
Enhanced Surveillance of Maternal Mortality in North Carolina

Paul A. Buescher, PhD, Margaret Harper, MD, Robert E. Meyer, PhD

In 1916, there were 774 pregnancy-related deaths per 100,000 live births in North Carolina; by 1999 this ratio had declined to 12.3 deaths/100,000 live births (See Figure 1). Over the same time span, the annual number of pregnancy-related deaths decreased from 593 to 14. The decline in pregnancy-related deaths (based on death certificate records) is attributed to improved obstetrical care and particularly the use of effective antibiotics, which dramatically reduced deaths due to infection.¹ The legalization of induced abortion in the early 1970s significantly furthered the decline in pregnancy-related deaths in North Carolina^{1,2} by removing the risk of illegal abortion.²

Since there has been a very large reduction in pregnancy-related deaths over this century, one might ask why public health officials are still interested in maternal mortality. First, because maternal mortality is an indicator of the overall effectiveness of the obstetrical health care system and the health care system in general. Second, because persisting, still large discrepancies in maternal mortality among various demographic groups indicate the potential for further prevention. Third, because there has been little improvement in maternal mortality in North Carolina and the United States since the early 1980s. And fourth, because we have not nearly reached the *Healthy People 2000* goal of 3.3 maternal deaths/100,000 live births.

A persisting problem is that pregnancy-related deaths, though relatively rare, are seriously underreported in death certificate data. The State Center for Health Statistics and Wake Forest University School of Medicine are cooperating in a program to enhance surveillance of pregnancy-related deaths in North Carolina. A more complete ascertainment of

pregnancy-related deaths and better characterization of the causes should allow us to prevent many of these deaths.

The State Center for Health Statistics links several data bases in order to identify pregnancy-related deaths.³ The Wake Forest University School of Medicine reviews each identified death in detail to confirm its relation to pregnancy and assign an accurate cause of death. In this report we describe the collaborative enterprise, which began in its current form in 1988, and present some current statistics on maternal 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 flags death certificates that have some written mention of pregnancy but do not list a pregnancy-related cause-of-death code.

The death records for all women aged 10-50 are matched to the live birth and fetal death files for the same and previous calendar years to identify maternal deaths that occur within one year after delivery. Matching is based 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 inspected visually, using full names and other information to confirm that the match is accurate. When a birth or fetal death record matches to a maternal death certificate, hard copies of both certificates are obtained and kept in pairs, because information on the delivery record often helps in

Dr. Buescher and Dr. Meyer are with the State Center for Health Statistics, Division of Public Health, North Carolina Department of Health and Human Services. Dr. Harper is with the Department of Obstetrics and Gynecology at Wake Forest University School of Medicine. Address correspondence to Dr. Buescher at State Center for Health Statistics, 1908 Mail Service Center, Raleigh, NC 27699-1908. Tel. 919/715-4478; fax 919/733-8485; email paul.buescher@ncmail.net.

establishing an accurate cause of death. The surveillance is further enhanced by obtaining hospital discharge records of women who die in hospital with a pregnancy-related discharge diagnosis. These records detect a few deaths missed otherwise, and they also provide supplementary data on medical diagnoses and procedures.

All information is sent to the Department of Obstetrics and Gynecology of the Wake Forest University School of Medicine. A detailed medical review is made by a single doctor who is board-certified in obstetrics and gynecology and in maternal and fetal medicine. The reviewer has more than 15 years of experience in the clinical practice of perinatology at 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, using the definition of maternal death adopted by the Centers for Disease Control and Prevention (CDC), namely, death during pregnancy or within one year of delivery or termination of pregnancy.

If the information provided by the State Center for Health Statistics does not permit classification of the death, a letter requesting specific information or an autopsy report is mailed to the medical examiner or physician who signed the death certificate. If death occurred at 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 public records in North Carolina, we observe strict confidentiality during the review process in order to maintain approval of the Wake Forest University School of Medicine Institutional Review Board.

All women who die during pregnancy or within the year following pregnancy are assigned a specific cause of death, classified as either "pregnancy-related" or "not-pregnancy-related." According to CDC definition, pregnancy-related deaths "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." All other deaths are related to pregnancy only temporally but not causally.

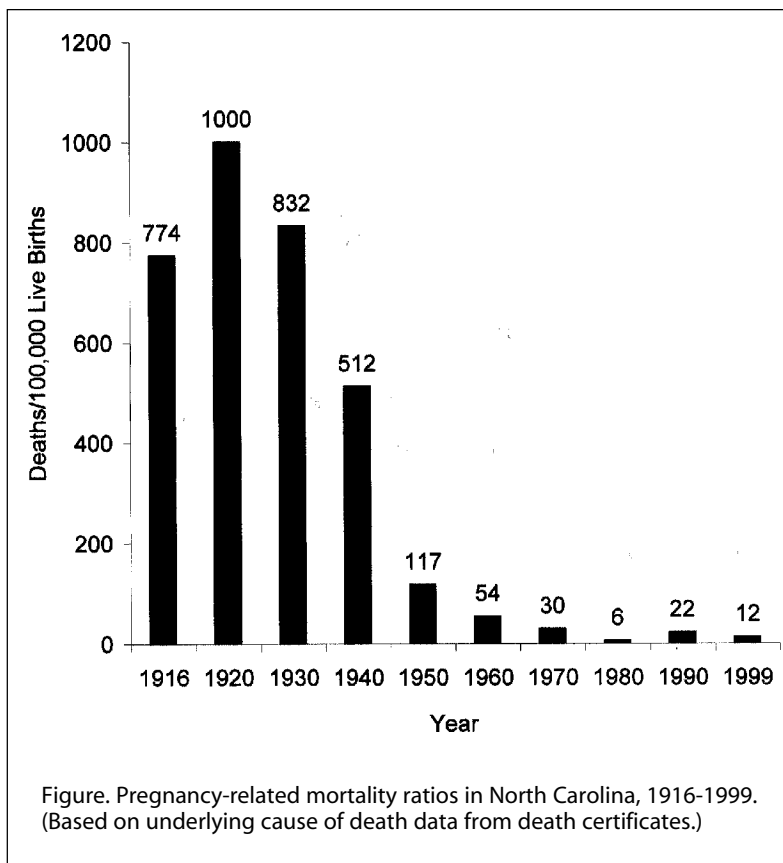


Table 1. Major causes of pregnancy-related deaths in North Carolina, 1993-1997

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

Results

From 1993 to 1997, the enhanced surveillance system identified a total of 297 maternal deaths; 119 were classified as pregnancy-related and 178 as not-pregnancy-related. Only 65 of the 119 pregnancy-related deaths (55%) were identified through death certificate listings of underlying cause-of-death codes, the usual method of measuring maternal mor-

Table 2. Major causes of not-pregnancy-related maternal deaths in North Carolina, 1993-1997

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 in North Carolina, 1993-1997

Group	Number of deaths	Deaths/100,000 live births
White, age <20	4	9.5
White, age 20-34	38	13.5
White, age 35+	10	27.3
Black, age <20	7	21.1
Black, age 20-34	41	42.6
Black, age 35+	14	149.7
<High school education	31	28.2
High school education	52	28.7
>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 because "other" races are not included here. Education groups do not add to total because education is not known in all cases.

tality. The error introduced by failing to ascertain nearly half of all pregnancy-related deaths from death certificates is substantial (giving a calculated pregnancy-related death rate per 100,000 live births of 12.6 instead of 23.1).

Table 1 shows the major causes of death in the 119 pregnancy-related cases. Cardiomyopathy was the leading cause of pregnancy-related death, in part because our enhanced surveillance detected some pregnancy-related cases up to a year after delivery that would otherwise be missed. The problem with the traditional system is shown by the fact that in some cases women died from embolism or hemorrhage on the day of delivery, yet there was no indication of pregnancy or childbirth on the death certificate.

Table 2 lists the major causes of death in the 178 not-pregnancy-related cases. The number of homicide deaths exceeds the number of deaths from any one of the pregnancy-related conditions.

Table 3 presents 1993-1997 pregnancy-related death ratios for selected demographic and educational groups.

These data indicate that older women, black women, and women with less education have higher pregnancy-related death ratios.

Discussion

The *Healthy People 2010* program set the goal for pregnancy-related mortality at 3.3 maternal deaths/100,000 live births (the same as the *Healthy People 2000* goal). In 1997, the ratio for the United States as a whole was 8.4, but this figure is based on data from death certificates (we estimate from this study that the true pregnancy-related mortality ratio is nearly

twice as high). Collecting more accurate maternal mortality data will make it even harder to achieve the goal of 3.3 deaths/100,000 live births.

We checked how completely we ascertained maternal deaths in 1996-1997 using the capture-recapture model.⁴ This method uses overlapping but incomplete lists of cases from two or more different sources. Our two lists of cases of maternal deaths were (1) death certificates with underlying cause-of-death codes 630-676 and (2) death certificates matched with birth or fetal death certificates, and hospital discharge summaries. The

analysis indicates that we ascertained 92% of all maternal deaths (pregnancy-related and not-pregnancy-related) and 98% of pregnancy-related maternal deaths.

The 1993-97 North Carolina pregnancy-related mortality ratio derived from our enhanced surveillance (23.1/100,000) is comparable to that found in other 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 Chicago area study of deaths up to 90 days postpartum showed a pregnancy-related mortality ratio of about 21/100,000.⁶

Some developing countries today report pregnancy-related mortality ratios of 500/100,000 or more,⁷ but these are based on official statistics and are likely to be skewed by underreporting. Still, they are comparable to early 20th century data from North Carolina (Figure 1).

Our data show large differences in maternal mortality by age, race, and education. The very large pregnancy-related mortality ratio for black women aged 35 and older (Table 3)

is based on only 14 deaths during 1993-1997 but is nearly identical to the ratio reported from enhanced surveillance in New York State.⁸ Clearly, there is considerable potential for reducing maternal mortality among black and older women. Of course, the racial differences presented here are purely descriptive; the causes of racial differences in health lie mainly among social, economic, and medical care differences that are associated with race.

Violence is a serious public health problem that is receiving increased attention. Our data show that a large number of women die from violence during and up to one year after pregnancy. For 1993-1997, the maternal mortality ratio for homicide (6.8 homicide deaths/100,000 live births) exceeded the ratio for any of the major pregnancy-related causes of death. The maternal mortality ratio for suicide (2.3/100,000) was also noteworthy. These data indicate the importance of screening pregnant and postpartum women for domestic violence and for depression. A recent study of violent maternal deaths in North Carolina⁹ indicated that obstetric providers knew of or suspected an abusive relationship in only two of six cases of homicide committed by

intimate partners, and were aware of depression in only three of the five suicide deaths.

For the next revision of the North Carolina death certificate, an item has been recommended that asks, "Was the decedent pregnant at the time of death or within the past year?" This information is expected to improve maternal mortality surveillance by identifying some maternal deaths not identified by matching to birth and fetal death certificates (for example, those due to abortion, miscarriage, or ectopic pregnancy).

The results of our maternal mortality surveillance are shared with the medical community in North Carolina to further efforts at preventing maternal deaths. Our data demonstrate that pregnancy-related mortality ratios have been greatly underestimated in the past when only data from death certificates were used to ascertain cases. Electronic matching and hospital discharge data along with death certificate data and in-depth medical review (enhanced surveillance) significantly improve ascertainment of maternal deaths from all causes.

References

- 1 May WJ, Greiss FC. Maternal mortality in North Carolina: a forty-year experience. *Am J Obstet Gynecol* 1989;161:555-61.
- 2 Meyer RE, Buescher PA. Maternal mortality related to induced abortion in North Carolina: a historical study. *Fam Plann Perspect* 1994;26:179-80,191.
- 3 May WJ, Buescher PA, Murray AL. Enhanced maternal mortality surveillance - North Carolina, 1988 and 1989. *MMWR Morb Mortal Wkly Rep* 1991;40:469-71.
- 4 Wittes JT, Sidel VW. A generalization of the simple capture-recapture model with applications to epidemiological research. *J Chron Dis* 1968; 21:287-301.
- 5 Bouvier-Colle MH, Varnoux N, Costes PH, Hatton F. Reasons for the under-reporting of maternal mortality in France as indicated by a survey of all deaths among women of childbearing age. *Int J Epidemiol* 1991;20:717-71.
- 6 Kemp AP, Geller S, Simonson L, et al. Maternal mortality in an urban perinatal center, 1992-1998. *Am J Obstet Gynecol* 2000;182(Pt. 2):S164.
- 7 UNICEF yearly report. Available at: <http://www.unicef.org/pon00/statistics.htm>. Accessed: March 5, 2001.
- 8 Zdeb M. Maternal mortality ascertainment in New York State. Paper presented at the 1998 Maternal, Infant, and Child Health Epidemiology Workshop, Centers for Disease Control and Prevention, Atlanta.
- 9 Parsons LH, Harper MA. Violent maternal deaths in North Carolina. *Obstet Gynecol* 1999;4:990-3.