

CHIS Studies

A Special Report Series by the Center for Health Informatics and Statistics
1908 Mail Service Center, Raleigh, N.C. 27699-1908
www.schs.state.nc.us/SCHS/

No. 125

April 2001

Enhanced Surveillance of Maternal Mortality in North Carolina

by

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ABSTRACT

Objectives: This study demonstrates serious under-ascertainment of maternal mortality through death certificate reporting alone, and presents selected statistics by cause of death and demographic groups based on an enhanced surveillance method.

Methods: All death records for women ages 10-50 were matched to live birth and fetal death files to identify deaths that occurred within one year after a delivery. Deaths reported as having an underlying or contributing cause of death related to pregnancy were also identified. Hospital discharge data were examined to identify additional deaths with a pregnancy-related discharge diagnosis. All of this information was then reviewed by a maternal-fetal medicine specialist to determine the role that pregnancy played in each death.

Results: Nearly twice as many pregnancy-related deaths are identified from the enhanced surveillance as from death certificates alone. Older women, African-American women, and women of lower educational attainment have substantially higher pregnancy-related death ratios. Homicide and suicide are major causes of death to women during pregnancy and after delivery.

Conclusions: Pregnancy-related mortality is seriously underestimated from death certificates alone. Enhanced surveillance significantly increases ascertainment of maternal deaths from all causes. This information helps improve our understanding of the causes and public health impact of pregnancy-related mortality, and provides a more realistic picture of our progress toward the Healthy People 2010 goal for this indicator.

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Introduction

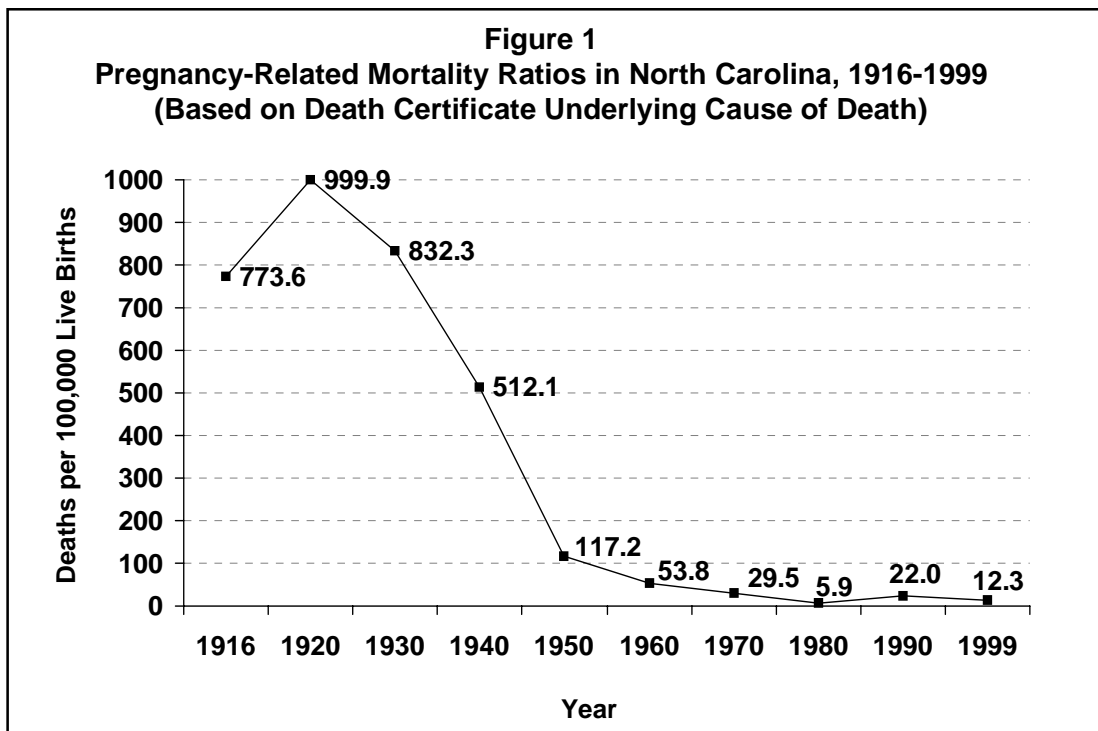
The pregnancy-related death ratio for residents of North Carolina declined from 773.6 deaths per 100,000 live births in 1916 to a ratio of 12.3 in 1999 (see Figure 1). During this period, the annual number of pregnancy-related deaths decreased from 593 to 14. These statistics are based on the underlying cause of death as recorded on death certificates. This decline in pregnancy-related deaths is associated with improvements in obstetric care and particularly the use of increasingly effective antibiotics, which has dramatically reduced deaths due to infection.¹

There is evidence that the legalization of induced abortion in the early 1970s significantly furthered the decline in pregnancy-related deaths in North Carolina.^{1,2} Deaths attributed to abortion decreased dramatically in North Carolina from the 1968-1972 to the 1973-1977 period.²

With the very large reduction in pregnancy-related deaths over this century, one might ask: why are we

still interested in maternal mortality? First, maternal mortality is an indicator of the overall effectiveness of the obstetric health care system and also of the general health care system. Second, there are still large differences in maternal mortality among certain demographic groups, which indicates the potential for further prevention. Third, there has been little improvement in the maternal mortality ratio in North Carolina and in the United States since the early 1980s. Fourth, we have not nearly reached the Healthy People 2000 goal of 3.3 maternal deaths per 100,000 live births (based on underlying cause from death certificates).

Pregnancy-related deaths, though relatively rare, are seriously underreported through death certificates alone. The Center for Health Informatics and Statistics and the Wake Forest University School of Medicine are cooperating in a program to enhance surveillance of pregnancy-related deaths in North Carolina. The goal is to more completely ascertain pregnancy-related deaths and to better characterize their causes as a basis for preventing as many of these deaths as possible.



The Center for Health Informatics and Statistics links several data bases in order to increase identification of pregnancy-related deaths.³ The Wake Forest University School of Medicine carries out a detailed medical review of each identified death to confirm that it is pregnancy-related and assign an accurate cause of death. This report describes this collaborative enterprise, which began in its current form in 1988, and presents some current statistics on pregnancy-related mortality in North Carolina.

Methods

Identification of maternal deaths is done on an annual basis. We start with deaths identified through death certificates as being related to pregnancy (ICD-9 codes 630-676, ICD-10 codes O00-O99). A nosologist at the Center flags death certificates where there is some written mention of pregnancy on the death certificate, but the death is not assigned a pregnancy-related cause-of-death code.

All death records for women ages 10-50 are matched to the live birth and fetal death files for the same and previous calendar years to identify deaths that occurred within one year after a delivery. Matching is done on last name (5 letters), first name (3 letters), date of birth of the mother, and social security number (where available). Records that match are reviewed visually, using full name and other information, to confirm that the match is accurate. Where there is a match of a death certificate to a birth or fetal death record, hard copies of the certificates are obtained and kept in pairs since information on the delivery record often helps in establishing an accurate cause of death.

Hospital discharge records are used to further enhance the surveillance. Records with a pregnancy-related discharge diagnosis where the woman died in the hospital are identified. These records identify a few deaths missed from other sources and also provide supplementary data on medical diagnoses and procedures.

All of this information is given to the Department of Obstetrics and Gynecology of the Wake Forest University School of Medicine. A detailed medical review is done by a physician who is board certified in obstetrics and gynecology and in maternal and fetal medicine. This physician has more than 15 years of experience in the clinical practice of perinatology within a tertiary referral center. Deaths are classified according to the guidelines of the Committee on Maternal and Child Care of the Council on Medical Service of the American Medical Association. The definition of maternal death adopted by the Centers for Disease Control and Prevention (CDC) is applied, i.e. a death during pregnancy or within one year of delivery or termination.

If the information provided by the Center for Health Informatics and Statistics is inadequate to classify the death, a letter is mailed to the medical examiner or physician signing the death certificate requesting specific information or an autopsy report. For deaths within one of the referral centers, a perinatologist is asked to review the record and give an opinion. Expert opinion may also be requested from other colleagues, without identifying the deceased, the physician, or the hospital. Although death certificates are considered public records in North Carolina, during this review process there is strict adherence to confidentiality, and IRB approval from the Wake Forest University School of Medicine is maintained.

All of the deaths of pregnant women and deaths occurring within one year of delivery or pregnancy termination are assigned a specific cause of death, and also are classified as either “pregnancy-related” or “non-pregnancy-related” maternal deaths. According to the definition of the CDC, pregnancy-related deaths are those that “result from complications of the pregnancy itself, interventions elected or required because of the pregnancy, or from the chain of events initiated by the complications or interventions, or from a disease which was obviously aggravated by the physiologic effects of pregnancy.” Non-pregnancy-related deaths are those that are related in time to the pregnancy but not causally related.

Results

During the period 1993-1997, the total number of maternal deaths identified through our surveillance system was 297. Of these, 119 were classified as pregnancy-related and 178 were classified as non-pregnancy-related. In comparison to the 119 pregnancy-related deaths identified through the enhanced surveillance system, only 65 pregnancy-related deaths were identified through underlying cause-of-death coding on 1993-1997 death certificates, which is the usual method of measuring maternal mortality. The ratio of pregnancy-related deaths from enhanced surveillance to those from death certificate coding is 1.83, or nearly 2:1. The corresponding pregnancy-related death ratios (per 100,000 live births) are 23.1 and 12.6, respectively.

Table 1 shows the major causes of death for the 119 pregnancy-related deaths during 1993-1997. Nearly half of these deaths were not identified as pregnancy-related from the death certificates. In some cases, the woman died from embolism or hemorrhage on the day of delivery, yet there was no indication of pregnancy or childbirth on the death certificate. Cardiomyopathy was the leading cause of pregnancy-related mortality. Our enhanced surveillance methods, where all deaths up to one year after delivery are identified and reviewed, help detect some pregnancy-related cardiomyopathy deaths that would otherwise be missed.

Table 2 lists the major causes of death for the 178 non-pregnancy-related maternal deaths during 1993-1997. The number of homicide deaths exceeds the number of deaths from any one of the pregnancy-related conditions (Table 1).

Table 3 presents 1993-1997 pregnancy-related death ratios by selected demographic and educational groups. These data indicate that older women, African-American women, and women with lower educational attainment have higher pregnancy-related death ratios.

Table 1
Major Causes of Pregnancy-Related Deaths in North Carolina, 1993-1997
(From Enhanced Surveillance)

Cause	Number of Deaths
Peripartum cardiomyopathy	26
Hypertensive disorders of pregnancy	20
Pulmonary emboli (includes amniotic fluid and thrombotic emboli)	19
Infection	16
Hemorrhage	14
Other	11
Stroke (hemorrhagic or thrombotic)	7
Anesthesia	2
Suicide while pregnant	2
Undetermined	2
TOTAL	119

Table 2
Major Causes of Non-Pregnancy-Related Maternal Deaths in North Carolina, 1993-1997
(From Enhanced Surveillance)

Cause	Number of Deaths
Medical unrelated	66
Motor vehicle injury	47
Homicide	35
Suicide (after pregnancy)	10
Other injury	10
Drug related	10
TOTAL	178

Table 3
Pregnancy-Related Deaths and Death Ratios
for Selected Demographic Groups
North Carolina, 1993-1997
 (From Enhanced Surveillance)

Group	Number of Deaths	Deaths per 100,000 Live Births
White, ages < 20	4	9.5
White, ages 20-34	38	13.5
White, ages 35+	10	27.3
African American, ages <20	7	21.1
African American, ages 20-34	41	42.6
African American, ages 35+	14	149.7
Less than high school education	31	28.2
High school education	52	28.7
More than high school education	34	15.2
TOTAL	119	23.1

Note: Rates based on fewer than 20 deaths may be statistically unreliable. Race/age groups do not add to total due to "other" races not included here. Education groups do not add to total due to cases of unknown education.

Discussion

The Healthy People 2010 goal for pregnancy-related mortality is 3.3 maternal deaths per 100,000 live births, which is the same as the Healthy People 2000 goal. The 1997 baseline ratio for the United States is 8.4. However, this measure is based only on the underlying cause of death recorded on death certificates. From enhanced surveillance, we estimate that the true pregnancy-related mortality ratio is twice as high. Therefore, if more accurate maternal mortality data are used, it will be even harder to achieve the death certificate-based 2010 goal of 3.3.

We estimated the completeness of ascertainment of maternal deaths in 1996-1997 using the capture-recapture methodology.⁴ This method uses overlapping, but incomplete lists of cases from two or more different sources. In this case, the two lists of cases of maternal deaths were: a) death certificates with underlying cause-of-death codes 630-676, and b) death certificates matched with birth or fetal death certificates, and hospital discharge summaries. From the capture-recapture analysis, we estimated that the ascertainment of total maternal deaths (pregnancy-related and non-pregnancy-related) was 92 percent and that the ascertainment of pregnancy-related maternal deaths was 98 percent.

The 1993-97 pregnancy-related mortality ratio of 23.1 from our enhanced surveillance is comparable to that found in other studies in developed countries. A 1991 study in France, where all deaths to women of reproductive age were reviewed, found 21.9 pregnancy-related deaths per 100,000 live births.⁵ A 1992-1998 study in the Chicago area (which was limited to 90 days postpartum) also showed a pregnancy-related mortality ratio of about 21.⁶

Some developing countries today report pregnancy-related mortality ratios of 500 or more,⁷ though these are based on official statistics and are likely to be underreported. These levels are comparable to the North Carolina data from the early 20th century, shown in Figure 1 on page 2, which are based only on death certificate cause-of-death coding.

The data in this report show large differences in maternal mortality by age, race, and education. The very large pregnancy-related mortality ratio for African-American women ages 35 and older (shown in Table 3), though based on only 14 deaths during 1993-1997, is nearly identical to that reported from enhanced surveillance in New York State.⁸ Clearly, there is considerable potential for reducing maternal mortality among African-American women and

among older women. It should be mentioned that the racial differences presented here are purely descriptive; the causes of the racial differences lie mainly among social, economic, and medical care differences that are associated with race.

The data presented here show a large number of maternal deaths resulting from violence during pregnancy or up to one year after delivery. This is a serious public health problem that is drawing greater concern. For 1993-1997, the maternal mortality ratio for homicide (6.8 homicide deaths per 100,000 live births) exceeded the ratio for any of the major pregnancy-related causes of death. The maternal mortality ratio for suicide (2.3) was also noteworthy. These data indicate the importance of screening pregnant and postpartum women for domestic violence and for depression. A study of violent maternal deaths in North Carolina from 1992 to 1994⁹ indicated that the obstetric provider was aware of abuse in only one-third of the homicides committed by an intimate partner. The obstetric provider was aware of depression in 60 percent of suicide deaths.

For the next revision of the death certificate in North Carolina, a pregnancy check box has been

recommended. This question asks “Was the decedent pregnant at the time of death or within the past year?” This check box is expected to improve maternal mortality surveillance by identifying some maternal deaths not identified by matching to birth and fetal death certificates (e.g., abortions, miscarriages, ectopic pregnancies).

It is important that the results of our maternal mortality surveillance be shared with the medical community in North Carolina, to further prevention efforts. Reports based on the surveillance are disseminated to the Women’s Health Committee of the North Carolina Medical Society and also to the North Carolina Obstetrics and Gynecology Society. Occasional reports are published in the North Carolina Medical Journal and other periodicals. The data are also used as a state outcome measure for the Maternal and Child Health Title V block grant.

In summary, pregnancy-related mortality ratios are greatly underestimated from death certificates alone. The use of electronic matching and hospital discharge data bases along with death certificates and in-depth medical review (enhanced surveillance) significantly improves ascertainment of maternal deaths from all causes.

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