Factors That Mediate Racial/Ethnic Disparities in US Fetal Death Rates

Scott A. Lorch, MD, MSCE, Charlan D. Kroelinger, PhD, Corinne Ahlberg, MS, and Wanda D. Barfield, MD, MPH

Objectives. We sought to determine the importance of socioeconomic factors, maternal comorbid conditions, antepartum and intrapartum complications of pregnancy, and fetal factors in mediating racial disparities in fetal deaths.

Methods. We undertook a mediation analysis on a retrospective cohort study of hospital-based deliveries with a gestational age between 23 and 44 weeks in California, Missouri, and Pennsylvania from 1993 to 2005 (n = 7 104 674).

Results. Among non-Hispanic Black women and Hispanic women, the fetal death rate was higher than among non-Hispanic White women (5.9 and 3.6 per 1000 deliveries, respectively, vs 2.6 per 1000 deliveries; $P < .01$). For Black women, fetal factors mediated the largest percentage (49.6%; 95% confidence interval [CI] = 42.7, 54.7) of the disparity in fetal deaths, whereas antepartum and intrapartum factors mediated some of the difference in fetal deaths for both Black and Asian women. Among Hispanic women, socioeconomic factors mediated 35.8% of the disparity in fetal deaths (95% CI = 25.8%, 46.2%).

Conclusions. The factors that mediate racial/ethnic disparities in fetal death differ depending on the racial/ethnic group. Interventions targeting mediating factors specific to racial/ethnic groups, such as improved access to care, may help reduce US fetal death disparities. (*Am J Public Health.* 2012;102:1902–1910. doi:10.2105/AJPH.2012.300852)

In the United States, there continue to be racial/ethnic disparities in perinatal outcomes such as fetal death.[1–4] Studies have identified factors that are associated with increased rates of fetal death overall, including advanced maternal age,[5–7] previous cesarean delivery,[8] inadequate prenatal care,[9] and some chronic medical conditions.[10–12] However, none of these studies examined whether higher fetal death rates seen in minority racial/ethnic groups are potentially mediated by factors that occur later in pregnancy.[13–15] Understanding these factors and whether these mediating factors differ between racial/ethnic groups will better focus potential interventions to reduce these disparities.

We have identified factors that mediate racial/ethnic differences in fetal death rates between 23 and 44 weeks gestation. We grouped factors into 4 areas using the conceptual framework shown in Figure 1. These sets of factors included socioeconomic factors; maternal preexisting comorbid conditions; antepartum and intrapartum factors, primarily complications of pregnancy; and fetal factors, specifically gestational age at delivery.

METHODS

We obtained data from all hospital deliveries occurring in California, Missouri, and Pennsylvania between January 1, 1995, and June 30, 2005, with gestational ages between 23 and 44 weeks, including fetal death, live birth, maternal hospital discharge records, and newborn hospital discharge records. These data allowed us to compare women experiencing fetal deaths with women with live births. We chose these states for their data availability, large number of deliveries, and large number of rural and minority patients. We used probabilistic methods to match more than 98% of the live birth records and fetal death records to maternal and newborn hospital records, as described in prior work.[16–18] Unmatched records had similar gestational age and racial/ethnic distributions to the matched records, and we consequently excluded them from further study.

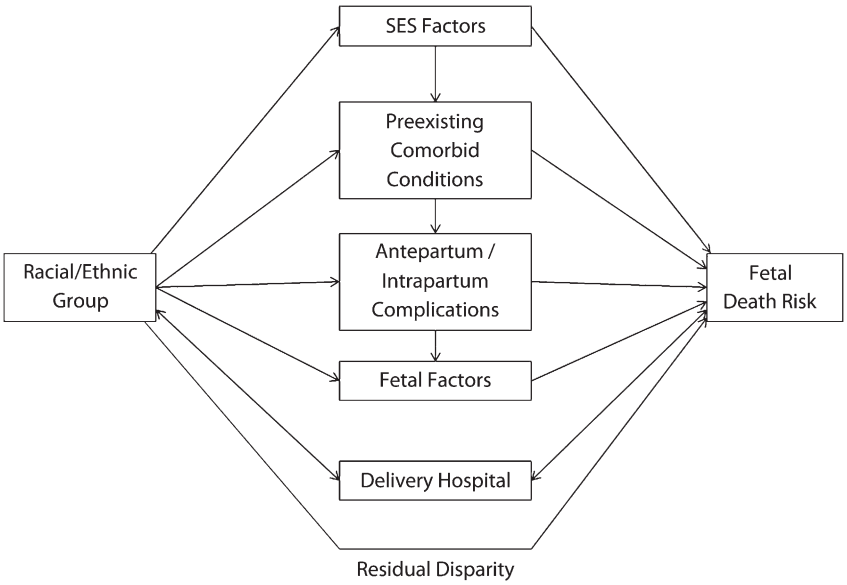
Among matched records, we excluded delivery records if they had a birth weight less than 400 grams or greater than 8000 grams, or if the birth weight was more than 5 SD from the mean birth weight for the recorded gestational age in the cohort because of potential data entry errors.[19] Initially, we identified 7 214 938 delivery records; 110 264 met the exclusion criteria, leaving 7 104 674 births in the final cohort.

Outcome and Explanatory Factor Variables

The primary outcome for this study was a pregnancy that ended with a fetal death, captured from fetal death data in each state. Although the definition of fetal death is the same for all states, these 3 states have different reporting requirements: Pennsylvania reports all fetal deaths with a gestational age of 16 weeks or more; California reports all fetal deaths with a gestational age of 20 weeks or more; and Missouri reports all fetal deaths with a gestational age of 20 weeks or more and a birth weight of 350 grams or greater.[20,21] We standardized the definition to the delivery of a fetus with a gestational age between 23 and 44 weeks and a birth weight greater than 400 grams, as fetal deaths below this gestational age or birth weight cutoff may not result in a hospital admission, and thus would not be included in our data set.

We classified maternal racial/ethnic group as non-Hispanic White, non-Hispanic Black, any Hispanic ethnicity, Asian, or other racial/ethnic group on the basis of information in the maternal hospital discharge record. Multiracial women comprised the majority of women in the other racial/ethnic group. Because multiracial women may be of any combination of racial/ethnic groups, we did not report data on the other racial/ethnic group.

We grouped mediating factors into 4 categories (Figure 1). Socioeconomic factors included maternal insurance status, education, starting trimester of prenatal care, and age



Note. SES = socioeconomic status. The residual disparity in fetal deaths, or fetal deaths unexplained by any of the included factors, is shown as the bottom pathway.

FIGURE 1—Hierarchical conceptual framework: racial/ethnic differences in fetal death, California, Missouri, Pennsylvania, 1993–2005.

identified from birth certificate data. Maternal preexisting comorbid conditions included conditions present before conception, such as chronic hypertension and diabetes. Antepartum and intrapartum complications of pregnancy included conditions that typically occur during pregnancy, such as cord and placentation anomalies and pregnancy-induced hypertension. The appendix (available as a supplement to the online version of this article at http://www.ajph.org) shows the *International Classification of Diseases, Ninth Revision* (*ICD-9-CM*)[22] codes we used to identify both maternal preexisting comorbid conditions and antepartum and intrapartum complications of pregnancy in hospital discharge data. Fetal characteristics included gestational age and birth weight, identified from birth certificate data, and the presence of 1 of 49 congenital anomalies identified using *ICD-9-CM* codes in infant hospital discharge records and grouped by the affected organ system (appendix).[16] Gestational age was missing in approximately 12% of the birth certificates, which we multiply imputed using PROC MI in SAS version 9.2 (SAS Institute, Cary, NC).

The delivery hospital may confound the relationship between racial/ethnic group and fetal death rate, either if women of certain racial/ethnic groups attend poor quality hospitals, which may convert some live births to fetal deaths,[16] or if the delivery hospital serves as a proxy for access to health care in a specific community.[23] It is less likely that the delivery hospital serves as a primary mediating variable alone. Thus, we examined delivery hospital as a confounding factor and reported the difference in odds ratios (ORs) when inclusion of delivery hospital changed the relationship between a racial/ethnic group and fetal death by more than 15%. The difference in our treatment of delivery hospital compared with other factors is noted in Figure 1.

Data Analysis

Mediation testing. On the basis of Baron and Kenny's framework,[24] a set of factors may mediate the relationship between racial/ethnic group and fetal death risk if the following conditions are met:

1. Racial/ethnic group is associated with fetal death risk.
2. Racial/ethnic group is associated with a set of potential mediating factors.
3. A set of potential mediating factors are associated with the risk of fetal death.
4. Including both racial/ethnic group and the set of mediating factors in a model changes the association between fetal death and racial/ethnic group observed in condition 1.

To test the first 2 conditions, we first measured the unadjusted association between racial/ethnic group and fetal death risk using logistic regression models. Then, we used the χ^2 test to assess the association between racial/ethnic group and each set of potential mediating factors.

Model construction. To test the third and fourth conditions, we constructed sequential logistic regression models,[13–15] adding each group of mediating factors in the temporal order that they occur in a pregnancy. We began model construction by examining only race/ethnicity and fetal death (model A). Model B included socioeconomic factors. We interpreted the ORs for racial/ethnic group as the part of the effect of racial/ethnic group on fetal death that was not mediated by sociodemographic factors. Each successive model included another set of factors in the following order: preexisting maternal conditions (model C), antepartum and intrapartum complications of pregnancy (model D), fetal factors (model E), and delivery hospital (model F).

For the third condition, we reported the association between a given mediating factor and fetal death, controlling only for those factors that occurred earlier in the conceptual model excluding racial/ethnic group. This method avoided overcontrolling for factors that may mediate the effect of a specific risk factor on fetal death risk. For example, pregnancy-induced hypertension may result in increased fetal death risk both through direct harm to the fetus and through delivery at an earlier gestational age. Controlling for gestational age in the regression model would result in an artificially lower association between pregnancy-induced hypertension and fetal death.

Finally, for the fourth condition, we reported the percentage of the fetal death disparity in each racial/ethnic group mediated by a set of factors. Evidence for mediation could be detected by comparing the coefficient for racial/ethnic group before the set of factors were added to the model to the coefficient in the successive model that included the set of

factors. Using MacKinnon and Dwyer's framework,[25] we calculated the mediation percentage as ((coefficient for racial/ethnic group)$_{prior}$ − (coefficient for racial/ethnic group)$_{successive}$)/(coefficient for racial/ethnic group)$_{crude}$. We used standardized regression coefficients in these calculations to allow comparisons of the coefficients between models.[26] To determine whether this mediation percentage was statistically significant, we used nonparametric bootstrap techniques to calculate the 95% confidence interval (CI) for each mediation percentage on the basis of rerunning the models on 200 random samples of 7 104 674 deliveries drawn with replacement. We have reported the mediation percentages if the 95% CI did not cross zero. For all models, we calculated robust SEs using the Huber-White method to control for clustering at the delivery hospital.[27–30] We added interaction terms between racial/ethnic group and each predictive factor to the models if the interaction terms retained statistical significance at the 5% level after controlling for multiple comparisons with the Bonferroni correction.

RESULTS

Of the 7 104 674 deliveries included in this cohort, 23 471 were fetal deaths (3.3 per 1000 deliveries). Black women had the highest rate of fetal death (5.9 fetal deaths per 1000 deliveries) compared with 2.6 per 1000 deliveries for non-Hispanic White women, 3.2 per 1000 deliveries for Asian women, and 3.6 fetal deaths per 1000 deliveries for Hispanic women. In univariable analysis (Table 1), fetal deaths were more prevalent in women older than 35 years and women with chronic comorbid conditions such as chronic hypertension and diabetes mellitus. Fetal deaths were more prevalent in women with intrapartum complications of pregnancy, such as placental abruption or when the fetuses were of lower birth weight or had a congenital anomaly. In unadjusted analysis, all 3 racial/ethnic groups had higher odds of a fetal death than did non-Hispanic White women (Blacks: OR = 2.24; 95% CI = 2.08, 2.42; Hispanics: OR = 1.37; 95% CI = 1.28, 1.47; Asians: OR = 1.18; 95% CI = 1.09, 1.28), which fulfilled condition 1 of our analysis.

TABLE 1—Univariable Associations of Mediating Factors: Racial/Ethnic Differences in Fetal Death, California, Missouri, Pennsylvania, 1993–2005

Mediating Factor	Fetal Death (n = 23 471), No. (%)	Live Birth (n = 7 081 203), No. (%)
Socioeconomic factors		
Maternal age, y		
< 18	1020 (4.35)	273 586 (3.86)
18–35	18 612 (79.30)	5 980 089 (84.45)
> 35	3839 (16.36)	827 528 (11.69)
Insurance status		
Fee for service	1666 (7.10)	675 273 (9.54)
Health maintenance organization	9014 (38.40)	3 142 077 (44.37)
Public	11 077 (47.19)	2 858 298 (40.36)
Other	532 (2.27)	202 711 (2.86)
Uninsured	1147 (4.89)	193 206 (2.73)
Missing	35 (0.15)	9638 (0.14)
Trimester of first prenatal care visit, mo		
0–3	18 086 (77.06)	5 921 065 (83.62)
4–6	3338 (14.22)	831 146 (11.74)
7–9	671 (2.86)	162 666 (2.30)
Missing	1376 (5.86)	166 326 (2.35)
Education		
< high school	15 054 (64.14)	5 105 433 (72.10)
≥ high school	6765 (28.82)	1 860 319 (26.27)
Missing	1652 (7.04)	115 451 (1.63)
Preexisting comorbid conditions		
Gestational diabetes	910 (3.88)	287 090 (4.05)
Diabetes mellitus	575 (2.45)	47 464 (0.67)
Chronic hypertension	410 (1.75)	45 169 (0.64)
Renal disease	63 (0.27)	7389 (0.10)
Antepartum and intrapartum complications		
Chorioamnionitis	2538 (10.81)	221 756 (3.13)
Cord abnormalities	2541 (10.83)	239 953 (3.39)
Cord prolapse	530 (2.26)	24 998 (0.35)
Disorders of placentation	2952 (12.58)	104 338 (1.47)
Eclampsia	78 (0.33)	6268 (0.09)
Placenta abruptio	2727 (11.62)	67 084 (0.95)
Placenta previa	268 (1.14)	39 285 (0.55)
Pregnancy-induced hypertension	1363 (5.81)	216 743 (3.06)
Premature rupture of membranes	4823 (20.55)	475 103 (6.71)
Preterm labor	1247 (5.31)	361 445 (5.10)
Shock	107 (0.46)	7195 (0.10)
Thrombosis	46 (0.20)	6183 (0.09)
Uterine rupture	118 (0.50)	5222 (0.07)

Continued

TABLE 1—*Continued*

	Fetal characteristics	
Birth weight categories, g		
400–999	7055 (30.06)	31 473 (0.44)
1000–1499	3041 (12.96)	44 405 (0.63)
1500–1999	2843 (12.11)	95 176 (1.34)
2000–2499	2882 (12.28)	299 801 (4.23)
2500–2999	2750 (11.72)	1 134 617 (16.02)
3000–3499	2438 (10.39)	2 669 786 (37.70)
3500–3999	1307 (5.57)	2 084 704 (29.44)
4000–4499	447 (1.90)	611 632 (8.64)
≥ 4500	356 (1.52)	108 852 (1.54)
Missing	352 (1.50)	757 (0.01)
Gestational status		
Multiple gestation	1637 (6.97)	207 994 (2.94)
Small-for-gestational-age	8446 (35.98)	630 504 (8.90)
Congenital anomalies groups		
Gastrointestinal	286 (1.22)	23 990 (0.34)
Genitourinary	151 (0.64)	24 054 (0.34)
Central nervous system	460 (1.96)	14 283 (0.20)
Pulmonary	151 (0.64)	18 827 (0.27)
Cardiac	380 (1.62)	30 765 (0.43)
Skeletal	343 (1.46)	12 510 (0.18)
Skin	741 (3.16)	10 776 (0.15)
Chromosomal	36 (0.15)	3791 (0.05)
Other	0 (0.00)	10 631 (0.15)

Note. All differences were statistically significant at the $P < .05$ level.

Potential Mediating Factors by Racial/Ethnic Group

Table 2 presents the prevalence of specific mediating factors by racial/ethnic group. For Black women, there was a higher rate of low birth weight and very low birth weight deliveries compared with other racial/ethnic groups. These lower birth weight categories had higher odds of fetal death compared with term delivery. Pregnancies of both Black and Asian women had higher rates of many antepartum and intrapartum complications of pregnancy, such as small-for-gestational-age status and chorioamnionitis. These complications tended to be associated with higher fetal death rates (Table 2). Black women also had a higher prevalence of placental disorders and pregnancy-induced hypertension, which were both associated with higher fetal death risk.

Regarding the socioeconomic factors, more Hispanic women had less than a high school education, later presentation for prenatal care, and higher use of public insurance than did non-Hispanic White women. Black women also had later presentation for prenatal care and higher use of public insurance than did non-Hispanic White women.

Sequential Model Analysis Results

To assess condition 3, we examined the association between each set of potential mediating factors and fetal death risk (Table 2). Of the socioeconomic factors, maternal age older than 35 years, public insurance and no insurance, and less than high school education were associated with higher fetal death risk. Most preexisting comorbid conditions and antepartum and intrapartum complications of pregnancy were also associated with different fetal death risk, with ORs as high as 5.14 for uterine rupture. The association between fetal death and both pregnancy-induced hypertension and chorioamnionitis differed between racial/ethnic groups, with larger associations for Black and Asian women for pregnancy-induced hypertension and Hispanic women for chorioamnionitis. Lower birth weight and small-for-gestational-age status were fetal factors associated with higher fetal death risk. These data support our third condition that the potential mediating factors are associated with fetal death risk.

Finally, Table 3 presents the percentage of the racial/ethnic disparity in fetal deaths mediated by each set of factors. For Black women, the OR for fetal death compared with non-Hispanic White women declined from 2.24 to 1.98 (95% CI = 1.81, 2.15) when socioeconomic factors were added to the model, 1.56 (95% CI = 1.42, 1.70) when antepartum and intrapartum complications were added, and 1.04 (95% CI = 0.95, 1.14) when fetal factors were added. The inclusion of delivery hospital did not further change the OR. As a result, fetal factors mediated the largest percentage (49.6%) of the extra fetal deaths attributable to Black race. Antepartum and intrapartum complications of pregnancy and socioeconomic factors mediated an additional 29.7% and 15.7%, respectively, of the extra fetal deaths.

Asian women showed a pattern of mediation similar to that of Black women. The OR decreased from 1.18 to 1.11 (95% CI = 1.03, 1.20) when socioeconomic factors were added and became statistically nonsignificant when antepartum and intrapartum complications were included. Thus, unlike Black women, antepartum and intrapartum complications of pregnancy mediated the largest percentage of extra deaths (62.2%), followed by socioeconomic factors (37.8%).

Unlike the other 2 minority racial/ethnic groups, only the addition of 1 set of factors, socioeconomic status, changed the OR for Hispanic women compared with non-Hispanic White women (OR 1.23; 95% CI = 1.14, 1.30). This reduction resulted in socioeconomic factors mediating 35.8% of the fetal death disparity in Hispanic women. Hispanic ethnicity had the largest percentage of fetal deaths not mediated by 1 of the 5 sets of factors of the 3 minority racial/ethnic groups examined. Inclusion of delivery hospital further reduced the OR for fetal death in Hispanic women to 1.05 (95% CI = 1.03, 1.08).

TABLE 2—AORs by Selected Characteristics With Distribution of Characteristics: Racial/Ethnic Differences in Fetal Death, California, Missouri, Pennsylvania, 1993–2005

Characteristic	Fetal Death, AOR (95% CI)	White (n = 3 267 285), %	Black (n = 541 400), %	Hispanic (n = 2 461 374), %	Asian (n = 531 164), %
Socioeconomic factors					
Maternal age, y					
< 18	0.97 (0.90, 1.03)	2.43	7.31	5.59	1.45
18–35	1.00 (Ref)	83.54	84.13	86.28	81.42
> 35	1.61 (1.55, 1.67)	14.03	8.56	8.12	17.13
Insurance status					
Fee for service	1.00 (Ref)	16.00	5.53	2.65	4.83
Health maintenance organization	1.08 (0.98, 1.19)	53.63	31.93	29.66	65.91
Public	1.31 (1.19, 1.45)	23.95	54.57	63.52	24.34
Other	0.95 (0.80, 1.13)	4.13	5.71	0.63	1.11
Uninsured	2.02 (1.78, 2.30)	2.11	2.05	3.50	3.78
Missing	1.31 (0.90, 1.89)	0.19	0.21	0.04	0.04
Trimester of first prenatal care visit, mo					
0–3	1.00 (Ref)	87.61	75.57	79.74	85.64
4–6	1.18 (1.11, 1.25)	8.57	15.97	15.26	10.76
7–9	1.15 (1.02, 1.28)	1.54	3.11	3.17	2.00
Missing	1.98 (1.60, 2.45)	2.28	5.35	1.83	1.60
Education					
< high school	1.06 (1.01, 1.11)	11.06	21.64	51.68	11.85
≥ high school	1.00 (Ref)	87.68	75.71	46.56	86.20
Missing	3.83 (2.99, 4.89)	1.26	2.66	1.76	1.95
Preexisting comorbid conditions					
Gestational diabetes	0.88 (0.82, 0.94)	3.42	3.14	4.49	6.78
Diabetes mellitus	3.17 (2.85, 3.53)	0.55	0.90	0.81	0.62
Chronic hypertension	2.20 (1.99, 2.43)	0.72	1.51	0.37	0.53
Renal disease	2.51 (1.92, 3.28)	0.12	0.14	0.08	0.08
Antepartum and intrapartum complications					
Chorioamnionitis		2.90	4.01	2.94	4.64
White women	3.63 (3.37, 3.90)				
Black women	3.48 (3.11, 3.89)				
Hispanic women	4.07 (3.79, 4.36)				
Asian women	3.20 (2.74, 3.74)				
Cord abnormalities	2.88 (2.68, 3.10)	3.35	2.73	3.52	4.08
Cord prolapse	2.87 (2.47, 3.33)	0.38	0.43	0.32	0.30
Disorders of placentation	3.39 (2.34, 4.91)	1.54	2.03	1.26	1.91
Eclampsia	2.02 (1.54, 2.65)	0.07	0.15	0.11	0.05
Oligohydramnios	1.17 (1.07, 1.28)	2.09	3.23	2.66	2.05
Placenta abruption	2.68 (1.85, 3.87)	1.02	1.48	0.81	0.99
Placenta previa	0.57 (0.41, 0.80)	0.56	0.59	0.47	0.95
Pregnancy-induced hypertension		3.09	4.44	2.92	2.17
White women	1.08 (0.98, 1.19)				
Black women	1.43 (1.26, 1.61)				
Hispanic women	0.99 (0.89, 1.09)				
Asian women	1.16 (0.92, 1.46)				

Continued

TABLE 2—*Continued*

Premature rupture of membranes	0.60 (0.56, 0.65)	5.52	6.09	4.12	5.53
Preterm labor	1.94 (1.76, 2.13)	6.84	10.28	5.91	6.14
Shock	2.03 (1.60, 2.57)	0.11	0.13	0.08	0.13
Thrombosis	1.75 (1.30, 2.36)	0.11	0.12	0.06	0.04
Uterine rupture	5.14 (4.18, 6.32)	0.08	0.10	0.07	0.07
		Fetal characteristics			
Birth weight categories, g					
400–999	1963.00 (1710.00, 2254.00)	0.47	1.32	0.48	0.40
1000–1499	579.00 (505.00, 663.00)	0.63	1.37	0.56	0.54
1500–1999	195.40 (171.10, 223.10)	1.34	2.65	1.14	1.25
2000–2499	27.20 (24.10, 30.70)	4.06	7.55	3.65	4.62
2500–2999	3.68 (3.30, 4.10)	14.27	22.57	15.52	21.61
3000–3499	1.17 (1.05, 1.30)	35.89	37.33	38.88	42.60
3500–3999	0.81 (0.72, 0.90)	31.51	21.22	29.83	23.22
4000–4499	1.00 (Ref)	10.01	5.06	8.41	4.99
≥ 4500	5.04 (4.36, 5.84)	1.80	0.87	1.52	0.77
Missing	1129.00 (519.00, 2451.00)	0.02	0.06	0.00	0.01
Gestational status					
Multiple gestation	0.59 (0.54, 0.64)	3.60	3.71	2.02	2.31
Small-for-gestational-age	4.85 (4.65, 5.06)	7.90	14.75	8.42	11.86

Note. AOR = adjusted odds ratio; CI = confidence interval. Odds ratios are adjusted for the factors that occurred previously. For example, the factors listed under preexisting comorbid conditions control for the factors listed under the socioeconomic factors heading.

DISCUSSION

Using data from more than 7 million births between 1993 and 2005, we found persistent, increased rates of fetal deaths in Black, Hispanic, and Asian women compared with non-Hispanic White women. However, this increase appears to be mediated by different factors between racial/ethnic groups. For Black women, deliveries that occur prematurely and deliveries with antepartum and intrapartum complications of pregnancy are the primary mediating factors for this increased risk in fetal death. These differences in fetal death risk may be manifestations of differences in social environment or differences in the underlying risk for antepartum and intrapartum complications of pregnancy or preterm birth. For Hispanics, though, socioeconomic factors are the primary factors associated with higher fetal death rates compared with non-Hispanic White women. Delivery hospital also appeared to confound this disparity because the OR for the association between Hispanic ethnicity and fetal death, compared with non-Hispanic White women, decreased by more than 60% after including delivery hospital in the analysis. Each of these factors met the 4 conditions for mediation set out by Baron and Kenny.[24] Because it may be difficult to achieve changes in many lifetime processes that may underpin differences in reproductive outcomes, these findings suggest that interventions targeted to specific mediating factors occurring during pregnancy may help reduce fetal death disparities in the United States.

Previous studies of the racial disparities in fetal death either describe the disparity[2–4] or focus on specific risk factors for fetal death across all racial/ethnic groups. In our study, in which we used a large, population-based cohort to identify mediating factors for racial/ethnic disparities frequently reported in fetal death rates, we used an approach to include risk factors in a temporal fashion to address important complex relationships between racial/ethnic group and more temporally distant sets of risk factors. Similar methods have been used in studies that examine complex, temporally related factors that mediate infant morbidity[15] and pediatric respiratory illness.[13]

Previous work suggests that social circumstances and behaviors underlie much of the disparity in fetal death risk.[31] This was

TABLE 3—The Impact of Potential Mediating Factors: Racial/Ethnic Differences in Fetal Death, California, Missouri, Pennsylvania, 1993–2005

Mediating Factor	Black, % (95% CI)	Hispanic, % (95% CI)	Asian, % (95% CI)
Socioeconomic factors	15.7 (10.6, 20.1)	35.8 (25.8, 46.2)	37.8 (13.3, 65.4)
Antepartum and intrapartum complications of pregnancy	29.7 (24.7, 34.7)	. . .	62.2 (62.2, 10.0)
Fetal factors	49.6 (42.7, 54.7)	. . .	. . .
Residual disparity	5.0	64.2	3.4

Note. CI = confidence interval. Maternal preexisting comorbid conditions did not mediate a statistically significant proportion of fetal death disparity for any racial/ethnic group. Ellipses indicate that the percentage of fetal death disparity mediated by set of factors is not statistically significant for specific racial/ethnic group.

supported by the fact that in all 3 minority racial/ethnic groups, socioeconomic factors mediated some percentage of the disparity. Antepartum and intrapartum complications of pregnancy played a larger mediating role in Black and Asian women than in other groups. Many of these factors are those identified in prior work as increasing a woman's risk of fetal death.[10–12] This effect could relate to differences in prevalence, or, as we saw with pregnancy-induced hypertension and chorioamnionitis, different associations with fetal death. One explanation of this observation is a difference in illness severity between racial/ethnic groups. Such differences in illness severity have been noted in nonpregnancy conditions such as prostate cancer presentation[32] and acute lung injury.[33] Among obstetric patients, studies suggest that the severity of pregnancy-induced hypertension is greatest in Black patients.[34–36] This difference in risk should be considered in the antepartum and intrapartum monitoring of women of different racial/ethnic groups.

Fetal factors, particularly differences in preterm delivery rates, mediated much of the disparity in fetal death rates for Blacks. The increased importance of preterm birth in Black women may result from our inability to measure other factors in a large population database that may be associated with poor pregnancy outcomes, such as exposure to stress and poverty during childhood. Although other factors mediate a smaller percentage of fetal death disparity in Black women compared with fetal factors, factors such as antepartum and intrapartum complications may be more amenable to intervention at the current time compared with different rates of preterm delivery.

Finally, our data suggest that the delivery hospital confounds much of the fetal death disparity between Hispanic and non-Hispanic White women. Because most women tend to deliver at a hospital near where they live,[23] this finding is another example of the impact that place has in explaining disparities in health outcomes.[37] Explanations for this finding include Hispanic patients' difficulty accessing adequate health care[38] and language barriers.[39,40] Delivery hospital does not play a similar role in Black patients, who also may suffer from poorer quality of outpatient care.[41–46] One possible reason for this finding is that, as with social circumstances and behaviors, the increased incidence of fetal deaths in Black women or a differential effect of various antepartum and intrapartum complications of pregnancy reduces the impact of delivery hospital environment on fetal death risk in Black women but not in Hispanic women. Alternatively, it is possible that Hispanic women preferentially attend poorer quality hospitals than do other racial/ethnic groups. However, because many fetal deaths even in later gestational ages occur before the woman goes to a hospital for delivery, the quality of hospital care may play a lesser role in explaining this finding than it does in other studies of racial/ethnic disparities in hospital care.

Limitations

Our study was unable to capture information on other environmental factors, such as the quality of antepartum obstetric care, which may explain the association between delivery hospital and higher rates of fetal death in Hispanic women. Additionally, we have no information on factors that occur years before the pregnancy, such as early childhood exposure to stress and poverty, which may explain some of the racial/ethnic differences in the role of antepartum and intrapartum complications and preterm birth on fetal death rates. Future longitudinal studies that include measurement of these important social factors of health are needed to quantify the importance of these factors.

We relied on *ICD-9-CM* codes to identify maternal preexisting comorbid conditions and maternal complication rates and birth weight estimates for fetal deaths. Although there are no studies to suggest a systematic bias in the reporting of these codes between different delivery hospitals, it is possible that coding or measurement differences could explain some of the differences between Hispanic women and non-Hispanic White women. States have different regulatory requirements for the reporting of fetal death, primarily in the gestational age or birth weight inclusion criteria.[20,21] We accounted for these differences by specifying a gestational age threshold in this study that was consistent for all 3 states. Finally, racial/ethnic group was the reported race/ethnicity of the mother on either the maternal hospital discharge record or the birth certificate, as with other population-based studies with similar data.[1]

Additionally, some of the groups of factors examined in this project may not be mediators of the racial/ethnic disparities in fetal death risk, but rather confounding factors. Both types of factors are associated with the outcome of interest—fetal death risk—and the primary predictor variable—racial/ethnic group. The difference between the 2 stems from the fact that mediating factors are part of the causal pathway, whereas confounding factors are not. This difference cannot be easily determined with statistical modeling[47] but rather through the examination of the conceptual framework that may explain racial/ethnic disparities in fetal death risk. In this study, the factors examined are likely to be part of the causal pathway, and thus mediating factors.

Finally, our study examined fetal deaths occurring in a specific gestational age—23 to 44 weeks—that differs from other studies. As a result, our fetal death rates were lower than were other reports. We have also reported results from 3 large, diverse states in the United States. Our data, then, may not be generalizable to populations in different areas of the United States or for fetal deaths that occur before 23 weeks gestation. However, the use of rigorous statistical techniques, including bootstrap analyses to obtain a likely CI for the mediation percentage across other populations outside these 3 states, improves the generalizability of our findings.

Conclusions

The factors that mediate racial/ethnic disparities in fetal death differ depending on the racial/ethnic group, suggesting that reducing high rates of extreme premature birth resulting from acute conditions of pregnancy and improving access to care are areas of focus for reducing US racial and ethnic disparities in fetal death. ■

About the Authors

Scott A. Lorch is with the Department of Pediatrics, Children's Hospital of Philadelphia and the University of Pennsylvania School of Medicine, Philadelphia. Charlan D. Kroelinger and Wanda D. Barfield are with the Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA. Corinne Ahlberg is

with the Center for Outcomes Research, Children's Hospital of Philadelphia.

Correspondence should be sent to Scott A. Lorch, MD, MSCE, The Children's Hospital of Philadelphia, Center for Outcomes Research, 3535 Market Street, Suite 1029, Philadelphia, PA 19104 (e-mail: lorch@e-mail.chop.edu). *Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.*

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Contributors

S. A. Lorch, C. D. Kroelinger, and W. D. Barfield conceptualized and designed the study and interpreted the data results. S. A. Lorch and C. Ahlberg participated in data collection and analysis. All authors participated in drafting and revising the article.

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Human Participant Protection

The institutional review boards of the California, Missouri, and Pennsylvania Departments of Health and the Children's Hospital of Philadelphia approved this study, whereas the institutional review board from the Centers for Disease Control and Prevention declared it exempt.

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