For the past 5 decades, Black women have consistently experienced an almost 4-times greater risk of death from pregnancy complications than have White women. This increased risk of pregnancy-related death among Black women is independent of age, parity, or education. An increased risk of death from other conditions, such as breast and gynecological cancer, has also been reported for Black Women. Black women are also more likely to die from complications of pregnancy, including hemorrhage, hypertensive disorders of pregnancy, and cardiomyopathy. However, the reasons for this excess mortality remain unclear. Our lack of knowledge about what factors cause the disparity in pregnancy-related mortality between Black and White women impedes our ability to formulate appropriate research and to design interventions to eliminate this disparity.

Excess mortality from a condition can be caused by a higher prevalence of the condition, a higher case-fatality rate, or a combination of these factors. To better understand the reasons for the higher pregnancy-related mortality rate among Black women, we calculated prevalence and case-fatality rates for 5 selected complications of pregnancy among Black and White women to determine the contribution of each factor to the difference in pregnancy-related mortality ratios. These 5 conditions—preeclampsia, eclampsia, abruptio placentae, placenta previa, and postpartum hemorrhage—account for 26% of all pregnancy-related deaths in the United States. We defined the prevalence rate for each of the 5 selected conditions as the number of pregnant women with the condition per 100,000 live births. We used data from the US National Hospital Discharge Survey (NHDS) to estimate the number of women with each selected pregnancy condition during the study period. We used the US National Vital Statistics System natality data to determine the number of live births over the same period. Data for the NHDS are collected via an annual survey of hospital discharge records conducted by the National Center for Health Statistics and are used to calculate national statistics on inpatient hospitalizations. The NHDS uses a probability sample of nonfederal general and short-stay specialty hospitals and is representative of hospitalizations among the US civilian resident population. National natality data are also gathered by the National Center for Health Statistics and are actual counts of births compiled from birth certificates in the United States.

We defined the case-fatality rate for each of the 5 selected conditions as the number of deaths attributable to that condition per 100,000 women with the condition. The numerators of the case-fatality rates were obtained from the Pregnancy Mortality Surveillance System (PMSS) at the US Centers for Disease Control and Prevention. The denominators were prevalence estimates we calculated using NHDS data. The PMSS is an ongoing surveillance system of all pregnancy-related deaths in the United States. Pregnancy-related deaths are defined as deaths that occur during pregnancy...
or within 1 year after pregnancy has ended and that are caused by complications of the pregnancy, a chain of events initiated by the pregnancy, or the aggravation of an unrelated condition by the effects of the pregnancy. Because the PMSS uses multiple data sources, it identifies approximately one third more deaths caused by pregnancy complications than do surveillance systems that use death certificates alone.\textsuperscript{15}

We defined the PRMR as the number of pregnancy-related deaths from each of the selected conditions per 100,000 live births. The numerators for the PRMRs were pregnancy-related deaths obtained from the PMSS. The denominators were live births from the US National Vital Statistics System natality files.

We first computed the prevalence and case-fatality rates for each pregnancy condition for both Black and White women; we then estimated the Black–White rate ratios, with 95% confidence intervals (CIs), for these 2 measures for each of the 5 selected conditions. For each condition, we partitioned the excess pregnancy-related mortality found for Black women into the percentage attributable to a greater prevalence rate and the percentage attributable to a higher case-fatality rate.

To evaluate the statistical significance of our findings, we first calculated the standard errors for the prevalence and case-fatality rate estimates with relative standard error curves that were obtained by the regression of the variances of the totals on the estimates of the totals of selected variables.\textsuperscript{14} Then, to calculate CIs for the Black–White rate ratios for the prevalence and case-fatality rates, we used the Taylor linearization method.\textsuperscript{13} Because the PRMR is the product of the prevalence rate and the case-fatality rate, we determined the percentage contribution of each factor to the PRMR difference by converting the Black–White prevalence rate ratios, the Black–White case-fatality rate ratios, and the Black–White PRMRs to log base 10. We then partitioned the difference in the PRMRs for Black and White women into the sum of the difference in the prevalence and the difference in the case-fatality rates.

For delivery hospitalizations, the NHDS contains fields for up to 6 diagnoses in addition to the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)\textsuperscript{16} VM code V27, which denotes delivery of a fetus of at least 20 weeks’ gestation; the diagnoses are not necessarily ranked in order of clinical importance in the NHDS. Of records with at least 1 of the diagnoses of interest, 96% had only 1 of the diagnoses and the remaining 4% contained 2 to 4 diagnoses. For records that included more than 1 diagnosis, we used our knowledge of the progression of pathological processes in pregnancy to develop the following decision rules for selecting the condition judged most likely to be the cause of the death. If a code for placenta previa was present on the record, the case was classified as placenta previa regardless of other diagnoses. In the absence of a placenta previa code, eclampsia took precedence over preeclampsia. If a postpartum hemorrhage code existed along with eclampsia or preeclampsia, a case was classified as postpartum hemorrhage. On the other hand, if a postpartum hemorrhage code existed in combination with abortion, a case was classified as abruptio placenta. Eclampsia and preeclampsia were selected over abruptio placentae, because the former conditions were considered the likely etiology for abortion. If eclampsia or preeclampsia, abortion, and postpartum hemorrhage were all present, the case was considered attributable to eclampsia or preeclampsia.

Overall, 21.4% of the NHDS records used in our study did not include information on race, because since 1985 a significant proportion of the NHDS data have been obtained from administrative data sources that infrequently contain this information. A prior analysis demonstrated that in the NHDS, those hospitals whose data do not include race were in areas where the population was predominantly White; therefore, White individuals were underreported in the NHDS to a greater extent than were persons of other races.\textsuperscript{15} Thus, we designated records with unknown race as White. To determine the effect of an alternate method for allocating records with this variable missing, we also calculated prevalence and case-fatality rates after proportionally redistributing cases with unknown race according to the distribution of values among those for whom the race was known. We used the $z$ test to determine whether the Black–White prevalence and case-fatality rate ratios obtained from the 2 methods of allocating cases with unknown race were significantly different statistically.

Fewer than 1% of the PMSS records lacked race information. For these deaths, the surveillance system assigned race according to the known distribution of race among other women who died of pregnancy-related causes in the same state and during the same year as the decedent.

RESULTS

For the 5 pregnancy conditions that we selected, the Black–White prevalence rate ratios ranged from 0.8 for postpartum hemorrhage to 1.6 for eclampsia; none of these ratios statistically were significantly different from 1 (Table 1). However, case-fatality rates for all 5 conditions statistically were significantly higher among Black women. The case-fatality rate ratios for Black versus White women ranged from 2.4 for placenta previa to 3.3 for postpartum hemorrhage.

For each of the selected complications, the PRMRs for Black women were between 2.5- and 3.9-times greater than those for White women (Table 2). For each of the 5 conditions, at least two thirds of the difference in the Black–White PRMRs was attributable to higher case-fatality rates among Black women. One third or less of the difference was attributed to a higher prevalence of the condition among Black women, ranging from 0% for hemorrhage to 34% for eclampsia.

The results were not significantly affected by the method used to redistribute women of unknown race. Ratios calculated after redistributing women with unknown race to White were not significantly different from those calculated when cases with unknown race were redistributed in proportion to the distribution of known cases (data not shown).

DISCUSSION

In 2000, the United States ranked 30th in maternal mortality in the world, and our poor international standing derives in part from racial disparities.\textsuperscript{16} We undertook this study to determine the relative contribution of 2 factors to the Black–White disparity in
pregnancy-related mortality, neither of which had been previously examined. We used large, population-based databases to estimate prevalence and case-fatality rates for 5 pregnancy complications: preeclampsia, eclampsia, abruptio placentae, placenta previa, and postpartum hemorrhage. The prevalence rates of these conditions among Black women were not significantly greater compared to those among White women. However, for all 5 complications, Black women had case-fatality rates that were 2- to 3-times greater than those of White women. This resulted in Black women having cause-specific PRMRs that were 2.5- to almost 4-times greater than PRMRs for White women.

Our decision to limit our analysis to the 5 selected pregnancy conditions (see box on this page) was dictated by 2 methodological issues: the need to account for the design of the NHDS and inconsistencies in coding that can occur in the ICD-9-CM.

Our first consideration was that the NHDS data were organized by occurrence of hospitalization, not by individual being hospitalized, and if an individual had more than 1 hospitalization, no identifying data were available to link the separate hospitalizations, enabling the same person to be counted more than once. Traditionally, the pregnancy conditions that we selected for our analysis are almost always present during the delivery hospitalization, even if they also resulted in hospitalization prior to delivery. By limiting study cases to those present during the delivery hospitalization, we ensured that a woman who was hospitalized more than once with the same condition was only counted once—at the time of delivery.

The second consideration that led us to limit our analysis to the 5 selected conditions during the delivery hospitalization was that some complications that occur because of pregnancy can also occur in nonpregnant women. Although ICD-9-CM codes for pregnancy (630–676) should be used to code these conditions if they occur during pregnancy or the puerperium, sometimes the analogous code for the condition in the nonpregnant state is used. Limiting conditions to those that would be present during the delivery hospitalization made it less likely that we would miss complications that occurred before or after the delivery hospitalization but had not received the ICD-9-CM code indicating pregnancy.

The 5 pregnancy complications investigated accounted for a quarter of the pregnancy-related deaths reported to the PMSS during the study period. Other complications of pregnancy were not included, because either the NHDS does not contain a sufficient number of cases to provide a stable estimate for the study years (e.g., amniotic fluid embolism), the complications do not consistently manifest themselves during the delivery hospitalization (e.g., pulmonary embolism, cerebrovascular accident, and cardiomyopathy), or the complication may resolve and recur (e.g.,

### Table 1—Prevalence and Case-Fatality Rates and Black-White Rate Ratios (With 95% Confidence Intervals [CIs]) for 5 Selected Pregnancy Complications, By Race: United States, 1988–1999

<table>
<thead>
<tr>
<th>Condition</th>
<th>Prevalence Rate (Black)</th>
<th>Prevalence Rate (White)</th>
<th>Prevalence Rate Ratio (95% CI)</th>
<th>Case-Fatality Rate (Black)</th>
<th>Case-Fatality Rate (White)</th>
<th>Case-Fatality Rate Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preeclampsia</td>
<td>1172</td>
<td>2654</td>
<td>1.2 (0.8, 1.7)</td>
<td>73.5</td>
<td>27.4</td>
<td>2.7 (1.8, 3.6)</td>
</tr>
<tr>
<td>Eclampsia</td>
<td>131</td>
<td>83</td>
<td>1.6 (0.9, 2.3)</td>
<td>1536.5</td>
<td>626.2</td>
<td>2.5 (1.4, 3.5)</td>
</tr>
<tr>
<td>Abruptio placentae</td>
<td>970</td>
<td>895</td>
<td>1.1 (0.7, 1.5)</td>
<td>58.4</td>
<td>21.3</td>
<td>2.8 (1.8, 3.7)</td>
</tr>
<tr>
<td>Placenta previa</td>
<td>454</td>
<td>433</td>
<td>1.1 (0.7, 1.4)</td>
<td>40.7</td>
<td>17.3</td>
<td>2.4 (1.5, 3.2)</td>
</tr>
<tr>
<td>Postpartum hemorrhage</td>
<td>1428</td>
<td>1890</td>
<td>0.8 (0.5, 1.0)</td>
<td>68.3</td>
<td>21.0</td>
<td>3.3 (2.1, 4.4)</td>
</tr>
</tbody>
</table>

Note. NHDS = National Hospital Discharge Survey.

*Prevalence rates were calculated as the number of pregnant women with the condition (obtained from the NHDS) per 100,000 live births (obtained from National Center for Health Statistics natality files).

**Case-fatality rates were calculated as the number of deaths attributable to that condition (obtained from the Pregnancy Mortality Surveillance System) per 100,000 women with that condition (obtained from the NHDS).
infection). We elected to include postpartum hemorrhage because, although it may occur up to several weeks postpartum, 87% of cases occur within 24 hours of delivery, including most of those cases that are life threatening.14,18

The reporting of conditions and deaths could possibly differ by race. To calculate the prevalence rates, we used data from the NHDS. The Black–White prevalence rate ratios we estimated using NHDS data were similar to those obtained when using rates of complications for Black and White women derived from birth certificate data.20 To calculate the case-fatality rates, we used PMSS data21 to identify pregnancy-related deaths. A comparison of the PMSS data with maternal mortality data from the National Vital Statistics System did not reveal any difference between the 2 systems in their reporting of deaths from pregnancy complications for White and Black women.12 Although the prevalence and case-fatality rate estimates presented here may not be exact, our goal was the comparison of rates in White and Black women, and we have no reason to suspect that ascertainment of the selected conditions or deaths differed by race. The fact that race was missing in 21% of the records in the NHDS during the study period was problematic. In the NHDS, hospitals that do not report race have a larger proportion of White patients than do hospitals that report race.20 Consequently, we chose to designate women with unknown race as White. We believe this provides estimates close to the true population distribution. In addition, our analyses of the proportional reallocation of women with unknown race yielded results that did not differ significantly from those of our initial allocation method.

Several factors may contribute to the elevated case-fatality rates among Black women, including patient attributes, such as disease severity, coexisting medical conditions, and the timing of entry into care, and health system factors, such as access to care and the quality and consistency of care. Although researchers have increasingly accepted the idea that race is more of a social rather than a biological construct, race can have biological consequences, when operating through a variety of factors, that we were unable to measure in this study.22 Compared with White women, Black women are less likely to begin prenatal care in the first trimester and less likely to receive adequate care.23 Black women, including women of reproductive age, are more likely to have a comorbidity or preexisting medical condition, such as hypertension, diabetes, or obesity,24–27 which can affect the course of their pregnancy. In addition, a recent Institute of Medicine report found that for a wide variety of medical problems, minority patients receive a generally lower quality of care, even with equal access to care and insurance coverage.28

Because the number of pregnancy-related deaths is relatively small, national data sets were necessary to obtain sufficient numbers of cases for the analyses presented here. However, these national data sets did not allow us to examine the reasons for the disparity in case-fatality rates. After stratifying the deaths by condition and race, we lacked sufficient numbers to assess modifying factors such as age, region, and urban or rural residence.

To understand why Black women have higher case-fatality rates for the pregnancy-related conditions we examined, a complex interaction of biological and health services factors must be untangled. We hope that research will advance beyond the descriptive epidemiology of racial disparities in pregnancy-related mortality to studies that will help elucidate the causes of disparity. Progress will depend on researchers’ abilities to define more precisely the mechanisms affecting complication severity and risk of death and then to apply this knowledge in designing interventions that improve pregnancy-related outcomes.

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Contributors
M.J. Tucker and C.J. Berg designed and implemented the study. M.J. Tucker was primarily responsible for preparing the article, with substantial contributions from C.J. Berg and W. Callaghan. J. Hsia provided analytic expertise and statistical oversight. All authors helped develop study ideas, interpret findings, and review drafts.

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Human Participant Protection
No human participation protocol approval was required for this study.

References
The Spirit of the Coalition
By Bill Berkowitz, PhD, and Tom Wolff, PhD

The Spirit of the Coalition is about creating and maintaining local community coalitions. It teaches practitioners about community building by providing the “nitty gritty” details of what makes coalitions work. The first-hand accounts, told by public health practitioners, illustrate how coalitions can be built and sustained, leading to measurable, lasting results.

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