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Classification differences and maternal mortality: a European study

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Objectives	To compare the ways maternal deaths are classified in national statistical offices in Europe and to evaluate the ways classification affects published rates.
Methods	Data on pregnancy-associated deaths were collected in 13 European countries. Cases were classified by a European panel of experts into obstetric or non-obstetric causes. An ICD-9 code (International Classification of Diseases) was attributed to each case. These were compared to the codes given in each country. Correction indices were calculated, giving new estimates of maternal mortality rates.
Subjects	There were sufficient data to complete reclassification of 359 or 82% of the 437 cases for which data were collected.
Results	Compared with the statistical offices, the European panel attributed more deaths to obstetric causes. The overall number of deaths attributed to obstetric causes increased from 229 to 260. This change was substantial in three countries ($P < 0.05$) where statistical offices appeared to attribute fewer deaths to obstetric causes. In the other countries, no differences were detected. According to official published data, the aggregated maternal mortality rate for participating countries was 7.7 per 100 000 live births, but it increased to 8.7 after classification by the European panel ($P < 0.001$).
Conclusion	The classification of pregnancy-associated deaths differs between European countries. These differences in coding contribute to variations in the reported numbers of maternal deaths and consequently affect maternal mortality rates. Differences in classification of death must be taken into account when comparing maternal mortality rates, as well as differences in obstetric care, underreporting of maternal deaths and other factors such as the age distribution of mothers.

Keywords	Maternal mortality, maternal mortality rates, International Classification of Diseases, cause of death, Europe
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Maternal mortality is not only a tragic event, but is also considered as a reflection of the quality of obstetric care in a country. Several years ago a European Concerted Action[1] on 'Avoidable Deaths' highlighted considerable differences in maternal mortality rates between countries. Several hypotheses can be advanced for these. Firstly, maternal mortality depends on the prevalence of maternal diseases which may vary from country to country. This could be due to differences in obstetric care or in demographic, socioeconomic, biological or behavioural factors. Secondly, maternal mortality rates depend on the process of death certification and whether pregnancy is mentioned on the death certificate. The extent of underreporting of maternal deaths varies from one country to another. Moreover, maternal deaths are rare, and differences in coding could also affect maternal mortality rates.

The European Concerted Action on 'MOthers' Mortality and Severe morbidity' (MOMS) aimed to investigate the variations in maternal mortality rates in Europe. Participants at the first meeting, in 1994, decided to undertake two surveys: survey-A on maternal mortality, based on death certificates, at national level; and survey-B on maternal morbidity, in selected areas.

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Table 1 Pregnancy-associated deaths included in the Mothers' Mortality and Severe Morbidity (MOMS)-A database, by country

		Data sources					
	Years	Routine data[a]	Linkage[b]	Special enquiry[c]	**Cases included**	**Complete cases**	**% of complete cases**
Austria	92–93–94	yes			34	27	79
Bavaria (G)	92–93–94	yes			51	49	96
Catalonia (SP)	95			yes	3	1	33
Denmark	92–93		yes		22	22	100
Finland	93–94		yes		17	16	94
Flanders (BE)	94		yes		8	8	100
France	94			yes	94	82	87
Hungary	94–95	yes			35	33	94
Ireland	93–95	yes			5	0	0
The Netherlands	93–94	yes			44	43	98
Norway	93–94		yes		2	2	100
Portugal	93–94			yes	21	15	71
UK	93	yes			101	61	60
Total					**437**	**359**	**82**

[a] Routine data from maternal mortality committee and/or confidential enquiry into maternal deaths.

[b] Linkage between death registration, medical birth register.

[c] Special enquiry carried out for this study.

This paper considers results from survey-A. The objectives were to reclassify the causes of deaths as obstetric or non-obstetric, as judged by an international panel of experts, to compare the ways maternal deaths were coded in each country and to explore the consequences for comparisons of their reported levels of maternal mortality.

Methods

Questionnaire

In all participating countries (Table 1), a common questionnaire was used to collect data on deaths of women while pregnant or within one year of the end of pregnancy. It was a 4-page form, in two parts. In part I, information from the death certificate, including causes of death, was reported. When available, ICD-codes (International Classification of Diseases) allocated by the statistical office of the country were extracted from the death certificate. Part II collected any available complementary information from specific surveys or confidential enquiries, maternal mortality committees, hospital records or birth registers. Information was anonymized: the names of women and the places of death were not recorded on the questionnaire.

European panel

A European panel was constituted to examine the information collected about the deaths. Two experts were selected from each country: one member of the MOMS group and one obstetrician chosen by the country's relevant professional organization. They were asked to classify the deaths into obstetric or non-obstetric causes, and to determine the 'underlying cause of death', using information from the death certificate and the complementary information from the other sources. Before being submitted to the panel, all questionnaires were retyped by the Paris unit, in English, without any mention of the country in which data had been collected.

The definitions used were: *pregnancy-associated death* is the death of a woman while pregnant or within one year of the end of pregnancy, irrespective of the duration and the site of the pregnancy, and irrespective of the cause of death; *obstetric death* is the death of a woman while pregnant or within one year of the end of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes; *non-obstetric death* is the death of a woman while pregnant or within one year of the end of pregnancy, irrespective of the duration and the site of the pregnancy, from accidental or incidental causes.

The term 'pregnancy-associated death' was introduced by the Centers for Disease Control (CDC) and the American College of Obstetricians and Gynecologists (ACOG).[2] This definition was retained because it includes women who died after 42 days of a non-obstetric cause. As recommended in the Ninth and Tenth Revisions of the ICD,[3] the term 'maternal death' is used to identify an obstetric death that occurred within 42 days of the end of the pregnancy and the maternal mortality rate is defined as the ratio of maternal deaths to the number of live births. Unfortunately, the interval between the death and the end of the pregnancy is generally not available on death certificate. That is the reason why the group decided to extend the definition to one year after the end of the pregnancy.

Deaths from non-obstetric causes were subdivided into three categories: (1) *accidental/incidental*: without mention of any relationship to pregnancy; (2) *suicides*: they were treated as a specific group because the experts considered that the information collected was generally insufficient to decide whether the suicide was related to the pregnancy or not; (3) *unknown*: if information was insufficient to determine any 'underlying cause of death'.

To make the conclusions of the panel as consistent as possible, further rules were agreed: (1) murders and accidents were

classified as accidental/incidental deaths, except where additional information in medical records strongly suggested that it was an indirect obstetric death; (2) deaths of women affected by communicable diseases were generally classified as accidental/incidental, except for infections known to be aggravated by pregnancy such as chickenpox, gonorrhoea, herpes, hepatitis C; (3) deaths of women with cancer were classified as accidental/incidental deaths, except for pregnancy-related cancer such as choriocarcinoma; (4) deaths of women with heart conditions, peripartum cardiomyopathies, cardiovascular diseases and rupture of the splenic vein were classified as indirect obstetric deaths; (5) deaths of women with cerebrovascular diseases not due to pregnancy hypertension were classified as indirect obstetric deaths because of the general change in circulatory mechanisms related to pregnancy. Cerebrovascular diseases with pregnancy hypertension were classified as direct obstetric deaths.

Data collection

Data were collected in 13 European countries or regions (Table 1). Deaths were reported for periods from one to 3 years between 1992 and 1995. Because of confidentiality issues and the small numbers of deaths, some countries with low figures collected data on more than one year. Of the 440 reported deaths, three were excluded because they occurred more than one year after the end of the pregnancy, so 437 cases were included in the analysis.

The sources of data for the study differed from country to country. Some countries had existing national enquiries into maternal deaths. In the four countries of the UK, confidential enquiries into maternal deaths have been done for many years and the methods are well documented in the enquiry reports.[4] Similar methods are used in Austria, Bavaria, Hungary, Ireland and the Netherlands, which have national (or regional) maternal mortality committees. These enquiries routinely assemble data about maternal deaths, which are ascertained from a multiplicity of sources, including birth and death registration and hospital records.

In four countries, Flanders, Denmark, Norway and Finland, cases were ascertained by linkage between death and birth registers. In Finland, it was also possible to make linkage between death registers and registers of legal abortions, miscarriages and ectopic pregnancies.

The remaining countries undertook special enquiries to collect data for the European study. In Catalonia, hospital registers were checked against birth registration records. In France and Portugal, death registrations where pregnancy was mentioned were identified, including those where it was not coded as the 'underlying cause'. Additional information was then collected by sending questionnaires to the certifying doctor.

Analysis

The classification by the European panel was compared with the classification which had already been made by the national statistical offices responsible for death statistics. To do this, it was necessary to distinguish obstetric and non-obstetric causes of deaths. In other words, it was necessary to verify whether the code for 'underlying cause of death' was in Chapter XI of the ICD, Ninth Revision or not. This chapter, 'Complications of pregnancy, childbirth and the puerperium' contains the codes 630.0–676.9. In many publications on death statistics, these codes are regrouped under the headings 38–41 of the ICD-9 basic tabulation list.[5]

Complete cases were defined as deaths for which both parts of the questionnaire were correctly filled in. In particular, it means that both ICD codes were available: the code allocated by the statistical office and the code derived from the conclusions of the European panel. In all, 78 incomplete cases were excluded. Of these, 59 were cases for which the ICD code was not available from the death certificate, and 19 other cases did not have enough information to permit them to be classified into obstetric or non-obstetric.

To assess the concordance between the two categorizations, the Kappa statistic (κ) was calculated.[6] The correction index (ci), which is the ratio between the proportions of obstetric deaths according to each classification, was used to estimate a corrected number of obstetric deaths and hence to estimate a revised maternal mortality rate. Differences were tested using a χ^2 on matched pairs. This χ^2 based on divergent cases only is usually used to compare two proportions or two counts in two paired samples.[7] Values greater than 3.84 represent a probability less than 5% that the difference could have occurred by chance. Detailed calculations of these three indices are shown in Table 2.

Indices were also calculated for each participating country. Two exceptions were the Republic of Ireland where death certificates were not available to the study and Catalonia (Spain) where calculation of indices was not possible because there was only one obstetric case.

The corrected numbers of obstetric deaths were then considered in relation to the number of maternal deaths in the data published by the statistical office in each country. Official maternal mortality rates were calculated for the period covered by the data collection in each country. Then, revised maternal mortality rates were obtained by multiplying the official rate by the correction index.

Results

Classification

The 359 complete cases for which both the classification by the European panel and the ICD code given by the country

Table 2 Calculation of the Kappa statistic, the χ^2 on matched pairs and the correction index (ci)

	European panel			
Statistical offices	Obstetric	Non-obstetric	Total	**Indices**
Obstetric	a	b	a + b	$\kappa = 2\,(ad - bc)/[(a + b)(b + d) + (a + c)(c + d)]$
Non-obstetric	c	d	c + d	$\chi^2 = (c - b)^2/(c + b)$
Total	a + c	b + d	a + b + c + d	$ci = (a + c)/(a + b)$

Table 3 Classification of complete cases into obstetric and non-obstetric causes according to the statistical offices and according to the European panel

Statistical offices	European panel			
	Obstet	Non-obs	Total	**Indices**
Obstetric	215	14	229	$\kappa = 0.62$
Non-obstetric	45	85	130	$\chi^2 = 16.29$
Total	260	99	359	ci = 1.14

were available, were subdivided into obstetric and non-obstetric causes according to each (Table 3). There were 300 cases which were classified in the same way. Of these, 215 cases were classified as obstetric by both the European panel and statistical offices and the remaining 85 cases were classified as non-obstetric by both. The Kappa statistic (0.62) shows that the agreement is not very good. There were 229 obstetric deaths according to the statistical offices but as many as 260 according to the panel. The correction index is 1.14, which means that the panel increased the number of obstetric deaths by 14% and this increase is highly significant ($P < 0.001$).

Calculations were performed separately for each country (Table 4). The correction index differed between countries. In seven countries, Austria, Denmark, Finland, Hungary, Norway, Portugal and the UK, the correction index was greater than one. In the four remaining countries, Bavaria (Germany), Flanders (Belgium), France and The Netherlands, the correction index was less than or equal to one. Differences in classification were highly significant only in Austria, Hungary and the UK. Correction indices in these three countries were greater than one which means that statistical offices of these countries tended to classify fewer deaths as obstetric than did the European panel.

Estimation of maternal mortality rates

New estimates of maternal mortality rates based on the classification by the European panel are shown in Table 5. Using these revised estimates the aggregated maternal mortality rate for the 11 countries was 8.7 deaths per 100 000 live births ($P < 0.001$), compared with 7.7 based on death certification alone. The range of the rates was slightly narrower, from 3.3 to 11.9.

Discussion

Our results show that the way deaths are classified in the obstetric chapter of ICD differs between countries. There are a number of explanations for this. Firstly, rules of classification may be interpreted differently. Secondly, certifying doctors can be more or less likely to mention pregnancy on the death certificates. This can depend on the situation in each country, in particular whether it has a specific box on the death certificate to indicate that the deceased woman was pregnant and also whether it has a confidential enquiry.

For example, if we consider the 45 cases which were classified as obstetric according to the European panel but non-obstetric according to the statistical offices, 17 mentioned pregnancy on the death certificate. With the 28 other cases, the statistical offices had no reason to classify them in Chapter XI, because they were not aware of the pregnancy. In these cases, additional information from special enquiries or record linkage showed

Table 4 Classification of complete cases in each country into obstetric and non-obstetric causes according to the statistical offices and according to the European panel

Statistical offices	European panel			
	Obstet	Non-obs	Total	**Indices**
Austria				
Obstetric	15	0	15	$\kappa = 0.18$
Non-obstetric	10	2	12	$\chi^2 = 10.00$
Total	25	2	27	ci = 1.67
Bavaria (Germany)				
Obstetric	27	6	33	$\kappa = 0.65$
Non-obstetric	2	14	16	$\chi^2 = 2.00$
Total	29	20	49	ci = 0.88
Catalonia (Spain)				
Obstetric	0	0	0	$\kappa = –$
Non-obstetric	1	0	1	$\chi^2 = –$
Total	1	0	1	ci = –
Denmark				
Obstetric	9	0	9	$\kappa = 0.73$
Non-obstetric	3	10	13	$\chi^2 = 3.00$
Total	12	10	22	ci = 1.33
Finland				
Obstetric	7	0	7	$\kappa = 0.64$
Non-obstetric	3	6	9	$\chi^2 = 3.00$
Total	10	6	16	ci = 1.43
Flanders (Belgium)				
Obstetric	3	0	3	$\kappa = 1.00$
Non-obstetric	0	5	5	$\chi^2 = –$
Total	3	5	8	ci = 1.00
France				
Obstetric	67	2	69	$\kappa = 0.91$
Non-obstetric	0	13	13	$\chi^2 = 2.00$
Total	67	15	82	ci = 0.97
Hungary				
Obstetric	16	1	17	$\kappa = 0.26$
Non-obstetric	11	5	16	$\chi^2 = 8.33$
Total	27	6	33	ci = 1.59
The Netherlands				
Obstetric	26	3	29	$\kappa = 0.74$
Non-obstetric	2	12	14	$\chi^2 = 0.20$
Total	28	15	43	ci = 0.97
Norway				
Obstetric	1	0	1	$\kappa = 0.00$
Non-obstetric	1	0	1	$\chi^2 = 1.00$
Total	2	0	2	ci = 2.00
Portugal				
Obstetric	11	0	11	$\kappa = 0.59$
Non-obstetric	2	2	4	$\chi^2 = 2.00$
Total	13	2	15	ci = 1.18
UK				
Obstetric	33	2	35	$\kappa = 0.58$
Non-obstetric	10	16	26	$\chi^2 = 5.33$
Total	43	18	61	ci = 1.22

Calculations for each country have been done as shown in Table 2.

them to be obstetric deaths. The misclassification might have been avoided if there had been a specific box on death certificate to mention pregnancy. These 28 cases came from countries where such a box was not in use at the time of the survey.

Other collaborative studies have already pointed out similar differences in death certification. For instance, the Eurodiab study group[8] has shown the importance of taking account of certification and coding practices in international comparisons of mortality data in relation to diabetes.

If we assume that the classification of the European panel is the reference, then the number of obstetric deaths is underestimated. At the level of the individual countries, results must be interpreted with caution, particularly given the small numbers of deaths from some countries. Except in Austria, Hungary and the UK, differences are not greater than would be expected by chance. In these three countries, correction indices are greater than one. It means that the offices responsible for death statistics tend to classify fewer deaths as obstetric than the European panel. Consequently, official numbers of maternal deaths and maternal mortality rates published by the statistical offices of these countries, or reported in the WHO Annuals,[5] may be underestimated.

Fortunately further data on maternal mortality are available in these countries. In Austria for instance, a medical quality control exists to ascertain the incidence of maternal deaths. Among the 27 Austrian cases for which it is possible to compare ICD-codes, 10 cases reclassified as obstetric by the panel were added to the 15 cases already considered as obstetric by the statistical office. This shows the importance of the steps taken in Austria to collect additional information on all pregnancy-associated deaths. Circumstances are similar in Hungary where the National Institute of Obstetrics and Gynaecology is responsible for collecting all pregnancy-associated deaths. In the four countries of the UK, the 'Confidential Enquiries into Maternal Deaths' report higher rates of maternal mortality than those based on death certificates alone.[4]

These results show that comparisons between countries should not be restricted to maternal mortality rates published by the national offices responsible for death statistics.

New estimates of maternal mortality rates (Table 5) must also be interpreted with caution. In most countries, differences were no greater than would be expected by chance, except in Austria, Hungary and the UK. In these three countries, corrected rates are higher than the official rates provided by the offices responsible for death statistics. It is important to stress that these corrections are due only to differences in classification. These do not explain all the differences in maternal mortality rates. Other possible reasons include differences between countries in the prevalence of conditions giving rise to mortality, quality of maternity care, age distribution of mothers[9] and underreporting of maternal deaths.[4,10–12]

It is known that maternal deaths are underreported in most of the countries. This probably explains a considerable proportion of the variation in the official maternal mortality rates, but the methodology of this survey focused on cases reported as pregnancy-associated deaths and does not enable us to assess the magnitude of underreporting. Therefore, the correction indices that we have calculated relate only to misclassifications recognized through applying two different processes to the same data.

Table 5 Published maternal mortality rates for study data collection periods and revised rates, by country

Per 100 000 live births	Published rates	Revised rates	*P*-values[a]
Austria	5.7	9.4	0.002
Bavaria (G)	8.6	7.6	0.157
Denmark	7.4	9.8	0.083
Finland	6.9	9.9	0.083
Flanders (BE)	4.7	4.7	–
France	11.7	11.3	0.157
Hungary	7.5[b]	11.9	0.004
The Netherlands	7.7	7.4	0.655
Norway	1.7	3.3	0.317
Portugal	7.6	9.0	0.157
UK	5.6	6.9	0.021
All countries	7.7	8.7	<0.001

[a] *P*-values related to the χ^2 on matched pairs shown in Tables 3 and 4.

[b] The official rate in Hungary was calculated by using the number of maternal deaths coded to the Chapter XI of ICD-9 on death certificates.

Data sources and methods of collection differed between countries. This has probably some important effects on underreporting. Most of the deaths that are not recognized as maternal are pregnancy-associated deaths that were not coded in the obstetric chapter of ICD by the statistical offices. Consequently, their omission minimizes the correction index, by minimizing the figures c and d in Table 2.

Data sources also affect the completeness of cases. Data for more than 10% of cases were incomplete in Austria, Catalonia, France, Ireland, Portugal and the UK (Table 1). Catalonia and Ireland are excluded from this analysis. In Austria and the UK, incomplete cases are those for which ICD codes from the statistical offices were not available for our study. Most of these cases come from the UK where the death certificates themselves were not always included in the confidential enquiry, although it used material derived from them. Part I of the MOMS' questionnaire, using data from death certificates, could not be completed for deaths in Scotland and Northern Ireland. It was completed for deaths in England and Wales only when there was a mention of pregnancy on the death certificate. This means that some of the other UK cases considered as incomplete may not have been classified as obstetric by the statistical office although they were reported to the confidential enquiry. Consequently, by excluding them we tend to minimize the corresponding correction index. In France and Portugal, 13% and 29% of cases were incomplete respectively. Additional information was not available. The panel could not reclassify them but nearly all of them were classified as obstetric by the statistical offices. Consequently, their exclusion probably did not have much effect on the correction indices of these two countries.

The rules of classification used by the European panel were the result of a consensus reached by the European experts when they examined the MOMS-A cases. Some suicides, accidents, infectious diseases, cancers and unknown causes were classified as obstetric by the statistical offices. This applied particularly to infections and unknown causes. The rules of classification used by the panel did not do this and so tended to decrease the

global number of obstetric deaths. As well as underreporting or different data sources or incomplete cases, the rules of classification used by the European panel have tended to minimize the correction index.

Another important point is the interval between the end of pregnancy and death. According to the ICD definition of maternal mortality, death must occur within 42 days of the end of pregnancy, but in most of the countries, the timing of death is not stated on the death certificate. Among the 359 deaths analysed in this paper, 27 were found to be late deaths, occurring between 42 days and one year after the end of the pregnancy. Among these, the interval was mentioned on the death certificate in only four cases. This was the reason why we decided to compare obstetric and non-obstetric deaths instead of maternal and non-maternal deaths. Thus the revised maternal mortality rates we derived using the correction indices included late maternal deaths, as defined in the Tenth Revision of the ICD. This reflects the fact that, in most countries, at least some late deaths are inadvertently included in the published total numbers of maternal deaths. Also, it is important to note that late deaths accounted for only 5% of the obstetric deaths reported to our study.

In conclusion, it appears that differences in practices both in completing death certificates and interpretation of rules used for coding information about causes of deaths have direct consequences on maternal mortality rates. Therefore comparisons of official rates provided in each country by the office responsible for death statistics must be interpreted cautiously. Even if rules for coding the causes of death reported on death certificates were standardized it would be a much larger task to re-train doctors to complete them in a way which eliminated inconsistencies between countries.

Nevertheless, two other recommendations can be made. Firstly, the underreporting of maternal deaths must be estimated more closely through specific surveys carried out in each country. Secondly, a specific question on pregnancy must be added to death certificates of all countries. In addition to the pregnant status of the woman, this 'pregnancy box' should have space to indicate the interval between the end of pregnancy and the death. This needs to be balanced with the fact that there are many other competing requests for additional information on death certificates. It is important to note that such a pregnancy box was already available at the moment of this study in Bavaria, Norway and Scotland. Pregnancy information was added to the French death certificate in 1997. England and Wales has also added a pregnancy box although this is on the back of the certificate and a box has also been added in Northern Ireland. So, this addition seems to be possible and should be a good way to improve the completeness of information about maternal deaths collected by the statistical offices, although it may be less useful for late deaths.

Maternal mortality rates are often considered as indicators of the quality of health care in a country. Consequently, it is important to improve our potential ability to do international comparisons. The best way to collect information on pregnancy-associated deaths is probably linkage of death certificates and birth registers. Unfortunately at the time of writing this is possible in only a few countries, but it would seem the best way ahead for the future.[13]

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