Racial Disparity in Pregnancy-related Mortality Associated with Livebirth: Can Established Risk Factors Explain It?

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The authors conducted a nested case-control study to determine whether the fourfold increased risk of pregnancy-related mortality for US Black women compared with White women can be explained by racial differences in sociodemographic and reproductive factors. Cases were derived from a national surveillance database of pregnancy-related deaths and were restricted to White women (n = 840) and Black women (n = 448) whose pregnancies resulted in a livebirth and who died of a pregnancy-related cause between 1979 and 1986. Controls were derived from national natality data and were randomly selected White women and Black women who delivered live infants and did not die from a pregnancy-related cause (n = 5,437). Simultaneous adjustment for risk factors by using logistic regression did not explain the racial gap in pregnancy-related mortality. The largest racial disparity occurred among women with the lowest risk of pregnancy-related death: those of low to moderate parity who delivered normal-birth-weight babies (adjusted odds ratio = 3.53, 95% confidence interval: 2.9, 4.4). In contrast, no racial disparity was found among women with the highest risk of pregnancy-related death: high-parity women who delivered low-birth-weight babies. These findings indicate that reproductive health care professionals need to develop strategies to reduce pregnancy-related deaths among both high- and low-risk Black women. Am J Epidemiol 2000;152:413–19.

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Abbreviations: CI, confidence interval; OR, odds ratio.

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A decreased risk of pregnancy-related mortality for White women in the United States has been reported since 1915, when White women had a mortality rate approximately 60 percent of that for women of other races (1). Over the past 50 years, these rates have decreased sharply for US women in all racial and ethnic groups. The Black-White racial disparity in pregnancy-related mortality, however, has both persisted and widened over time; in 1990, the rate for Black women was four times higher than that for White women (2, 3). Among the established risk factors for pregnancy-related mortality is older maternal age, low educational attainment, high parity, and no prenatal care (4). No studies to our knowledge have estimated how much of the racial gap can be explained by these and other known risk factors.

To determine whether this racial disparity can be explained, at least in part, by the association of race with other risk factors for pregnancy-related mortality, we conducted a nested case-control study based on data from a nationwide surveillance database of pregnancy-related deaths. We sought to identify sociodemographic and reproductive factors associated with racial disparity to determine whether the Black-White gap in pregnancy-related mortality can be accounted for by such factors. In addition, we sought to determine whether the racial disparity varied among selected subgroups of women.

MATERIALS AND METHODS

Our study population was derived from the Centers for Disease Control and Prevention (Atlanta, Georgia) Retrospective Maternal Mortality Study. Initiated in 1987, this surveillance project collected vital statistics data on all US and Puerto Rican women who died from pregnancy-related causes during 1979–1986. Health departments from the 50 US states, the District of Columbia, New York City, and Puerto Rico provided the Centers for Disease Control and Prevention with copies of death certificates (with no decedent-identifying information) for all suspected pregnancy-related deaths occurring over this 8-year period. In addition, matched birth and fetal death certificates linked to corresponding death certificates of mothers were provided, when available, for most women whose pregnancies resulted in a livebirth or stillbirth. Additional information on some cases was obtained from state maternal mortality review committees, private citizens, and the media.

We classified a woman’s death as pregnancy related if it occurred during pregnancy or within 1 year after the preg-
nancy and resulted from complications of the pregnancy itself, a chain of events initiated by pregnancy, or aggravation of an unrelated event by the physiologic or pharmacologic effects of the pregnancy. To ensure high sensitivity of the case definition, records for all women who died during or within 1 year following the pregnancy were reviewed by clinical epidemiologists and were coded by cause of death by using a classification system designed in collaboration with members of the Centers for Disease Control and Prevention/American College of Obstetricians and Gynecologists’ Maternal Mortality Study Group (5). All available information, including death certificates, matched fetal death and birth certificates, autopsy reports, maternal mortality review committee reports, and media accounts, was used to code each woman’s cause of death.

The cases selected for analysis in the case-control study were White women (n = 840) and Black women (n = 448) who died of a pregnancy-related cause, whose pregnancies resulted in a livebirth, and whose infants’ birth certificates were available. White subjects included White women of Hispanic heritage, and Black subjects included Black women of Hispanic heritage. Women whose deaths were associated with pregnancies that did not result in a livebirth (e.g., fetal death, abortive outcomes, and ectopic and molar pregnancy) were excluded from the analysis because livebirth birth certificates, but not fetal or maternal death certificates, provide data on pregnancy and prenatal care risk factors. The subjects whose deaths were associated with a livebirth represented 52 percent of all pregnancy-related deaths reported during the 8-year study period. Birth certificates linked to the mothers’ death certificates were available for 95 percent of potential cases.

The controls were randomly selected from all White women and Black women who delivered a livebirth in the United States between 1979 and 1986 and did not die from a pregnancy-related cause. Data for controls were derived from livebirth birth certificates stored in the 1979–1986 national natality database provided by the National Center for Health Statistics (Hyattsville, Maryland). Because advanced maternal age strongly influences the risk of pregnancy-related mortality (2–4), we needed to obtain a sample of controls that included adequate numbers of older women. To ensure adequate numbers of controls in the oldest age groups, we selected five times as many controls as cases within each age stratum. Although we considered age matching the controls to cases, we did not do so because matching would have negated our ability to evaluate the role of maternal age in the Black-White gap in pregnancy-related mortality.

Characteristics of the subjects included in the analyses were maternal age at delivery (<20, 20–24, 25–29, 30–34, 35–39, ≥40 years); marital status (married, not married); years of completed education (<12, 12, >12); actual year of death (1979–1986); adequacy of prenatal care (inadequate, intermediate, adequate, adequate plus, no care) as determined by the Kotelchuck index, which accounts for gestational age at delivery, timing of prenatal care, sex of the infant, and birth weight (6); gestational age at delivery (20–27, 28–32, 33–36, 37–41, ≥42 weeks); area of residence (metropolitan, nonmetropolitan); region of residence (Northeast, North Central, South, West); birth weight (<1,500, 1,500–2,499, ≥2,500 g); and livebirth order (1, 2, 3, 4, ≥5). Livebirth order was defined as the number of children born alive, including the index pregnancy. This variable was obtained from the birth certificate and served as a proxy for parity, information that was not available on the birth certificate.

The odds ratio was used to estimate the relative risk of pregnancy-related mortality associated with Black versus White race. Because pregnancy-related mortality is a rare event, the odds ratio provides an excellent approximation of relative risk. We calculated crude odds ratios and stratum-specific odds ratios to determine whether the magnitude of the racial disparity was constant for different subgroups of women. We tested for stratum-specific differences in the association of race with risk of pregnancy-related mortality by using the Breslow-Day test for heterogeneity (7). Odds ratios adjusted for risk factors were calculated by using the Mantel-Haenszel method to assess the presence of potentially confounding variables. Confidence intervals of 95 percent were calculated by using Woolf’s method (8) for crude odds ratios and Gart’s method for adjusted odds ratios (9).

We conducted multivariate logistic regression analysis to control simultaneously for the effects of confounding variables and to test and adjust for, as necessary, the interaction of race with reproductive and prenatal risk factors for pregnancy-related mortality. We introduced interaction terms suggested from results of the stratified analyses and tested for interactions by determining likelihood ratios and their chi-square statistics (p < 0.05). Because of the large study size and the limited number of variables for analysis, we decided, a priori, to retain all potentially confounding variables in the final model.

RESULTS

The frequency distributions of several demographic and reproductive characteristics differed for cases and controls (table 1). Among women of both races, those who died from pregnancy-related causes were more likely to be aged ≥30 years, to be of high parity (livebirth order ≥4), and to have given birth to a low-birth-weight infant or a preterm infant or to have had no prenatal care. White women who died were slightly more likely to be unmarried than were White controls, whereas Black decedents were slightly more likely to be married than were Black controls. Educational attainment was similar for Black subjects, whereas White cases had fewer years of education than White controls did.

The unadjusted odds of pregnancy-related death for Black women was 2.79, indicating that Black women were nearly three times more likely than White women to die from a pregnancy-related cause. Stratified analyses showed that the Black-White gap varied considerably among certain subgroups of women; racial disparities varied significantly according to marital status, infant birth weight, gestational age, and livebirth order (Breslow-Day test for heterogeneity: p < 0.05) (table 1). For example, the racial difference
was more pronounced for women who delivered a normal-birth-weight infant (odds ratio (OR) = 2.93, 95 percent confidence interval (CI): 2.5, 3.4) than for women who delivered a low-birth-weight infant (OR = 1.45, 95 percent CI: 1.0, 2.1) or a very-low-birth-weight infant (OR = 0.93, 95 percent CI: 0.5, 1.7).

Tests for interaction, which were indicated from results of the stratified analyses, focused on the interaction of race with each of the following dichotomized variables: marital status (married, not married), birth weight (<2,500, ≥2,500 g), gestational age (<37, ≥37 weeks), and livebirth order (1–3, ≥4). Birth weight and livebirth order interacted
significantly with race in the logistic regression model that included all main effect variables. Therefore, these two interaction terms were retained in the final model, and the final results were stratified by birth weight and livebirth order. Stratification resulted in four groups of subjects: 1) women who delivered normal-birth-weight infants and had low-to-moderate parity (livebirth order 1–3), which constituted the largest group; 2) women who delivered normal-birth-weight infants and had high parity (livebirth order ≥4); 3) women who delivered low-birth-weight infants and had low-to-moderate parity; and 4) women who delivered low-birth-weight infants and had high parity.

The absolute risk of pregnancy-related death for both White women and Black women increased in each of the four successive groups (figure 1). Women of both races who delivered normal-birth-weight infants and had low-to-moderate parity were at the lowest risk of death; however, they experienced the widest racial disparity in pregnancy-related mortality. In contrast, both high-parity Black women and White women who delivered low-birth-weight infants had the highest rates of maternal death yet showed no racial disparity; that is, the rates of pregnancy-related death for these high-risk White women were just as high as those for their high-risk Black counterparts.

To determine whether simultaneous adjustment for sociodemographic and reproductive risk factors could explain any of the Black-White gap in pregnancy-related mortality, we compared the crude and adjusted odds ratios calculated from the final interaction model, which yielded risk estimates for each of the four groups of subjects (table 2). Both the crude and adjusted odds ratios for the Black-White gap in pregnancy-related mortality were highest for

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**FIGURE 1.** Rate of pregnancy-related mortality for women with a livebirth outcome, United States, 1979–1986, by birth-weight status (normal birth weight (≥2,500 g) or low birth weight (<2,500 g) and livebirth order (low (1–3) or high (≥4)).

**TABLE 2.** Crude and adjusted odds ratios for the Black-White gap in maternal mortality, stratified by birth weight and livebirth order, United States, 1979–1986

<table>
<thead>
<tr>
<th>Group 1: normal birth weight</th>
<th>No. of cases</th>
<th>No. of controls</th>
<th>No. of cases</th>
<th>No. of controls</th>
<th>Crude odds ratio</th>
<th>Adjusted odds ratio (95% confidence interval)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥2,500 g, livebirth order 1–3</td>
<td>415</td>
<td>4,643</td>
<td>214</td>
<td>762</td>
<td>3.06</td>
<td>3.53 (2.9, 4.4)</td>
</tr>
<tr>
<td>≥2,500 g, livebirth order ≥4</td>
<td>99</td>
<td>464</td>
<td>63</td>
<td>134</td>
<td>2.15</td>
<td>2.13 (1.5, 3.2)</td>
</tr>
<tr>
<td>&lt;2,500 g, livebirth order 1–3</td>
<td>158</td>
<td>284</td>
<td>93</td>
<td>116</td>
<td>1.46</td>
<td>1.51 (1.1, 2.2)</td>
</tr>
<tr>
<td>&lt;2,500 g, livebirth order ≥4</td>
<td>29</td>
<td>23</td>
<td>22</td>
<td>25</td>
<td>1.05</td>
<td>0.91 (0.6, 1.5)</td>
</tr>
</tbody>
</table>

* Adjusted for maternal age (<20, 20–24, 25–29, 30–34, 35–39, ≥40 years), education (<12, 12, 13–15, ≥16 years), Kotelchuck index (6) (no, inadequate, intermediate, adequate, adequate plus care), gestational age (<37, 37–41, ≥42 weeks), year of death (1979–1986), marital status (married, not married), low birth weight (yes, no), livebirth order (1–3, ≥4), region (Northeast, South, Midwest, West), metropolitan area resident (yes, no), livebirth order × low birth weight.
those women who delivered normal-birth-weight infants and had low-to-moderate parity (crude OR = 3.06, adjusted OR = 3.53, 95 percent CI: 2.9, 4.4), with the racial disparity decreasing in successive strata. In the stratum of subjects at the highest absolute risk of pregnancy-related mortality, that is, women who delivered low-birth-weight infants and had high parity, Black women and White women had approximately the same risk (crude OR = 1.05, adjusted OR = 0.91, 95 percent CI: 0.6, 1.5). Thus, simultaneous adjustment for the mortality risk factors available from the livebirth birth and death certificates did not explain any portion of the racial gap. In fact, statistical adjustment actually led to a widening of the racial disparity among women who delivered normal-birth-weight infants and had low-to-moderate parity.

To determine whether the leading causes of maternal death varied by race, we compared the top four causes of death—pulmonary embolism, pregnancy-induced hypertension, hemorrhage, and infection)—within each of the four strata. We found that the four leading causes of pregnancy-related mortality were ranked similarly for White women and Black women.

**DISCUSSION**

Multivariate analysis did little to alter the odds ratio for the risk of pregnancy-related death associated with a live-birth outcome after we adjusted for risk factors available from vital records, including no prenatal care, education, maternal age, and parity. Furthermore, we found that the largest racial disparities for pregnancy-related mortality were for women who had the lowest rates of maternal death; that is, the Black-White gap was inversely related to the absolute risk of maternal death.

As for underlying medical or obstetric morbidity, two studies used data from the National Hospital Discharge Survey to estimate the prevalence of pregnancy complications by race as measured by nondelivery hospitalizations during pregnancy. Franks et al. (10) found that in 1986–1987, Black women were 1.4 times more likely than White women to be hospitalized during pregnancy for a pregnancy complication. Bennett et al. (11) found that in 1991–1992, Black women were 1.6 times more likely than White women to be hospitalized for pregnancy complications. Thus, although Black women are 40–60 percent more likely to be hospitalized for a pregnancy complication (10), they are four times as likely to die of a pregnancy complication. We suggest three possible scenarios to explain this observation. First, Black women use reproductive health care services (in particular, prenatal care) later and less often and have more severe complications when they do present to health care; thus, they have a higher case fatality rate. Second, Black women have complications similar in severity to those of White women but receive lower-quality care, resulting in a higher mortality risk. Third, a combination of these two scenarios is possible, such that Black women present with more advanced disease and receive later and lower-quality prenatal care.

Scientific evidence supports all of these hypotheses. Overall, Black women are less likely than White women to obtain early prenatal care. In 1980, 62.4 percent of Black mothers and 79.2 percent of White mothers started their prenatal care during the first trimester; in 1995, these percentages increased to 70.4 and 83.6 percent, respectively (12). Elam-Evans et al. (13) used national birth certificate data for 1980–1992 and reported that Black women were less likely than White women to receive prenatal care, and the racial gap in receipt of care widened over the study period. This lower rate of use of prenatal care may not be explained by limited access. Murray and Bernfield (14), reporting on the use of prenatal care by mothers enrolled in a prepaid health care plan, found that even when the opportunity to obtain prenatal care was equal for Blacks and Whites of similar age and education, Blacks used prenatal care services less extensively than Whites did. Moreover, it has been reported that Black women make fewer prenatal visits to clinicians than White women do during the last 2 months of pregnancy (15).

Women have varying degrees of control over their use of health care services; however, once a woman chooses a provider, control over the quality and quantity of health care shifts to the provider. Studies reveal that both the content and quality of care vary according to the demographic characteristics of women, including race. Hansell (16) reviewed data from the 1980 National Natality Survey and concluded that for many women who seek prenatal care, the quality of the care they receive is not even minimally acceptable. The types of advice and tests provided to women varied substantially according to sociodemographic factors. Hansell hypothesized that socially disadvantaged women perhaps discover early in life the low quality of the health services provided for them and decide that the costs of making visits (e.g., child care, transportation, opportunity costs of time spent) exceed the benefits. In another study, Brett et al. (17) found that the content of prenatal care received by Black women and White women differed; amniocentesis was used less frequently by Black women, and White women had a slightly higher probability of receiving a prenatal ultrasound examination. Further support comes from an analysis of the 1988 National Maternal and Infant Health Survey, which found that Black women who received prenatal care were significantly less likely to report receiving smoking and alcohol cessation advice (15).

Just as our study found the Black-White gap to be widest among the women at the lowest absolute risk of pregnancy-related mortality, studies of the racial disparity in the risks of low and very low birth weight have also found the Black-White gap to be widest among mothers at the lowest risk. By using national birth certificate data from 1983, Kleinman and Kessel (18) found that for very-low-birth-weight babies, the Black-to-White odds ratio was 3.4 for low-risk women. The low-risk group included married, primiparous women aged 20–29 years and low-parity women (aged ≥20 years with ≥13 years of education). In contrast, for the high-risk women, the Black-to-White odds ratio of 1.7 was much lower than that for the low-risk women. The high-risk group included unmarried teenagers, primiparous women aged ≥30 years, and high-parity women with <12 years of education (18). Studies of Black-White differences in the risk of low birth weight among college-educated women have also
found the Black-White differences to be present in these advantaged groups (19, 20). Similarly, an analysis of 1989 US birth certificates for infants born after 39 weeks of gestation showed a threefold higher incidence of low birth weight among Black women than among White women, even though both groups had the same levels of education, prenatal care, and smoking (21).

Our finding that the racial disparity in pregnancy-related mortality is most prominent among lower-risk women provokes examination of other differences between Black women and White women that may contribute to the racial disparity, even in homogeneous groups such as college-educated women. For instance, differences may exist in current health status, childhood and adolescent health history, stress levels, nutrition, parents’ and grandparents’ socioeconomic status, income, and quality of medical care during pregnancy (18).

Geronimus and Bound (22) examined national mortality rates for 10 specific causes of death that are also risk factors for adverse pregnancy outcome among women in their childbearing years. These authors found that by the time women were in their middle to late twenties, death rates for US Black women increased significantly more rapidly than White women’s death rates from all causes, medical causes, external causes, and 7 of the 10 causes of death examined (especially for hypertensive diseases and anemia). Thus, findings from this study suggest that the health of US Black women during their prime childbearing years deteriorates more rapidly than that of White women during those years. The poorer general health status of Black women of reproductive age may explain a portion of the Black-White gap in pregnancy-related mortality. However, we did not find any large differences in the causes of death that would help explain the racial gap.

Because the present study was based on an analysis of vital records, it is subject to the limitations inherent in such data. Perhaps the major limitation was the lack of information available on each maternal death. Thus, we were unable to analyze the effects of medical and social history and treatment, the content and quality of prenatal care, or behavioral risk factors such as smoking, drinking, and drug use. Also, numerous studies have shown that pregnancy-related mortality should not be ascertained from vital records alone but should rely on multiple sources of reporting (as was done in this study) to identify more cases (23, 24). In addition, our analysis focused on only half of the pregnancy-related deaths, those associated with a livebirth outcome; therefore, our findings on the risk of pregnancy-related death are generalizable only to pregnancies that result in a livebirth.

In summary, our findings indicate that the threefold increased risk of pregnancy-related death associated with livebirth for Black women cannot be explained by sociodemographic and reproductive variables available from birth certificate data. In fact, the Black-White gap in pregnancy-related death was widest for Black women who belonged to subgroups at the lowest absolute risk. In response to these findings, the health care system needs to develop new strategies to make comprehensive reproductive health services more available to Black and other minority women and to ensure that these women are able and willing to use these services. These activities will be effective in reducing the Black-White gap in pregnancy-related mortality only if health care services include effective interventions designed to reduce risks for all Black women. However, success in identifying risks that are modifiable by clinical interventions has been limited (25). Medical care practitioners also need to realize that social determinants of disease, which strongly affect a woman’s ability to avoid or minimize risk, are not always under an individual woman’s control (26). Therefore, public health programs and social policy should complement medical practice when these determinants are considered. Models of prenatal care must be flexible enough to allow for the possibility that Black women in the United States may have risk factors not traditionally considered by health care providers, especially psychological and social stress.

REFERENCES

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