 to 1994 and 1995 to 2000 versus 1983 to 1988 ( $P < .01$ , Table II). Similarly, the timing of obstetric death in relation to delivery showed a marked decrease in the proportion of antepartum and intrapartum deaths in 1989 to 1994 versus 1983 to 1988 ( $P < .02$ , Table III); the proportion of postpartum deaths remained stable over the study period.

Maternal mortality increased with age (35-39 years vs 20-24 years:  $P = .01$ , Table IV). In the first study period, 1983 to 1988, it was also higher in non-Germans than in Germans ( $P = .01$ , Table V).

Throughout the study period the main cause of direct obstetric death was thromboembolism, including amniotic fluid embolism, followed by hemorrhage, hypertensive disease, and sepsis; cardiovascular disease accounted for over half of all indirect obstetric deaths (Table VI). Road traffic accidents, followed by suicide, were the main causes of coincidental deaths throughout the study period (Table VII).

## Comment

Although maternal deaths have become rare in the industrialized world, it is important for them to be reliably documented and classified if we are to draw valid international comparisons and raise awareness among the professionals concerned. Bavarian death certificates throughout the study period composed a pregnancy checkbox for documenting death in pregnancy and/or within 42 days of its termination. Death certificates in other European countries, eg, Belgium, Denmark,

**Table V** Maternal mortality in German vs non-Germans

	1983-1988	1989-1994	1995-2000
German			
Live births	638,418	700,955	643,324
Maternal deaths	78	53	60
MMR	12.2	7.6	9.3
Non-German			
Live births	61,246	92,267	113,102
Maternal deaths	17	10	11
MMR	27.8	10.8	9.7
German/non-German MMR	0.44*	0.70†	0.96
Total MMR	13.7	7.9	9.4

\*  $P = .01$

†  $P = .4$

Ireland and the United Kingdom, have a similar pregnancy checkbox. France attached a pregnancy checkbox to the death certificate in 1997 after evidence of 56% underreporting.<sup>10</sup> Elsewhere in Europe, in the continued absence of a pregnancy checkbox, underreporting rates run from 26% in The Netherlands<sup>11</sup> to 38% in Austria<sup>12</sup> and 60% in Finland.<sup>5</sup>

Over the study period, the extended database of the Board of the Bavarian Society of Obstetrics and Gynecology revealed 22 maternal and coincidental deaths in addition to those identifiable from the death certificates alone. This equates to an underreporting rate of 7.1%, a low figure compared with the recent CEMD estimate of 41.3% in the United Kingdom,<sup>7</sup> suggesting that the civil registry system is fairly reliable.

On this basis, our analysis revealed a significant decrease in direct obstetric deaths over the last 18 years. Indirect obstetric deaths, on the other hand, remained stable, even tending to increase during the last 6-year period.

**Table VI** Direct and indirect causes of maternal mortality

	1983-1988		1989-1994		1995-2000	
	n	DOMR	n	DOMR	n	DOMR
<b>Direct</b>						
Thrombosis and thromboembolism	24	3.4	13	1.6	20	2.6*
including amniotic fluid embolism	6	0.9	3	0.4	9	1.2*
Hemorrhage	16	2.3	10	1.3	8	1.1*
Pregnancy-induced hypertension	10	1.4	8	1.0	4	0.5*
Sepsis	12	1.7	7	0.9	5	0.7*
Abortion	8	1.1	—	—	3	0.4*
Ectopic pregnancy	4	0.6	2	0.3	—	—
Anesthetic	4	0.6	3	0.4	1	0.1*
Other	1	0.1	1	0.1	—	—
Total (N = 164)	79		44		41	
DOMR		11.3		5.5		5.4 <sup>†</sup>
	n	MMR	n	MMR	n	MMR
<b>Indirect</b>						
Cardiovascular diseases	9	1.3	13	1.6	16	2.1*
Extragenital infections	4	0.6	1	0.1	3	0.4*
Pulmonary diseases	2	0.3	—	—	2	0.3*
CNS diseases	1	0.1	4	0.5	4	0.5*
GI tract diseases	—	—	1	0.1	1	0.1
Other	1	0.1	—	—	5	0.7*
Total (N = 67)	17		19		31	
Indirect obstetric mortality		2.4		2.4		4.1*
Indirect obstetric mortality (%)	17.7		30.2		43.1	
MR		13.7		7.9		9.5

CNS, Central nervous system; GI, gastrointestinal.

\* NS.

<sup>†</sup>  $P < .01$ .

The ratio between direct and indirect obstetric deaths decreased from 4.6 to 1.3 from the first to the third study period. The United Kingdom also saw a decrease in direct obstetric deaths from 1.6 in 1985 to 1987 to 0.8 during 1997 to 1999,<sup>7</sup> the latter figure being comparable to the Bavarian rate in the final study period (Table II).

As in Bavaria, the United Kingdom has experienced an increase in indirect obstetric deaths over the last decades, most likely because of improved reporting. The dependence of maternal mortality on maternal age documented in the Bavarian statistics confirms the relationship revealed by the CEMD,<sup>7</sup> the Dutch confidential enquiry,<sup>4</sup> and the CDC.<sup>13</sup> Even in the developing world,<sup>14</sup> maternal mortality increases with maternal age but rates are 10 to 30 times higher than in Europe.

Maternal mortality differed significantly between German and non-German women only in the first third of our study. This contrasts with the CEMD data and is probably because the current uptake of obstetric care in Bavaria is satisfactory across all the different nationalities.

All professionals caring for parturient women must keep in mind that two thirds of maternal deaths are postpartum (Table III). The leading cause of direct obstetric death in Bavaria over the study period was thromboembolism—including, as recommended by the

European Association of Perinatal Medicine,<sup>15</sup> amniotic fluid embolism—with no change of note in its absolute or relative incidence over time (Table VI). This is in agreement with the latest CEMD<sup>7</sup> and the latest report from the CDC in the United States.<sup>13</sup> This is in contrast to previous reports from the United States, where bleeding was the major cause of maternal death during 1987 to 1990<sup>16</sup> and The Netherlands, where from 1983 to 1992 it was preeclampsia.<sup>4</sup>

Hemorrhage was the second most common cause of maternal death in Bavaria in all 3 study periods, although its frequency dropped from 2.3 to 1.1 per 100,000 live births between the first and third periods. The rate of hemorrhagic obstetric death in the United Kingdom is markedly lower, accounting for DOMRs of 0.7 in 1985 to 1987 and 0.4 in 1997 to 1999.<sup>7</sup> In Bavaria and the United Kingdom, maternal mortality caused by ectopic pregnancy has decreased remarkably over the last decades: the latest CEMD documented 13 obstetric deaths from ectopic pregnancies (DOMR 0.6), whereas in Bavaria, there were none at all in the final 6 years of our study. As for the next most common causes of direct obstetric death, sepsis, hypertension, and abortion, these decreased by more than 50% from the first to last study period.

**Table VII** Causes of coincidental maternal deaths (n) 1983-2000

Cause	1983-1988	1989-1994	1995-2000
Undetermined	4	4	4
Suicide	4	9	5
Cancer	3	3	3
Unnatural	7	18	14
Road traffic accident	4	16	9
Murder	3	1	3
Drowning-bath	0	0	1
Suffocation-house fire	0	0	1
Drug abuse	0	1	0
Total	18	34	26

The leading cause of indirect obstetric death throughout the study period was cardiovascular disease, also in the CEMD, followed by extragenital infection and airway disease.

Coincidental deaths increased markedly from the first to the final 2 study periods, most probably because of the introduction of systematic coincidental death documentation by the Bavarian Statistics Office in early 1987. Coincidental death now accounts for 34% of all pregnancy-related deaths in Bavaria versus only 12% in the United Kingdom. The most common causes in Bavaria are road traffic accidents and suicide, the latter being included among coincidental deaths on the recommendation of the European Concerted Action on MOMS group.<sup>15</sup> The latest CEMD, on the other hand, classifies suicide as an indirect obstetric death.<sup>7</sup> Either way, all professionals involved in prenatal and postnatal care should be alert to symptoms or illness predictive of suicide.

ICD-10 and the 1986 CEMD<sup>17</sup> introduced the term "late maternal death" to encompass severely ill women kept alive by improved life-sustaining care for more than 42 days after the end of pregnancy. We could not document such cases in our study because the Bavarian statistics did not include them. In 2001 the Bavarian death certificate was adjusted to incorporate an additional checkbox to document pregnancy terminating at any time between 43 days and 1 year before death.

Our study showed a marked reduction in direct obstetric deaths over the study period. In particular, those caused by hemorrhage, hypertension, and sepsis were more than halved, possibly because of the awareness raised at various meetings of the Bavarian Society of Obstetrics and Gynaecology. Unfortunately, however, the main cause of direct obstetric death—thromboembolism, including amniotic fluid embolism—showed no marked reduction over the study period. This is an instructive illustration of the use of maternal mortality

surveys: they not only document the past but point to the issues that need to be addressed in the future.

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