

Pregnancy-Associated Deaths and Pregnancy-Related Deaths in Wisconsin, 1998-2001

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ABSTRACT

Background: Although the risk of dying during childbirth or from complications afterward has been greatly reduced during the past 100 years, the current rate of approximately 1 death in 10,000 live births is still too high. The goal of the US Department of Health and Human Services is to reduce this rate by more than half by the year 2010.

Objective: To present Wisconsin data regarding pregnancy-associated deaths and pregnancy-related deaths.

Methods: Cases in which a woman had died during pregnancy or within 1 year of the end of her pregnancy were identified, and case-specific data were collected. The Wisconsin Maternal Mortality Review Team then conducted systematic reviews of the information, summarized issues related to maternal mortality, considered the relationship to pregnancy and factors of avoidability, and made recommendations to improve maternal health and survival. Finally, pregnancy-associated and pregnancy-related mortality ratios were calculated.

Results: From 1998 through 2001, 23 Wisconsin women died as a result of their pregnancy or from

complications up to a year later. This gives a Wisconsin pregnancy-related mortality ratio of 8.4 per 100,000 live births. This ratio was higher in African American women and in women who smoked. The primary cause of death was embolic disease. Almost half of the pregnancy-related deaths (48%) occurred during the postpartum period, and nearly one-quarter (22%) were avoidable.

Conclusions: The disparity in pregnancy-related mortality ratios among ethnic groups and the finding of avoidable deaths are areas that should be targeted by health care providers and public health workers. Six areas on which to focus include the following: addressing racial disparities, assuring the performance of autopsies, lifestyle changes related to obesity and smoking, and management of embolic and cardiovascular disease, as well as postpartum hemorrhage.

INTRODUCTION

The death of a woman during a pregnancy, or in the weeks or months that follow, by causes thought to be related to the pregnancy itself, marks a rare but sentinel event in this country's current health care environment. The grim reality faced by childbearing women a century ago was that nearly 1 in 100 died as a result of her pregnancy. Rates of maternal deaths have declined dramatically during the past 100 years. In the year 2000, that rate was closer to 1 in 10,000—a 100-fold decrease—in the United States.¹ Although the reduction in maternal mortality has been remarkable, closer scrutiny of the data suggest that even lower rates are achievable. In fact, the US Department of Health and Human Services, in the report *Healthy People 2010*, set a goal to reduce the current rate of pregnancy-related deaths by more than half, to a rate of 3.3 per 100,000 by the year 2010.²

Like other states, Wisconsin has a system in place to review deaths of women who are pregnant or in the 12

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months following a pregnancy. Various definitions of maternal deaths are used, depending on the organization conducting the review. For example, the World Health Organization and National Center for Health Statistics utilize maternal mortality rates, which traditionally encompass deaths related to pregnancy that occur during the pregnancy itself or within 42 days postpartum. In contrast, in 1986 the Centers for Disease Control and Prevention (CDC) and the American College of Obstetricians and Gynecologists (ACOG) set forth new terminology and timeframes of death, with “pregnancy-associated deaths” and “pregnancy-related deaths,” which are defined below.³ In addition, different states elect to use a variety of time limits after the termination of pregnancy to define their own state-specific pregnancy-associated mortality.

The following definitions are used by the Wisconsin Maternal Mortality Review Team, and are adapted from the CDC/ACOG definitions:

Pregnancy-Associated Death: The death of a woman while pregnant or within 1 year of termination of pregnancy, regardless of cause. (For the purposes of this report, termination of pregnancy is defined as the end of any pregnancy, whether by vaginal delivery, cesarean section, spontaneous or elective abortion, or ectopic pregnancy.)

Pregnancy-Related Death: The death of a woman while pregnant or within 1 year of termination of pregnancy, regardless of the duration and site of the pregnancy, from any cause related to or aggravated by her pregnancy or its management, but not from accidental or incidental causes.

Not Pregnancy-Related: The death of a woman while pregnant or within 1 year of termination of pregnancy, due to a cause unrelated to pregnancy.

The team then further categorized pregnancy-related deaths into avoidable, not avoidable, and undetermined.

The current report examines the causes and trends of pregnancy-associated and pregnancy-related mortality in Wisconsin from 1998-2001.

METHODS

Case Identification

The first step of the surveillance activity is to identify women who died during pregnancy or within 1 year following the end of pregnancy. The Wisconsin Division of Public Health, Bureau of Health Information and Policy, first matches death certificates to birth certificates, in order to identify any recent pregnancy in the deceased.

In addition, a review is conducted of the cause of death and underlying conditions identified on death records for all women of childbearing age (15-44 years). If current or recent pregnancy is not identified, medical providers are consulted as needed to identify cases of pregnancy-associated mortality. This process identified 36 such deaths in Wisconsin during the 4-year period 1998-2001. Beginning in 2003, questions to identify current or recent pregnancy status (any pregnancy within the past year) were added to the standard death certificate, thereby simplifying the identification process in the future.

Case Review

The case review process begins with collecting information about a pregnancy-associated mortality, including individual and clinical risk factors, health care utilization, and community services. Data related to prenatal care, labor and delivery, postpartum care, other hospitalizations, outpatient visits, transport, and the terminal event are abstracted in detail. If possible, on-site record reviews are conducted to carry out this task. A detailed summary of case-specific data is generated and presented to the case review team. The team completes a systematic review of each case. This review includes a summary of issues related to maternal mortality and identification of important contributing factors. Each case is categorized as “related to pregnancy” or “possibly related” for those cases in which relatedness is uncertain. Next, the review team determines whether the death should be considered avoidable. Finally, through a group process, the team makes recommendations for policies, services, and programs to improve maternal health and survival.

Calculation of Mortality Ratios

When the total number of deaths has been determined, mortality ratios are calculated, in which the numerator is the number of deaths in a given category, and the denominator is the number of live births in the same category or population from which the deaths arose. This ratio is multiplied by 100,000 to have the number of deaths standardized per 100,000 live births, a commonly used statistic in discussions of maternal mortality and pregnancy-associated death.⁴ Both the pregnancy-associated mortality ratio (PAMR) and pregnancy-related mortality ratios (PRMR) were calculated. The data were then stratified by several demographic characteristics. Chi-square and Fisher exact tests were used to evaluate the data for statistically significant differences. All analyses were performed using STATA statistical software.

Table 1. Pregnancy-Related Mortality Ratio (PRMR), by Demographic Characteristics, 1998-2001 (N=23)

Demographic Characteristics	Number of Deaths	Number of Live Births	PRMR	P value
Age (year)				0.670
15-19	0	27,875	0	
20-24	6	61,175	9.81	
25-29	9	78,418	11.48	
30-34	5	69,970	7.15	
35-39	3	30,325	9.89	
40-44	0	5,391	0	
45+	0	280	0	
Education				0.445
<12 years	5	43,844	11.40	
12 years	9	86,679	10.38	
>12 years	9	142,789	6.30	
Marital Status				0.010
Married	10	192,706	5.19	
Unmarried	13	81,152	16.02	
Race/Ethnicity				<0.001
American Indian	1	3,539	28.25	
African American/Black	9	25,828	34.84	
Hispanic/Latino*	1	17,298	5.78	
Laotian/Hmong	0	4,170	0	
Other Asian/Pacific Islander	1			
White	11	218,761	5.03	
Smoking status				0.002
Smoker	10	45,970	21.75	
Non-smoker	13	227,593	5.71	
Body-Mass Index†				
<25 (Normal BMI)	7			
25-29.9 (Overweight)	4			
≥30 (Obese)	7			
Unknown	5			
TOTAL	23	273,858	8.40	

* Death report listed race as Hispanic or Mexican
 † Denominators for BMI are not available

Of note, the term “rate” is not appropriately applied to this statistic because the denominator does not represent the full population from which the deaths arose. For example, an ectopic pregnancy resulting in death from hemorrhage would be counted in the numerator, but could not be part of the “live births” denominator. Therefore, “ratio” is a more appropriate term.

RESULTS

Pregnancy-Associated Mortality Ratio (PAMR)

From the beginning of 1998 through the end of 2001, 36 cases of pregnancy-associated mortality were identified in Wisconsin, where 273,861 live births occurred. The calculated crude PAMR was 13.15 per 100,000 live births.

Among these 36 cases, 23 (64%) were determined to be deaths causally related to pregnancy, while 10 (28%) were unrelated. The remaining 3 (8%) cases were considered possibly related. The following analysis is limited to the 23 pregnancy-related deaths.

Pregnancy-Related Mortality Ratio (PRMR)

Among these 23 pregnancy-related deaths, the PRMR is 8.4 per 100,000 live births in Wisconsin (Table 1). Although a similar ratio is calculated for the US population, statistical comparison between Wisconsin and US data cannot be carried out because of differences in methods of case ascertainment.

Demographics

In national data, both increasing age and lower educa-

Table 2. Primary Cause of Death (N=23)

Cause of Death	Number (Out of 23)	Percent	US Percent [†]
Embolic disease	7	30.4	19.6
Hemorrhage	3	13.0	17.2
PIH/preeclampsia/eclampsia*	3	13.0	15.7
Infection	0	0	12.6
Cardiomyopathy	3	13.0	8.3
Cerebrovascular accident	1	4.3	5.0
Anesthetic complication	0	0	1.6
Other	6	26.0	19.2
Trauma	1	-	-
Other cardiovascular	5	-	-
Cancer	0	-	-
Neurologic	0	-	-
Unknown	0	0	0.7

* PIH=pregnancy-induced hypertension
[†] From MMWR, 2003⁴

Table 3. Time of Death in Perinatal Period (N=23)

Time of Death in Perinatal Period	Number	Percent
Antepartum	3	13
1st trimester	3	
2nd trimester	0	
3rd trimester	0	
Labor and Delivery	9	39
Postpartum	11	48
<42 days	8	
42-365 days	3	
Total	23	100

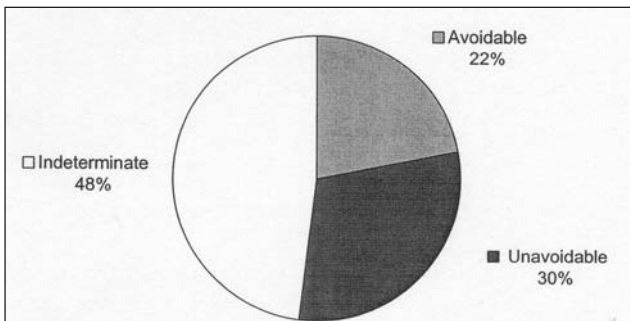


Figure 1. Avoidability of deaths. N=23.

tion status are consistently associated with higher pregnancy-related mortality, but these trends were not evident in Wisconsin data, perhaps because of small numbers overall. Factors associated with higher pregnancy-related mortality in Wisconsin include unmarried marital status, African American race, and smoking; these findings are similar to findings from national data.

Primary Cause of Death

Similar to national data, the leading cause of pregnancy-related maternal mortality among Wisconsin women is embolic disease (7 cases), which includes thromboembolism (4 cases), amniotic fluid embolism (2 cases), and air embolism (1 case). The 3 leading causes of death in Wisconsin are also the 3 leading causes of death nationally (Table 2).

Time of Death

Nearly half (48%) of pregnancy-related deaths occurred after the pregnancy ended; of these, 73% occurred in the first 6 weeks following delivery or termination of pregnancy. During labor and delivery, 39% of the pregnancy-related deaths occurred; comparatively few women died during the antenatal period (Table 3).

Avoidability of Deaths

The review team determined that 5 (22%) of the 23 pregnancy-related deaths were clearly avoidable, and another 7 (30%) were unavoidable (Figure 1). In 11 of the cases (48%), the team could not conclusively determine whether the death was avoidable or not. In 7 cases, no autopsy was performed, thereby limiting the team's ability to determine causality and avoidability.

DISCUSSION

The pregnancy-related mortality ratio in Wisconsin was found to be somewhat lower than national data (8.4 compared with 11.8 per 100,000 live births), which may reflect the different case-finding methods that the CDC has adopted in order to reduce apparent underreporting of maternal deaths. Because of this difference in case ascertainment, direct statistical comparisons between Wisconsin data and US data cannot be performed.

Regarding cause of death, no major differences were found between the most common causes in Wisconsin and those of the entire United States. Our demographic data did not reveal any unexpected trends, although we did fail to find either an age-associated or education-associated trend as is seen in larger analyses. Whether this is due to small numbers in those groups or a true lack of trend is not possible to determine. As more years of data are accumulated, these questions can be reevaluated.

The most striking finding in our data analysis is the racial disparity between black and white women. This trend is seen nationally as well, and maternal mortality represents an area of health care with one of the largest racial disparities.⁵

Determination of whether deaths are avoidable or

not is critical to the maternal mortality review objective of reducing such deaths. Regarding avoidability, our team review process was unable to categorize nearly half of pregnancy-related deaths. This is in part due to the lack of autopsy, which led team members to feel they had inadequate information to make this decision.

RECOMMENDATIONS AND STRATEGIES

The review team identified 6 key issues for current and future efforts.

Racial Disparity

The large difference in maternal mortality seen between black and white women in Wisconsin and in the entire United States is an area of great concern. Disparities are probably due to multiple and interrelated factors (e.g., biological, lifestyle, social, economic, health care, environmental) that differentially impact women over the entire life course. However, additional research is needed to understand the underlying determinants that lead to the significant racial disparities seen in pregnancy-related mortality. Culturally-appropriate health care and education, utilization of community workers, and social and economic support specifically tailored to the communities most affected by these adverse trends may begin to close the disparity gap.

Lack of Autopsy

Although there are no uniform guidelines among medical examiners and coroners regarding indications for autopsies, there must be a low threshold to perform one in a case of pregnancy-associated death. Seven of the 36 cases lacked an autopsy, which precluded optimal review. In January 2004, members of the Wisconsin Maternal Mortality Review Team met with and addressed the Wisconsin Coroners and Medical Examiners Association at their statewide meeting to convey data and emphasize the importance of autopsy in cases of pregnancy-associated deaths.

Obesity

Obesity is a major risk factor for many of the causes of pregnancy-related deaths, such as those from cardiac, thromboembolic, and hypertensive disease. Obese women are also at increased risk for cesarean delivery, gestational diabetes, and large-for-gestational-age infants.⁶ As a means of reducing health risks, weight loss is recommended prior to pregnancy, but it is currently not recommended during pregnancy. Consequently, the preconception period is an ideal time to address weight management. More public health efforts to reduce obesity are emerging. In July 2003, Wisconsin was

awarded a 5-year grant from the CDC to establish a nutrition and physical activity plan to prevent obesity and other chronic diseases.

Smoking

Compared to non-smokers, smokers have higher rates of a number of pregnancy complications, including a 1.8 times greater risk for ectopic pregnancy, a 3.4 times greater risk for miscarriage, and a 1.4 times greater risk for stillbirth.⁷ Higher PRMR for smokers creates an increased burden, since Wisconsin has historically been above the national average for women who report smoking during pregnancy; in 2001, Wisconsin reported 15.8% and the national average was 12.0%.⁵ Efforts in this area need to focus on preventing youths from starting to smoke as well as supporting women in their cessation attempts.

Embolic Disease

The rapid diagnosis and management of all types of embolic disease is of vital importance, since time is generally critical in such events. Those who provide health care to pregnant and postpartum women need to have a high index of suspicion for these life-threatening complications. In addition, in the case of thromboembolism, prevention may be the most useful approach to reducing these deaths.

Cardiovascular Disease

Symptoms typical of cardiovascular disease, such as weakness, shortness of breath, and dizziness, are not uncommon in healthy pregnant women as well. Differentiating between those symptoms that are not harmful and those that are dangerous represents a great challenge to those who provide care for pregnant women. Consumer and provider education may be beneficial in reducing such deaths.

Postpartum Hemorrhage

Hemorrhage, particularly postpartum hemorrhage, is a leading cause of pregnancy-related mortality. Education about prevention, rapid recognition, and immediate interventions is key to reducing maternal deaths. In the fall of 2003, ACOG, Wisconsin Section, and the Wisconsin Association for Perinatal Care (WAPC) presented regional forums in 9 locations around Wisconsin. More than 280 perinatal care providers from Wisconsin and Minnesota attended. Participants received educational posters (prevention, recognition, and medical and surgical interventions), teaching tools (postpartum hemorrhage drill), and protocols to use in their hospitals. The content of the regional forums was presented in April 2004 as part of

the WAPC annual conference and will be available on the WAPC Web site at www.perinatalweb.org.

CONCLUSION

The frequency of, and underlying causes leading to, pregnancy-related deaths in Wisconsin are generally similar to those of the US population overall. Racial disparity, in particular between black and white women, is striking and warrants the full attention of the health care system.

We recommend a multifaceted approach to reduce pregnancy-related deaths that would target issues such as obesity and smoking and optimize the timely recognition and treatment by health care providers of medical complications such as embolism, cardiovascular illness, and hemorrhage.

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REFERENCES

1. Achievements in public health, 1900-1999: healthier mothers and babies. *MMWR Morb Mortal Wkly Rep.* 1999;48:849-858.
2. U.S. Department of Health and Human Services. *Healthy People 2010: Understanding and Improving Health.* 2nd ed. Washington, DC: US Government Printing Office, November 2000.
3. Ellerbrock TV, Atrash HK, Hogue CJR, Smith JC. Pregnancy mortality surveillance: a new initiative. *Contemp Ob Gyn.* 1988;31:23-34.
4. Pregnancy-related mortality surveillance-United States, 1991-1999. *MMWR Morb Mortal Wkly Rep.* 2003;52:SS-2.
5. Katcher ML, Pritzl JJ, Talley Bartholomew M, et al. Healthy Babies in Wisconsin: A Call to Action. *WMJ.* 2003; 102(5):48-50.
6. Lu GL, Rouse DJ, DuBard M, et al. The effect of the increasing prevalence of maternal obesity on perinatal morbidity. *Am J Ob Gyn.* 2001;185:485-489.
7. Jehn L, Lokker N, Matitz D, Christiansen B. First Breath prenatal smoking cessation pilot study: preliminary findings. *WMJ.* 2003;102(3):29-34.