

Maternal deaths in the Nordic countries

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Key words

Maternal death, pregnancy, cause of death, heart diseases, preeclampsia, suicide, thromboembolism

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Conflict of interest

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

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Abstract

Introduction. Despite the seriousness of the event, maternal deaths are substantially underreported. There is often a missed opportunity to learn from such tragedies. The aim of the study was to identify maternal deaths in the five Nordic countries, to classify causes of death based on internationally acknowledged criteria, and to identify areas that would benefit from further teaching, training or research to possibly reduce the number of maternal deaths. **Material and methods.** We present data for the years 2005–2013. National audit groups collected data by linkage of registers and direct reporting from hospitals. Each case was then assessed to determine the cause of death, and level of care provided. Potential improvements to care were evaluated. **Results.** We registered 168 maternal deaths, 90 direct and 78 indirect cases. The maternal mortality ratio was 7.2/100 000 live births ranging from 6.8 to 8.1 between the countries. Cardiac disease ($n = 29$) was the most frequent cause of death, followed by preeclampsia ($n = 24$), thromboembolism ($n = 20$) and suicide ($n = 20$). Improvements to care which could potentially have made a difference to the outcome were identified in one-third of the deaths, i.e. in as many as 60% of preeclamptic, 45% of thromboembolic, and 32% of the deaths from cardiac disease. **Conclusion.** Direct deaths exceeded indirect maternal deaths in the Nordic countries. To reduce maternal deaths, increased efforts to better implement existing clinical guidelines seem warranted, particularly for preeclampsia, thromboembolism and cardiac disease. More knowledge is also needed about what contributes to suicidal maternal deaths.

Abbreviations: BMI, body mass index; ICD, International Statistical Classification of Diseases and Related Health Problems; MBBRACE, Maternal, Newborn and Infant Clinical Outcome Review Program; MMR, maternal mortality ratio.

Introduction

Maternal mortality ratios (MMR) in the Nordic countries are among the lowest in the world (1). This is likely to be associated with generally accessible antenatal care free of charge and effective identification of high-risk pregnancies,

Key message

During 2005–2013 the Nordic countries had an overall average of 20 maternal deaths each year. Improvements in care might have made a difference to the outcome in about half the preeclamptic women and one-third of those with cardiac conditions, the two causes of death most frequently identified.

combined with access to emergency obstetric care for all in these high-resource and relatively equalitarian societies (2–4). However, each year women still die from complications of pregnancy or birth in the Nordic countries. In recent years, it has become evident that deaths from preexisting maternal disease – the so-called indirect maternal deaths – are increasingly important in many countries with better resources and healthcare systems (5,6). Unlike other countries such as the UK, the Nordic countries still seem to have more direct than indirect maternal deaths (7,8). Previous audit results show that with regard to direct deaths there is considerable potential for prevention (8–10). For example, in the case of deaths from preeclampsia, improvements to care might have made a difference to outcome in a majority of cases (7–10). Thus, there may still be a potential for reducing the number of maternal deaths even further in high-resource countries.

Underreporting of maternal deaths in official statistics is a global issue and is probably substantial also in the Nordic countries (7,11–13). Some of the background information regarding both the actual numbers and causes of maternal deaths in the Nordic countries is not readily available, particularly in relation to early pregnancy deaths. Underreporting has been documented both for direct and indirect deaths, especially with regard to psychiatric causes (7,11,12).

The Nordic Maternal Mortality Collaboration was initiated in 2010. The aim of the collaboration has been to gather information based on a large population that totals about 27 million inhabitants in these five countries with close historical and cultural ties and similarities in the healthcare systems. We have striven to use uniform methods to identify all maternal deaths in the Nordic countries, to classify them based on common international criteria, and to evaluate possible improvements to care. In collecting data to calculate the MMR for the five Nordic countries, we have sought to clarify current patterns of causes of death and to identify potential areas where there is a need to improve medical care and aspects of registration practices.

Material and methods

We defined maternal death as the death of a woman while pregnant or within 42 days after a pregnancy according to the 10th revision of the International Classification of Disease (14). For the detailed classification of the causes of deaths we used the criteria used by Centre for Maternal and Child Enquiries (15). We classified all psychiatric deaths as indirect due to limited information available about these cases. We report maternal deaths from the period 2005–2013 (complete years), but for Finland up to the end of 2012. For data from Denmark, Iceland, Finland and Norway we used register linkage

(between births and deaths registers, in-patient registers on pregnancy diagnoses) in combination with direct reporting from hospitals. The data from Sweden were based only on hospital-reporting. In Finland, an extensive register linkage between births, deaths, pregnancy terminations, and the in-patient register combined with direct reporting from hospitals was possible. Register linkage was facilitated by the unique personal identification numbers used in all the countries, based on date of birth and a four-digit numerical addition. All residents, citizens and others living in one of the study countries at the time of death were included. We were not able to identify deaths among all visitors, undocumented migrants or asylum seekers not yet registered with a personal identification number. We calculated the MMR with a 95% confidence interval (95% CI) as number of deaths by the number of livebirths in women 15–49 years old (12). The denominator was derived from the respective national birth registers, which all contain information about women giving birth to a living child or a stillbirth with a lower limit of gestational age ≥ 22 weeks and/or birthweight ≥ 500 g.

Experienced clinicians constituted the local audit groups in each country. These groups scrutinized each death to classify them into direct or indirect maternal deaths and to ascertain the underlying cause. To classify the cause of death and quality of care we used a form based on the Confidential Enquiry into Maternal and Child Health (CEMACH) maintained by the UK Maternal, Newborn and Infant Clinical Outcome Review Program (MBRRACE_UK) (5). We classified the quality of care as: (i) good care – no improvements identified, (ii) improvements to care identified which would have made no difference to the outcome, and (iii) improvements to care identified which may have made a difference to the outcome. Current clinical care guidelines for each country constituted the reference standard. Overall key messages for care pertaining to the specific causes of death were derived from the quality of care assessments.

Ethical approval

Ethical approval was sought in the respective countries according to national law stipulations. In Sweden, no ethical approval was needed as the study comprised deceased people. The Danish Data Protection Agency and the National Board of Health, the Icelandic National Bioethics Committee as well as the Data Protection Authority, and the National Institute for Health and Welfare and Statistics Finland gave their permissions to use the confidential health data imported for this study. Regional Committee for Medical and Health Research Ethics – North Norway in Tromsø approved the study for Norway (Ref: 2010/2854 –6, date of approval: 16.12.2010).

Results

We identified 168 maternal deaths (Table 1). Based on 2 553 058 live births, the MMR was estimated to be 6.6/100 000 (95% CI: 5.6–7.6). As underreporting was most likely for Sweden, the MMR was calculated excluding this country with 112 deaths among 1561 698 live births, giving an MMR of 7.2/100 000 (95% CI: 5.9–8.5). Inter-country MMR differences were small and insignificant.

The underlying causes of deaths are summarized in Figure 1. Of the deaths, 90 (54%) were direct and 78

(46%) indirect. The most frequently identified causes of direct deaths were preeclampsia ($n = 25$), thromboembolic complications ($n = 20$), hemorrhage ($n = 14$), amniotic fluid embolism ($n = 12$), obstetric sepsis ($n = 7$), ectopic pregnancy ($n = 4$), anesthetic deaths ($n = 2$) and peripartum cardiomyopathy ($n = 2$). The most prevalent causes of indirect deaths were cardiac disease ($n = 26$), psychiatric disease ($n = 20$), central nervous system disease ($n = 12$), non-genital sepsis ($n = 8$) and breast cancer ($n = 3$). Thirteen deaths were due to other causes, including complications of cesarean section, uterine rupture, liver failure for a non-identified reason, and H1N1-infection (swine influenza). Preeclampsia, cardiac disease and thromboembolism were the most frequent causes of death in Norway, Sweden and Denmark. Finland had a different pattern of causes of death, with psychiatric disease, amniotic fluid embolism and hemorrhage being the most prevalent causes. Iceland had only one death from thromboembolism (Figure S1).

Ten of 28 cardiac deaths were due to aortic dissection, four to myocardial infarction and myocarditis, respectively, and three to cardiomyopathy, sudden adult death syndrome and congenital heart disease, respectively. Of the women who died from cardiac disease, 10 (36%) were ≥ 35 years compared with 10% in the general pregnant population.

Nineteen of the 25 preeclamptic deaths were due to cerebral causes, mainly cerebral hemorrhage, but brain edema ($n = 2$), brain infarction ($n = 1$) and subarachnoid hemorrhage ($n = 1$) were also noted. Four women died

Table 1. Maternal mortality ratios (MMR) in the Nordic countries, 2005–2013.

Country	Live born	Maternal death	Direct/Indirect	MMR	95% CI
Denmark	560 964	40	20/20	7.1	4.9–9.3
Finland ^a	416 697	34	18/16	8.1	5.4–10.9
Iceland ^b	40 746	1	1/–	NA	–
Norway	543 291	37	21/16	6.8	4.6–9.0
Sweden	991 360	56	30/26	5.6	4.1–7.1
Total	2 553 058	168	90/78	6.6	5.6–7.6
Total excluding Sweden ^c	1 561 698	112	60/52	7.2	5.9–8.5

^a2005–2012, Data for 2013 not collected.

^bNumbers too small to calculate MMR.

^cAs underreporting was most likely for Sweden, the MMR was calculated excluding that country.

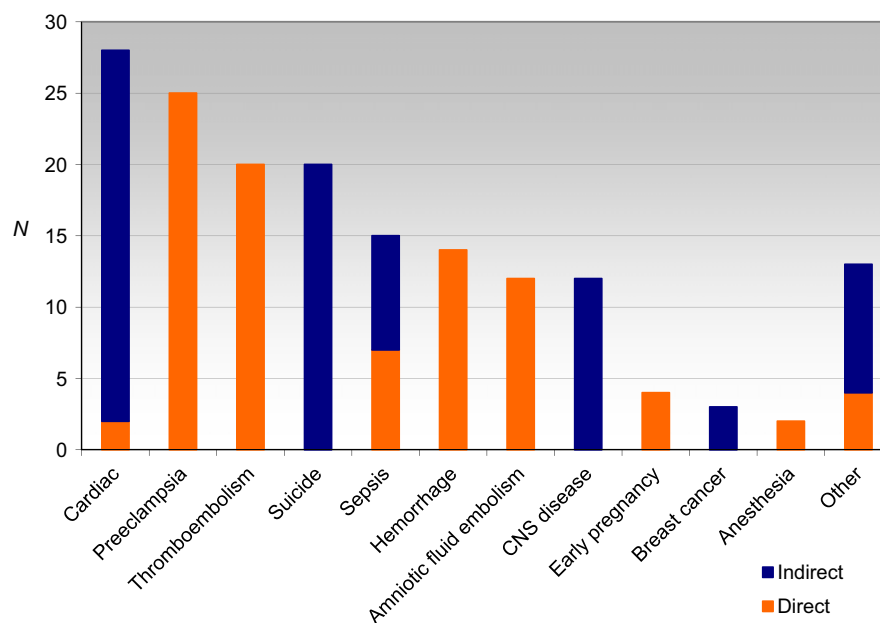


Figure 1. Causes of maternal deaths ($n = 168$) in the Nordic countries, 2005–13.

of respiratory distress syndrome. Gestational age was ≥ 37 weeks in 15 (60%) of cases and five (20%) of the women had a body mass index (BMI) ≥ 30 kg/m².

Seventeen of 20 deaths from thromboembolism were due to pulmonary embolism and three to cerebral vein thrombosis. Nine occurred before delivery and 11 after delivery, in six instances after cesarean section. Eight (40%) occurred at an age ≥ 35 years and six women (30%) had a BMI ≥ 30 kg/m².

Among the 20 suicides, overdose ($n = 8$) was the most common cause, followed by gunshots ($n = 3$), hanging ($n = 3$), intentional road accident ($n = 2$), self-immolation ($n = 1$) and drowning ($n = 1$). In two cases, the mode of death was unknown. Thirteen (65%) of the women who committed suicide had a recorded psychiatric diagnosis and 10 women (50%) were drug- or alcohol-dependent (Table 2).

Table 2. Main causes of maternal deaths in the Nordic countries 2005–13.

	N
Cardiac disease $n = 28$	
Dissection of aorta	10
Myocardial infarction	4
Myocarditis	4
Sudden adult death syndrome	3
Cardiomyopathy	3
Congenital	3
Mitral stenosis	1
Age ≥ 35 years	10
BMI ≥ 30	5
Preeclampsia $n = 25$	
Cerebral	19
Pulmonary	4
Hepatic	1
Other	1
Age ≥ 35 years	7
BMI ≥ 30	5
Gestational age ≥ 37 weeks	15
Thromboembolic disease $n = 20$	
Pulmonary embolism	17
Cerebral vein thrombosis	3
Age ≥ 35 years	8
BMI ≥ 30	6
Suicide $n = 20$	
Overdose	8
Gunshot	3
Hanging	3
Intentional road accident	2
Self-immolation	1
Drowning	1
Unknown	2
Psychiatric diagnosis	13
Drug or alcohol abuse	10

Results from the audit assessment using clinical guidelines as the reference standard showed that in 32% of the cases, improved care might have made a difference to the outcome. We found the greatest potential for improvement in deaths from preeclampsia. In 15 (60%) of the 25 deaths, improvements to care might have made a difference to the outcome, as was also the case for nine (45%) of 20 deaths from thromboembolism and for nine (32%) of 28 deaths from cardiac disease. Based on scrutiny of the cases we derived the following overall key messages for care: (i) pregnant women with moderate to severe heart disease should receive care at a center with a multi-disciplinary medical team encompassing special competences, including for heart surgery; (ii) treatment of women with preeclampsia who have a systolic blood pressure >150 mm Hg should be commenced without delay and induction of labor should be considered from gestational week 37; (iii) all women should undergo pre- or early pregnancy risk assessment for thromboembolism; (iv) caregivers should refer pregnant women or women who have recently given birth and who present with increasing dyspnea, for evaluation of pulmonary embolism; (v) there should be awareness of increased vulnerability around delivery among women with a psychiatric or addiction disease.

Discussion

We identified 168 maternal deaths in the Nordic countries during a nine-year observation period. The MMR was low at around 7.2/100 000 live births, with small variations between the individual countries which are organizationally, culturally and economically alike and have comparable healthcare systems. As in earlier periods, direct deaths associated with complications of pregnancy and birth exceeded the number of indirect deaths caused by preexisting maternal disease (7,9). Overall, cardiac disease was the most common cause, followed by preeclampsia, thromboembolism and suicide. Audit assessment showed that there was potential for improvements of care with regard to several of these indirect and direct causes of death. Improved care might have made a difference to the outcome in one-third of the cases, particularly with regard to deaths from preeclampsia (in 60%) and thromboembolism (in 45%).

Maternal deaths are underreported globally. A study from the USA and Europe documented underreporting of maternal deaths of between 40% and 60% (16). In the 2010 Peristat Report, the MMR for Sweden was 3, for Finland 4.7, for Denmark 3.1, and for Iceland 0 (Norway did not participate), all considerably lower than reported in the current study (17). Previous studies about this issue showed underreporting of maternal deaths of 64%

and 54% in Sweden and Norway, respectively (7,11). These results indicate that around half or even more of the 168 deaths included in our study may not have appeared in official statistics. To advise targeted measures to prevent maternal deaths, accurate data about the numbers of deaths and their causes are needed. To obtain this it is necessary to use multiple sources of identification, including extensive register linkage, access to all hospital records on the women who died and to autopsy data. This was largely present in four of the five countries and helped us identify close to all direct and indirect maternal deaths in the study period. However, deaths in early gestation before pregnancy was confirmed, could have occurred, and closer attention to deaths in early pregnancy is required. In Sweden, cases were only identified based on voluntary reporting from the hospitals. This is likely to indicate some underreporting, especially of deaths that did not occur in association with obstetric care. Improved case ascertainment by register linkage in Sweden could also have changed the frequency order of the causes of death. Judging from a previous MMR estimate based on register linkage from Sweden (11), it is possible that up to nine cases from Sweden could have been missed.

In Finland, six of 10 suicides occurred after termination of pregnancy. The more extensive register linkage that included access to registered pregnancy terminations in Finland could contribute to a high case ascertainment for these causes. The registry linkage conducted in Denmark, Norway and Iceland is also supposed to identify all deaths with an International Statistical Classification of Diseases and Related Health Problems (ICD) code related to pregnancy, including women who died in relation to pregnancy terminations and those who committed suicide. A previous publication showed that in most cases, induced abortion was not mentioned in the death certificate (13). This prevented assessment of the degree to which pregnancy termination contributed to suicide and whether suicide was related to other adverse life circumstances (18). In the latter case, these deaths should be classified as coincidental, which is a category not included in the current study. This clearly shows the need to include a specific question about pregnancy in the death certificates for all five countries and indeed for international maternal mortality recording.

In an international perspective, the Nordic countries have a very low MMR. Ninety-nine percent of maternal deaths occur in low-resource countries. Notably, in sub-Saharan Africa the MMR was around 546/100 000 in 2015. Nine countries in the most recent world report on maternal mortality achieved the aimed-for MMR reduction of 75% during 1990–2015. Rwanda, with a population of around 11 million, was one of them, reporting a

change from 1300 to 290/100 000. This is still 44 times higher than in the five Nordic countries with a combined 27 million inhabitants. For the Nordic countries the report documented a 15% reduction over the same period of time (1).

There appears to be potential for a further reduction of maternal deaths in the Nordic countries. This includes maternal deaths from preeclampsia, where in the UK a 50% reduction in maternal deaths since 2004 has been noted. In the latest MBRRACE report from the UK, the maternal death rate from preeclampsia was the lowest ever reported, at 0.08/100 000 maternities. This transcribes to approximately one death per million live births and shows that most deaths from preeclampsia could be preventable. The death rate from preeclampsia in the Nordic countries was approximately 12.5 times higher, estimated at 1/100 000 live births. In their recent *Lancet* publication, Shennan et al. propose that the introduction of the UK National Health Service evidence-based guidelines which have focused on the systematic use of interventions may be the catalyst that has reduced deaths from hypertensive diseases of pregnancy. More recently, planned delivery from 37 weeks of gestation onwards has been shown to reduce morbidity, and has become a standard of care in the UK (19). Updated treatment guidelines for preeclampsia are by now in use in all Nordic countries and their correct implementation is a current main challenge (19). Improved and adequate blood pressure medication and timely referral/delivery must be achieved, and induction of labor from gestational week 37 should be considered (20,21).

Thromboembolism was the third most common cause of death. Pregnancy increases the risk of venous thromboembolism, which is further aggravated in the immediate postpartum period. In our material, nine of the 20 thromboembolic events occurred after delivery, and six after a cesarean section. Several of these deaths occurred suddenly without known maternal risk factors. Nonetheless, we found a potential for improved care in 45% of these cases. Delayed referral of pregnant women with dyspnea played an important role. Observational data support the benefit of risk factor-based thromboprophylaxis for reducing obstetric thromboembolism (22,23). All women should undergo pre- or early pregnancy risk assessment for thromboembolism, and care-givers should refer pregnant women or women who have recently given birth and complain of dyspnea for evaluation of thromboembolism or pulmonary embolism.

Cardiac disease was the most frequently reported cause of death in this study and was a significant part of the overall MMR, as also shown in the most recent MBRRACE report from the UK (6). Aortic dissection

contributed substantially to this. Hereditary fibrillinopathies, mainly Marfan's syndrome, are at the base of such disasters, but acute myocardial infarction and hypertension have also been reported as underlying causes of aortic dissection (24). A publication from the Netherlands showed that vascular dissection caused 45% of the indirect maternal deaths during 1993–2008, the aorta being the most common location. Hypertension was present in 61% of those deaths. Inadequate assessment of women with complaints such as chest pain, infra-scapular pain, back pain and dyspnea, and a related delay in diagnosis were the most frequent problems identified. The authors concluded that a high index of suspicion when a woman presents with suggestive complaints could improve the prognosis for the woman and fetus (25). We found a potential for improvement of care among nine (32%) of the women who died from cardiac disease. Increased attention to both congenital and acquired heart disease among pregnant women seems warranted. Healthcare personnel should refer pregnant women with moderate to severe heart disease to a center with a multidisciplinary medical team with special competences, including for heart surgery.

Twenty-five of 73 deaths from cardiac disease, preeclampsia and thromboembolism in our study were in women ≥ 35 years, and 16 were obese, with a BMI of ≥ 30 . A study from the USA showed increasing maternal age to be an important factor in maternal deaths (26). Results from the Hunt study in Norway showed that an increasing trend towards obesity from 13.3% to 18.3% to 23.1% over three decades was greatest in women of fertile age (27). Hence, the changing nature of maternal health, primarily with regard to age, obesity and other serious co-morbidities, increases the need for specialist obstetric care.

Suicide was as common a cause of death as thromboembolism. More than half of the women who committed suicide had a psychiatric diagnosis, and drug- or alcohol-dependence was common. There is evidence to indicate that women are at increased risk of experiencing new onset severe mental illness after delivery. Moreover, in such circumstances previous mental disorders may be exacerbated or recur (28). Maternal deaths from suicide have emerged as one of the leading causes of maternal death in several middle- or high-resource countries (6,7,18), not least among the late maternal deaths between 42 and 365 days postpartum. According to Esscher *et al.* suicides during pregnancy are rare, but are equally distributed between 0 and 181 days and between 182 and 365 days postpartum. The deaths occurring postpartum were more often related to external causes of injuries (28). To strengthen care for pregnant women with mental disorders, the advice is now to

establish perinatal mental health clinical networks, including access to specialist addiction services (6). Awareness of increased vulnerability around delivery and the postpartum period and even up to 1 year after delivery in women with a psychiatric disease or addiction should be heightened.

Thus, even in the high-resource Nordic countries there seems to be potential for further reduction of maternal deaths. Specific areas for future research relate to the changing demographics in a society with increasing rates of obesity and older mothers (8,26,27,29). It is also necessary to consider how improvements in obstetric and midwifery training as well as in general practice could contribute to prevent future maternal deaths, notably with regard to clinical management of preeclampsia, thromboembolism and cardiac disease. Implementation of evidence-based guidelines seems a key issue here. For every mother who dies, more than 100 will experience a severe complication that, if untreated, mistreated or treatment is delayed, may lead to long-term complications or death (30). Reducing maternal mortality therefore has implications beyond those most tragic events, namely to reduce the number of women with serious pregnancy complications which often profoundly affect their own short- and long-term health and that of their families.

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Figure S1. Most important causes of deaths in each country.