Maternal education and racial/ethnic disparities in nulliparous, term, singleton, vertex cesarean deliveries in the United States

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BACKGROUND: Racial and ethnic disparities in obstetrical and neonatal outcomes are prevalent in the United States. Such racial or ethnic disparities have also been documented in the prevalence of cesarean deliveries.

OBJECTIVE: We aimed to evaluate the impact of maternal education on racial or ethnic disparities in the prevalence of low-risk nulliparous, term, singleton, vertex cesarean deliveries in the United States.

STUDY DESIGN: This is a retrospective analysis of the Centers for Disease Control and Prevention live births database (2016—2019). Nulliparous, term, singleton, vertex births from the following racial/ethnic groups were included: non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, and Hispanic. Pregnancies complicated by gestational or pregestational diabetes mellitus and hypertensive disorders were excluded. Data were analyzed on the basis of the level of maternal education (less than high school graduate, high school graduate, college graduate, and advanced degree). We compared the prevalence of cesarean deliveries among the different racial or ethnic groups within each education level using Pearson chi-square test with Bonferroni adjustment. Multivariate logistic regression was performed to assess the association between cesarean deliveries and maternal race/ethnicity, maternal education, and the interaction between maternal race or ethnicity and education level, while controlling for potential confounders. To demonstrate the effect of the interaction, separate logistic regression models with similar covariates were performed for each education level and for each race/ethnicity group. Statistical significance was determined as $P<.05$, and results were displayed as adjusted odds ratios with 95% confidence intervals.

RESULTS: The overall prevalence of cesarean deliveries during the study period was 23.4% (695,214 of 2,969,207 births). All racial or ethnic minority groups had higher rates of cesarean deliveries than non-Hispanic White women (non-Hispanic Black, 27.4%; non-Hispanic Asian, 25.6%; Hispanic, 23.0%; and non-Hispanic White, 22.4%; [$P<.001$ for all comparisons]). Similar racial or ethnic differences in cesarean delivery rates were detected among all education levels. Higher levels of education were associated with a lower likelihood of cesarean delivery (adjusted odds ratio, 0.88; [95% confidence interval, 0.87—0.89]) in women with advanced degrees than in women who did not graduate from high school. However, although maternal education was associated with a protective effect in non-Hispanic White and non-Hispanic Asian women (adjusted odds ratio, 0.83 [95% confidence interval, 0.81—0.85] and adjusted odds ratio, 0.81 [95% confidence interval, 0.77—0.86], respectively, for women with advanced degrees), it had a smaller protective effect in non-Hispanic Black women (adjusted odds ratio, 0.93 [95% confidence interval, 0.89—0.97]) and no protective effect in Hispanic women (adjusted odds ratio, 0.98 [95% confidence interval, 0.96—1.01]).

CONCLUSION: We document a significant racial/ethnic disparity in the prevalence of low-risk nulliparous, term, singleton, vertex cesarean deliveries in the United States. Furthermore, our findings suggest that although a higher level of maternal education is associated with a lower likelihood of cesarean delivery, this protective effect varies among racial or ethnic groups. Further research is needed to investigate the underlying causes for this racial/ethnic disparity.

Key words: cesarean delivery, delivery method, education level, ethnic disparity, ethnicity, nulliparous-term-singleton-vertex, race, racial disparity

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Why was this study conducted?
Racial and ethnic disparities in cesarean delivery rates are prevalent in the United States. Efforts to identify factors associated with these disparities are of great importance.

Key findings
Racial and ethnic disparities in cesarean delivery rates for low-risk nulliparous, term, singleton, vertex pregnancies in the United States were present from 2016 to 2019.
Higher levels of maternal education are associated with a lower likelihood of cesarean delivery.
The impact of education on cesarean delivery rates varies among racial or ethnic groups, with a lower protective effect for non-Hispanic Black women and no protective effect for Hispanic women.

What does this add to what is known?
The racial or ethnic disparity in the prevalence of cesarean deliveries increases with higher levels of maternal education.

Introduction

Cesarean deliveries (CDs) comprise a significant portion of deliveries in the United States and worldwide, reaching unacceptably high rates.[1–10] When indicated, CDs may prevent maternal and neonatal morbidity and mortality.[1,2] However, CDs are also associated with a significant risk of maternal morbidity and mortality.[1,2,11–17] Higher rates of placenta accreta spectrum disorders further complicate pregnancies following a CD.[18–21] Given these associated risks and the low prevalence of vaginal births after CD,[22] increased efforts have been made to reduce primary CD rates, particularly in nulliparous, term, singleton, vertex (NTSV) pregnancies.[1,23–25]

Racial and ethnic disparities have been documented in a range of adverse obstetrical outcomes, such as postpartum hemorrhage, preterm birth, low birthweight, maternal mortality, and neonatal mortality,[26–39] and in numerous maternal risk factors, such as obesity, diabetes mellitus, and hypertension.[40–43] Disparities in CDs have also been reported, with the highest rates found in non-Hispanic Black women.[36,44–46] In 2018, for example, the prevalence of CDs in NTSV births was 24.9% for non-Hispanic White, 30.3% for non-Hispanic Black, 27.6% for non-Hispanic Asian, and 25.4% for Hispanic women.[47] The exact reasons for these disparities are unknown, but multiple theories have been suggested. Several explanations have focused on racial and ethnic differences in clinical parameters, such as the preconception maternal health, age at delivery, body mass index (BMI), and biological factors, whereas others have focused on differences in nonclinical parameters, such as patient and provider characteristics, institutional policies, chronic stress, time of delivery, type of medical insurance, access to care, socioeconomic status, and institutionalized racism.[26,48–52]

Identifying racial and ethnic disparities, and effective strategies to eliminate them, continues to be important.[36] In this study, we explored the association between maternal education and racial/ethnic disparities in the prevalence of low-risk NTSV CDs. Education is an important social determinant of health, both in and of itself[53] and as a component of socioeconomic status,[54] and higher education levels are generally correlated with better healthcare outcomes.[55] Therefore, data on this relationship can potentially shed light on the root causes of this important healthcare disparity.

Materials and Methods

This was a retrospective cohort study using the United States Department of Health and Human Services (US DHHS), Centers for Disease Control and Prevention (CDC), and National Center for Health Statistics (NCHS), Division of Vital Statistics natality database for the years 2016 to 2019. The database includes data (which are derived from birth certificates) on all live births among US residents.[56]

Our study included women from the following racial/ethnic groups: non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, and Hispanic women (including all women of Hispanic ethnicity, regardless of race). Information on race and ethnicity is self-reported and multiracial/ethnic individuals were excluded. All nulliparous, term (defined as a birth between 37 and 42 weeks of gestation), singleton, vertex births were eligible for inclusion. Deliveries with the following high-risk conditions (chosen on the basis of data availability) were excluded: pregestational diabetes mellitus, gestational diabetes mellitus, chronic hypertension, and hypertensive disorders of pregnancy (including gestational hypertension, preeclampsia, and eclampsia). Observations with incomplete records were also excluded.

Maternal education level was categorized into 4 groups: less than high school graduate, high school graduate (including women with some college credits but not a degree), college graduate (including bachelor's and associate degrees), and advanced degree (including master's, doctoral, and professional degrees). We compared the total prevalence of NTSV CDs among the 4 racial/ethnic groups and among the education level groups within the different racial/ethnic groups, using Pearson chi-square test with the Bonferroni adjustment for multiple comparisons. Statistical significance was set at P value <.05. Multivariate logistic regression models were used to assess the association between CDs and maternal race/ethnicity, maternal education, and the interaction between maternal race/ethnicity and education level, while controlling for the following potential confounders: maternal age (defined as the actual age in years), maternal prepregnancy BMI (using the following groups: <18.5, 18.5–24.9, 25–29.9, 30–34.9, 35–39.9, and ≥40 kg/m^2),

maternal weight gain during pregnancy (in kg), type of medical insurance (Medicaid, private insurance or self-pay), and neonatal birthweight (using the following groups: <2500, 2500−2999, 3000−3499, 3500−3999, 4000−4499 and ≥4500 g). To demonstrate the effect of the interaction, separate logistic regression models with similar covariates were performed for each education level and for each race/ethnicity group. Results were displayed as adjusted odds ratios (aOR) and 95% confidence intervals (95% CI), with non-Hispanic White women representing the racial/ethnic reference group and an education level of less than high school graduate representing the education level reference group.

Institutional review board approval and informed consent were not required as the deidentified data are publicly available through a data use agreement with the NCHS.[57]

Results

Between 2016 and 2019, 14,751,954 live births occurred in the studied racial/ethnic groups. After applying our exclusion criteria, 2,969,207 live births comprised the study cohort and were further analyzed. Of those, 1,651,252 (55.6%) were non-Hispanic White, 375,489 (12.6%) were non-Hispanic Black, 246,839 (8.3%) were non-Hispanic Asian, and 695,627 (23.4%) were Hispanic women. Information regarding baseline characteristics for the included racial/ethnic groups is displayed in Table 1.

The overall NTSV-CD rate in our sample was 23.4% (695,214). All racial/ethnic minority groups had higher rates of CDs than non-Hispanic White women (non-Hispanic Black 27.4%, non-Hispanic Asian 25.6%, Hispanic 23.0%, and non-Hispanic White 22.4% [P<.001 for all comparisons]).

The prevalence of CDs in each racial/ethnic group, stratified by education level, is presented in Table 2. Within each education level, women in all racial/ethnic minority groups had a significantly higher CD rate than non-Hispanic White women (P<.001) (Table 2). In these unadjusted comparisons, the

difference in CD rates between non-Hispanic Black and non-Hispanic White women increased with higher levels of education, from 3.7% for women with less than a high school education to 12.7% for women with an advanced degree (Table 2).

In a logistic regression analysis controlling for potential confounders, both maternal race/ethnicity and maternal education were associated with a significant risk of a CD (Table 3). All of the racial/ethnic minority groups had an increased likelihood of a CD compared with non-Hispanic White women (aORs of 1.24, 1.45, and 1.54 for Hispanic, non-Hispanic Asian, and non-Hispanic Black women, respectively) (Table 3). In addition, higher education levels were associated with a small but significant protective effect in lowering the likelihood of a CD (aOR of 0.88 for women with an advanced degree) (Table 3).

However, the addition of an interaction term between maternal race and ethnicity and maternal education demonstrated a significant interaction (P<.001) (Figures 1 and 2). The results of the logistic regression models examining the association between race and ethnicity and CD rates for each education level are displayed in Figure 1. The figure illustrates that all racial/ethnic minority groups had a higher likelihood of a CD than non-Hispanic White women of any education level. In addition, for all racial/ethnic minority groups, the adjusted odds ratios (compared with non-Hispanic White women) increased with higher levels of education.

The results of the logistic regression models examining the association between maternal education and CD rates for each racial/ethnic group are displayed in Figure 2. The likelihood of having a CD decreased as the level of education increased in all racial/ethnic groups except Hispanic women. This protective effect of education was greatest for non-Hispanic White and non-Hispanic Asian women (aOR, 0.83 [95% CI, 0.81 −0.85] and aOR, 0.81 [95% CI, 0.77 −0.86], respectively, for women with

advanced degrees). Non-Hispanic Black women with an advanced degree had a lower likelihood of a CD (aOR, 0.93 [95% CI, 0.89−0.97]), whereas no significant difference in CD rates between high school and college graduates and non-high school graduates was found in this racial/ethnic group. Hispanic women with high school and college degrees had a slightly increased likelihood of a CD (aOR, 1.04 [95% CI, 1.02−1.06] and aOR, 1.03 [95% CI, 1.01−1.05], respectively) compared with non-high school graduates in this ethnic group.

Discussion
Principal findings
The results of our study illustrate several important findings. First, we detected a marked racial/ethnic disparity in the prevalence of low-risk NTSV CDs in the United States during the recent period of 2016 to 2019. Non-Hispanic Black, Non-Hispanic Asian, and Hispanic women had higher CD rates than non-Hispanic White women. Second, as expected, higher education levels appeared to have a protective effect, and were associated with a lower likelihood of a CD. Lastly, our findings demonstrated that maternal race or ethnicity had a significant impact on the association between maternal education and CDs. Specifically, higher education levels were associated with the greatest reduction in CD rates in non-Hispanic White and non-Hispanic Asian women, only a slight reduction in non-Hispanic Black women, and slightly increased but not clinically significant reduction in CD rates in Hispanic women. Therefore, the racial or ethnic disparity in the prevalence of CDs was found to be greater in women with higher education levels.

Results
Previous studies have also documented a significant racial/ethnic disparity in the prevalence of CDs in the United States.[58−61] For example, Tangel et al[58] reviewed a sample of delivery records from California, Florida, New York, Maryland, and Kentucky between 2007

TABLE 1
Maternal characteristics within each racial or ethnic group

Characteristic	Non-Hispanic White (n=1,651,252)	Non-Hispanic Black (n=375,489)	Non-Hispanic Asian (n=246,839)	Hispanic (n=695,627)
Maternal age, y, mean (SD)	27.1 (5.5)	24.1 (5.5)	29.9 (4.6)	24.3 (5.6)
BMI, kg/m^2 n (%)				
Underweight (<18.5)	65,566 (4.0)	17,920 (4.8)	24,735 (10.0)	28,559 (4.1)
Normal (18.5−24.9)	879,262 (53.3)	158,567 (42.2)	165,285 (67.0)	328,985 (47.3)
Overweight (25−29.9)	398,496 (24.1)	97,140 (25.9)	43,434 (17.6)	191,483 (27.5)
Obesity class 1 (30−34.9)	179,446 (10.9)	54,259 (14.5)	10,652 (4.3)	91,494 (13.2)
Obesity class 2 (35−39.9)	80,831 (4.9)	27,235 (7.3)	2,186 (0.9)	36,495 (5.3)
Obesity class 3 (≥40)	47,651 (2.9)	20,368 (5.4)	547 (0.2)	18,611 (2.7)
Weight gain during pregnancy, pounds, mean (SD)	33.3 (14.4)	30.8 (16.2)	29.8 (11.6)	30.3 (14.3)
Insurance status, n (%)				
Medicaid	432,010 (26.2)	240,767 (64.1)	49,872 (20.2)	400,388 (57.6)
Private	1,177,421 (71.3)	122,184 (32.5)	178,533 (72.3)	243,667 (35.0)
Uninsured / Self-Pay	41,821 (2.5)	12,538 (3.3)	18,434 (7.5)	51,572 (7.4)
Birthweight (g), n (%)				
<2500	36,905 (2.2)	21,092 (5.6)	9711 (3.9)	19,919 (2.9)
2500≥2999	251,208 (15.2)	102,843 (27.4)	64,023 (25.9)	139,221 (20.0)
3000−3499	702,640 (42.6)	165,801 (44.7)	113,942 (46.2)	316,879 (45.55)
3500−3999	518,965 (31.4)	72,100 (19.2)	50,307 (20.4)	180,154 (25.9)
4000−4499	125,715 (7.6)	12,224 (3.3)	8078 (3.3)	35,344 (5.1)
≥4500	15,819 (1.0)	1429 (0.4)	778 (0.3)	4110 (0.6)
Induction of labor	553,935 (33.6)	112,044 (29.8)	61,495 (24.9)	184,824 (26.6)
Augmentation of labor	498,782 (30.2)	103,007 (27.4)	82,341 (33.4)	209,405 (30.1)
Congenital abnormalities	4932 (0.3)	710 (0.2)	362 (0.2)	1385 (0.2)

BMI, body mass index; *SD*, standard deviation.

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TABLE 2

The prevalence of low-risk nulliparous, term, singleton, vertex cesarean deliveries by maternal education and racial or ethnic group

Variables	Non-Hispanic White	Non-Hispanic Black	Non-Hispanic Asian	Hispanic	Total
Less than high school	17.2% (18,217/105,733)	20.9%[a] (11,000/52,606)	23.1%[a] (2189/9475)	17.9%[a] (25,212/140,979)	308,793
High school graduate	22.0% (135,089/614,667)	26.3%[a] (59,161/225,060)	23.6%[a] (10,677/45,347)	22.5%[a] (85,842/381,039)	1,266,113
College graduate	23.0% (145,628/633,158)	32.5%[a] (23,561/72,614)	26.3%[a] (28,001/106,491)	27.7%[a] (37,727/136,399)	948,662
Advanced degree	23.6% (70,204/297,694)	36.3%[a] (9142/25,209)	26.1%[a] (22,349/85,526)	30.1%[a] (11,215/37,210)	445,639
Total	1,651,252	375,489	246,839	695,627	2,969,207

[a] Difference from non-Hispanic Whites with the same education level statistically significant with $P<.001$.

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TABLE 3

The impact of maternal race or ethnicity and education on the risk of cesarean delivery in low-risk nulliparous, term, singleton, vertex pregnancies

Risk factors	Adjusted odds ratio	95% confidence interval
Racial/ethnic group		
Non-Hispanic White	1.00	Reference
Non-Hispanic Black	1.54	1.53−1.56
Non-Hispanic Asian	1.45	1.43−1.46
Hispanic	1.24	1.23−1.25
Maternal Education		
Less than high school graduate	1.00	Reference
High school graduate	1.01	1.00−1.02
College graduate	0.93	0.92−0.94
Advanced degree	0.88	0.87−0.89

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and 2014, and reported that Black and Hispanic women were more likely to have undergone a CD than White women (aOR, 1.12 [95% CI, 1.12−1.13] and aOR, 1.23 [95% CI, 1.22−1.23], respectively). Similarly, an earlier study using a 1993−1995 sample of 21 hospitals in Ohio reported that non-White women were more likely than White women to have a primary CD (aOR, 1.34 [95% CI, 1.14−1.57]).[59] After stratifying their data on the basis of the predicted risk of a CD, the racial disparity between White and non-White women was significantly higher for those with the lowest predicted risk and nonexistent for those with the highest predicted risk. The authors suggested that the

most prominent differences between White and non-White women were seen in low-risk pregnancies.[59] A subsequent study focusing on low-risk NTSV births at a single US center reported that non-Hispanic Black and Asian women (but not Hispanic women) had a higher likelihood of CD than non-Hispanic White women.[46] Our analysis, which also focuses on low-risk NTSV pregnancies, is consistent with these findings, illustrating that the racial/ethnic disparity in CD rates extends to the entire US population and to the present time. In addition, although previous studies were consistent in documenting the racial gap in CD rates between non-Hispanic Black and non-Hispanic

White women, data on other racial or ethnic minority groups have been inconsistent.[46,60] On the basis of an evaluation of all US live births, we expand previous knowledge and show that the racial or ethnic disparity in the prevalence of NTSV CDs exists in other minority groups, and report the magnitude of this disparity in each group.

Education is an important social determinant of health that is generally considered to be a mitigating factor for adverse pregnancy outcomes.[55,61−64] For example, women with higher levels of education have a lower prevalence of preterm birth, stillbirth, small-for-gestational-age newborns, and pregnancy-related mortality.[55,64] Indeed, whereas

The association between maternal race and ethnicity and low-risk NTSV cesarean deliveries by level of maternal education
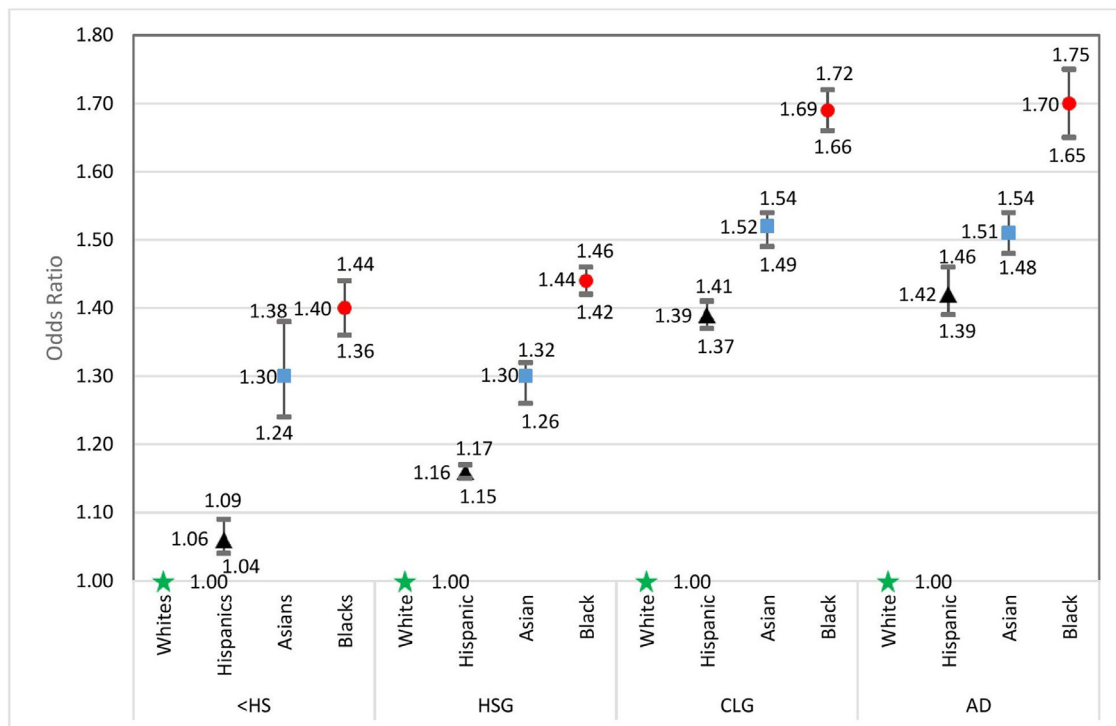
The figure displays the results of 4 logistic regression models estimating the association between race and ethnicity and low-risk NTSV CDs separately for each level of maternal education. The results are displayed as adjusted odds ratios with 95% confidence intervals. *Green star* represents non-Hispanic Whites (reference), *black triangle* represents Hispanics, *blue square* represents non-Hispanic Asians, and *red circle* represents non-Hispanic Blacks.

AD, advanced degree; *CD*, cesarean delivery; *CLG*, college graduate; *<HS*, less than high school graduate; *HSG*, high school graduate; *NTSV*, nulliparous, term, singleton, vertex.

Eliner. Maternal education and racial or ethnic disparities in cesarean delivery rates. Am J Obstet Gynecol Glob Rep 2022.

our unadjusted analysis demonstrated that women with higher levels of education, especially non-Hispanic Black women with advanced degrees, had higher rates of CDs (Table 2), our adjusted analysis showed that higher levels of education were associated with a protective effect, reducing the likelihood of a CD (Table 3). The difference between our adjusted and unadjusted results may primarily be attributed to maternal age. Women with higher levels of education are generally older, and advanced maternal age is a significant risk factor for CD. In our unadjusted analysis, the effect of age seems to be especially prominent for non-Hispanic Black women, given that Black women with advanced degrees have the highest rates of NTSV CDs. This finding may

be explained by the increased prevalence of uterine fibroids in both non-Hispanic Black women[65] and older gravidas,[66] given that uterine fibroids are known to be associated with an increased rate of CDs.[67] In addition, higher rates of obesity among non-Hispanic Black women may also contribute to higher CD rates in this population.[68]

Of interest, for all minority groups, we also found that the difference in the prevalence of CDs relative to non-Hispanic White women increased with higher levels of education, suggesting that the racial or ethnic disparities in CD rates are highest in those who are most educated (Figure 1). These puzzling results may be explained by the differential effects of education among the different racial or ethnic groups. Although

higher education levels had a greater protective effect in non-Hispanic White and non-Hispanic Asian women, they had a relatively small protective effect in non-Hispanic Black women. Interestingly, in Hispanic women, the impact of education was either reversed but of minimal clinical significance or statistically insignificant (Figure 2). This suggests that the impact of maternal education as a protective factor for CDs is dependent on race and/or ethnicity.

Using the 2006 CDC natality files, Roth and Henley[60] also attempted to explore the interaction between maternal race and ethnicity and education with respect to CDs. With a focus on all primary CDs, they reported racial or ethnic differences in the effect of education on the likelihood of a CD. Non-

FIGURE 2
The association between maternal education and low-risk NTSV cesarean deliveries by maternal race or ethnicity
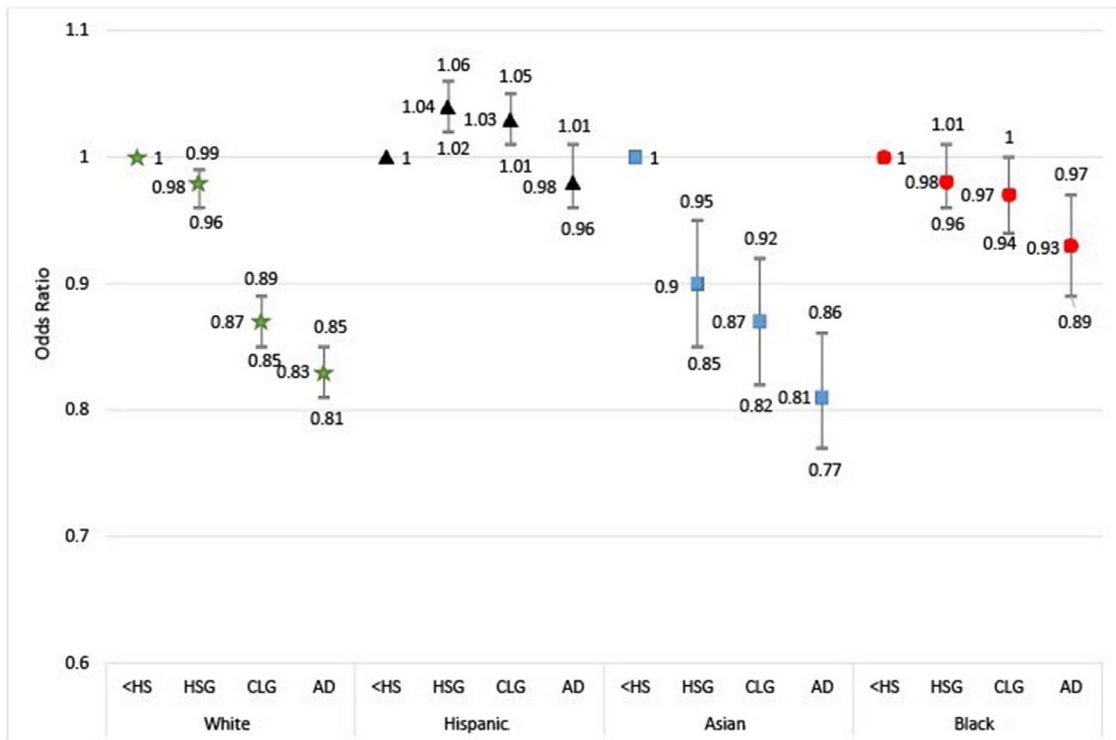
The figure displays the results of 4 logistic regression models estimating the association between the level of maternal education and low-risk NTSV CDs separately for each maternal racial or ethnic group. The results are displayed as adjusted odds ratios with 95% confidence intervals. *Green star* represents non-Hispanic Whites (reference), *black triangle* represents Hispanics, *blue square* represents non-Hispanic Asians, and *red circle* represents non-Hispanic Blacks.

AD, advanced degree; *CD*, cesarean delivery; *CLG*, college graduate; *<HS*, less than high school graduate; *HSG*, high school graduate; *NTSV*, nulliparous, term, singleton, vertex.

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Hispanic White women were found to have the greatest protective effect. This may imply that despite trends of increasing educational attainment among racial or ethnic minorities in the United States,[69] the racial or ethnic disparity in the effect of education on rates of CD is still present.

Clinical implications
Our results indicate that education may be effective in reducing the prevalence of NTSV CDs, pointing to the importance of education as a social determinant of health. However, our results further show that the protective effect of education is dependent on race/ethnicity. Previous studies have reported a greater protective effect of maternal education on infant mortality for White than for Black women.[62,63] This was also

observed for overall self-rated health,[70] suggesting that a similar differential effect might potentially be extended to other adverse obstetrical outcomes.

Several hypotheses may explain our findings. Education is a common and widely used proxy for socioeconomic status and is highly correlated with income.[54] However, although income has been shown to increase with higher levels of education, the magnitude of the increase varies by race and ethnicity.[70,71] Such variation may have contributed to our findings. Nonetheless, Tangel et al[58] stratified their analyses by median income and by type of insurance, and did not find these socioeconomic variables to have an impact on the racial/ethnic disparity in CD rates. Although we also controlled for types of medical insurance in our analyses, we did not have data on income.

Emotional stress may have also been an important factor contributing to these results. A growing body of literature has recently focused on the physiological and psychological impact of racism as a source of chronic stress among racial or ethnic minorities, and especially among non-Hispanic Black women. The impact of racism as a chronic stressor and its association with adverse obstetrical and prenatal outcomes is an emerging theme in health disparity research and is yet to be fully understood. Nonetheless, there is some evidence suggesting that racial and ethnic minorities with higher levels of education suffer from higher levels of stress.[70,72]

In addition, racial or ethnic differences in healthcare practices may also increase with higher levels of education.[64] For example, institutional racism,

and interpersonal (and potentially implicit) bias of healthcare providers, may impact practices toward different racial/ethnic groups.[73] Such biases may have a greater effect on the quality of care for more educated racial/ethnic minorities than for their less educated counterparts.[64,74] In the last few years, several prominent Black women have discussed their pregnancy-related complications with a consistent sentiment of "doctors not listening" as an indication that despite education and socioeconomic status, Black women are still subject to provider bias, which can contribute to poor outcomes.[75]

Finally, formal education may not directly correlate to health literacy. Advanced education may also bring a greater awareness of the historic perspectives of healthcare with respect to racial/ethnic minorities in the United States.[70] Thus, it may be suggested that less educated women from any race or ethnicity may lack the health literacy and self-advocacy to discuss their labor course and potential need for a CD, and that educated non-Hispanic White women may be more advocacy-confident than educated women from racial/ethnic minorities.[76] For many women, pregnancy is their first experience with the medical establishment. Given the historic and current disparities in the healthcare system, women from racial or ethnic minorities may potentially be guarded in their interaction with medical professionals, with a reduced trust in the healthcare system, and may thus not feel empowered to advocate for themselves in this setting. The inability to self-advocate may further be exacerbated for Hispanic women in cases in which the woman or her family has a language barrier.

These potential explanations largely suggest that social and cultural differences may cause education to have different effects on the likelihood of NTSV CDs among different racial and ethnic groups. In recent years, there has been an increased focus on the view that race and ethnicity are social constructs that reflect social and cultural differences between distinct groups of people, rather than biological and genetic differences.[77]

To that effect, our findings may provide evidence in support of the notion of race and ethnicity as social constructs.

Research implications

Further research is required to understand the underlying causes behind the differential effects of education for different racial/ethnic groups. In addition, and possibly more importantly, future research on potential interventions to reduce nonmedically indicated CDs, such as medical professional bias training or standardized and accessible prenatal education, should take into account not only the significant racial/ethnic disparity in the prevalence of low-risk NTSV CDs, but also the disparity in the impact of maternal education.

Strengths and limitations

Our study has several strengths. It relies on 1 of the largest and most comprehensive databases in the United States, representing the entire population of US live births, and is therefore not limited to the characteristics of a specific institution, community, or region. Furthermore, because the database includes data on maternal risk factors, we could exclude pregnancies with gestational and pregestational diabetes mellitus, chronic hypertension, and other hypertensive disorders of pregnancy, and focus on low-risk NTSV CDs, which are of interest in the prevention of primary CDs. Finally, this robust dataset also allowed us to control for several meaningful confounding factors that may significantly affect the relationship between race and ethnicity, education, and CDs, such as maternal BMI and insurance type.

Our study also has several limitations. As the data are derived from birth certificates, the quality of the data is highly dependent on the training and diligence of the hospital staff that completes these certificates, and might vary across institutions or even among different members of the same institution, potentially leading to inaccurate estimations. In addition, the retrospective nature of the data limits the statistical analysis to the information available in the database, which does not include data regarding the physician's race and/or ethnicity, which may be a

confounder, or any measure of income; thus, our analysis cannot accurately control for socioeconomic status. More importantly, the database does not include an assessment of the patient's labor course and management, the obstetrician's input in performing a CD, and data on all of the known indications for a CD. Although we could account for many risk factors and indications for a CD in our analyses, we could not account for all of the indications. When such indications or risk factors vary by race/ethnicity, they have the potential to confound the results. For example, the database does not include information on the presence of uterine leiomyomas, which are more prevalent among Black women.[65,78] Similarly, data on the location of the placenta or the presence of placenta previa, which has been found to be more common in Black and Asian women,[79,80] are not available in the database. Finally, the database does not contain information regarding the pelvic shape and size, which may also vary among women from different racial and ethnic groups,[81,82] potentially influencing our results.

Conclusions

A racial or ethnic disparity exists in the prevalence of low-risk NTSV CDs in the United States, with women in racial/ethnic minority groups having higher rates than non-Hispanic White women. Furthermore, our findings suggest that although a higher maternal education level is associated with a lower likelihood of CD, this protective effect varies among racial or ethnic groups. Specifically, education has a larger protective effect for non-Hispanic White and non-Hispanic Asian women than for non-Hispanic Black women, and no protective effect for Hispanic women. Consequently, the racial or ethnic disparity in the prevalence of CDs is largest in women with higher education levels. ∎

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