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Anthony M. Vintzileos MD

Cande V. Ananth PhD, MPH

John C. Smulian MD, MPH  
*Lehigh Valley Health Network*, [john.smulian@lvhn.org](mailto:john.smulian@lvhn.org)

William E. Scorza MD  
[William\\_E.Scorza@lvhn.org](mailto:William_E.Scorza@lvhn.org)

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# The impact of prenatal care on preterm births among twin gestations in the United States, 1989-2000

Anthony M. Vintzileos, MD,<sup>a</sup> Cande V. Ananth, PhD, MPH,<sup>b</sup> John C. Smulian, MD, MPH,<sup>a</sup> and William E. Scorza, MD<sup>a</sup>

New Brunswick, NJ

**OBJECTIVE:** The purpose of this study was to determine the association between prenatal care and preterm births among twin gestations in the presence and absence of high-risk pregnancy conditions.

**STUDY DESIGN:** Twin birth data in the United States were used to determine the association between preterm birth and prenatal care with the use of logistic regression.

**RESULTS:** Of the 779,387 twin births, 54.7% twin births were delivered preterm. The rate was higher among black women than among white women in the presence (57.0% vs 51.2%, respectively) and absence (70.3% vs 61.6%, respectively) of prenatal care. The absence of prenatal care increased the relative risk for preterm birth by 1.24-fold among black women and by 1.22-fold among white women. Lack of prenatal care was associated with increased preterm birth rates in the presence of most high-risk conditions.

**CONCLUSION:** Prenatal care is associated with fewer twin preterm births in the presence and absence of high-risk conditions. Increased prenatal care participation may help decrease preterm birth rates and also narrow the black-white twin preterm birth disparity. (Am J Obstet Gynecol 2003;189:818-23.)

**Key words:** Prenatal care, twin, preterm birth, high-risk condition

In recent years, the widespread availability of and access to assisted reproductive technologies has resulted in an ever-increasing number of twin and higher-order multiple births.<sup>1</sup> Although the rate of twinning is only 2%, they account for up to 12% of all preterm births, 9.5% of fetal deaths, and 16% of all neonatal deaths.<sup>2</sup> Other risk factors for prematurity include lack of prenatal care and race, with black women more likely to be delivered preterm.<sup>3-6</sup> However, whether the extent of the black-white disparity in twin preterm birth is the direct result of lack of prenatal care, per se, or is the result of the high frequency of antenatal medical and obstetric high-risk conditions that are seen among those women with no prenatal care remains largely unknown.

The objective of this large, population-based retrospective cohort study was to determine whether the association between prenatal care and preterm birth rate among twins is different among black and white women. We

further evaluated the association between prenatal care and preterm birth rates among twin gestations in the United States in the presence and absence of antenatal high-risk conditions.

## Material and methods

Data for this study were derived from the United States natality data files for the years 1989 to 2000 and were assembled and provided by the National Center for Health Statistics of the Centers for Disease Control and Prevention.<sup>7</sup> Analyses were restricted to twin live births that occurred at  $\geq 20$  completed weeks of gestation. Gestational age in these data files was calculated as the interval between the date of the delivery and the date of the last menstrual period (LMP). The gestational ages were imputed from records that were missing the date of the LMP but that had the valid month and year of the LMP.<sup>8</sup> When the LMP date was missing or when the LMP-based gestational age was inconsistent with birth weight, a clinical estimate of gestational age, also contained on these data files, was used instead (in approximately 5% of records). The clinical estimate of gestation is based on the birth attendant's estimate of gestation, which was based usually on either the Dubowitz or the Ballard assessment of gestational age. These imputations and replacements of gestational age by clinical estimates were performed by the National Center for Health Statistics. All antenatal, medical, and obstetric high-risk conditions are recorded by the use of a check-box format on birth certificates that indicated the presence or absence of the condition.<sup>9</sup>

*From the Division of Maternal-Fetal Medicine, Department of Obstetrics, Gynecology, and Reproductive Sciences,<sup>a</sup> and the Section of Epidemiology and Biostatistics,<sup>b</sup> University of Medicine and Dentistry of New Jersey, Robert Wood Johnson Medical School/Robert Wood Johnson University Hospital.*

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Infants with congenital or chromosomal anomalies, missing data on gestational age or gestational age of <20 weeks, birth weight of <500 g, and missing data regarding the presence or absence of prenatal care or maternal race were excluded from the analysis.

Prenatal care was considered present if there was at least one prenatal visit during the course of the pregnancy. Preterm and very preterm birth were defined as delivery at <37 and <32 weeks' gestation, respectively. The analyzed high-risk conditions included intrapartum fever, bleeding of unknown cause, chronic hypertension, diabetes mellitus (all classes), maternal anemia, previous small-for-gestational-age birth, placental abruption, small-for-gestational-age birth, placenta previa, renal disease, preeclampsia, and oligo/polyhydramnios. Maternal race was determined on the basis of self-report and was restricted to black and white women.

During the 12 years (1989-2000), there were 1,214,126 twin births in the United States. Of these, we sequentially excluded infants with congenital malformations or chromosomal anomalies ( $n = 366,492$  infants), birth weight <500 g ( $n = 10,304$  infants), missing data on gestational age after the imputations that were performed by the National Center for Health Statistics ( $n = 7827$  infants), and missing data on maternal race or on prenatal care status ( $n = 20,454$  infants). We further excluded 29,662 nonwhite and nonblack women, which left 779,387 live-born twins for analysis.

**Statistical analysis.** Rates of preterm birth were compared for women with and without prenatal care, and adjusted relative risks (RR) with 95% CIs were derived as measures of effect. Adjusted odds ratios that were derived from multivariable logistic regression models were transformed to adjusted RRs.<sup>10</sup> Covariates that were considered for adjustment in the regression models included obstetric and medical high-risk conditions, maternal age, gravidity (gravida 1, 2, and  $\geq 3$ ), maternal education ( $\leq 12$  or  $\geq 13$  completed years of schooling), marital status (unmarried or married), and smoking and alcohol use (yes/no) during pregnancy. To account for temporal trends in twin preterm births, birth cohort (year of birth) was adjusted additionally in all regression models.

Because the relationship among maternal age, birth weight, gestational age, and the risk of preterm birth were nonlinear, we modeled these three covariates by including second-degree polynomial terms. All these continuous covariates were centered before including them in the regression models for adjustment. Confounders that changed the unadjusted RRs by  $\geq 10\%$  were retained in the regression model for adjustment. Adjusted population attributable risks were derived with the use of the following formula:  $(p[(RR-1)]/[1 + p(RR-1)])$ , where RR denotes the adjusted RR and  $p$  denotes the proportion of preterm births that can be attributed to no prenatal care.

The data were analyzed with the SAS system (version 8.2; SAS Institute, Cary, NC) on the UNIX system. This study was approved by the ethics committee of the Institutional Review Board of the Robert Wood Johnson Medical School, University of Medicine and Dentistry of New Jersey.

## Results

Of the 779,387 twin live births to white and black women, 54.7% of twin live births ( $n = 426,292$ ) were delivered preterm (<37 weeks' gestation) and 1.3% women ( $n = 9708$ ) received no prenatal care. Black women were 6.1-fold more likely to have no prenatal care compared with white women (3.1% vs 0.5%). Table I compares preterm birth rates (<37 and <32 weeks' gestation) in twin gestations among black and white women, both in the presence and absence of prenatal care. Preterm birth rates (<37 weeks' gestation), in general, were higher among black women compared with white women in the presence (57.0% vs 51.2%) and absence (70.3% vs 61.6%) of prenatal care. Black and white women without any prenatal care were 24% (RR, 1.24; 95% CI, 1.10, 1.37) and 22% (RR, 1.22; 95% CI, 1.06, 1.44), respectively, more likely to be delivered preterm (<37 weeks' gestation). The absence of prenatal care increased the RR for preterm birth 1.36-fold among black women and 1.19-fold among white women. The population attributable risks for preterm birth because of lack of prenatal care were 12.0% and 10.1% among black and white women, respectively. An inverse dose-response relationship between the number of prenatal care visits and the twin preterm birth rate was evident both among black and white women (Fig 1). However, this relationship was confined to up to 15 prenatal care visits. Thereafter, the rate of preterm births among twins began to increase.

Fig 2 shows the cumulative gestational age-specific rate of preterm birth rate in twins that has been stratified on maternal race and prenatal care status. Throughout gestation, black women with no prenatal care had the highest preterm birth rate, followed by white women with no prenatal care, black women with prenatal care, and lastly white women with prenatal care. The differences between the two groups in gestational age-specific twin preterm birth rates were most pronounced at early (ie, up to 32 weeks' gestation,  $P < .001$ ) but not at later gestations.

At least one high-risk pregnancy condition was present in 45.6% of black women and 46.5% of white women who were delivered preterm (<37 weeks' gestation). Table II shows adjusted RRs for the preterm birth at <37 weeks' gestation in the presence of each antenatal high-risk condition and the absence of all high-risk conditions. Lack of prenatal care was associated with an increased risk of preterm birth for most high-risk conditions, which

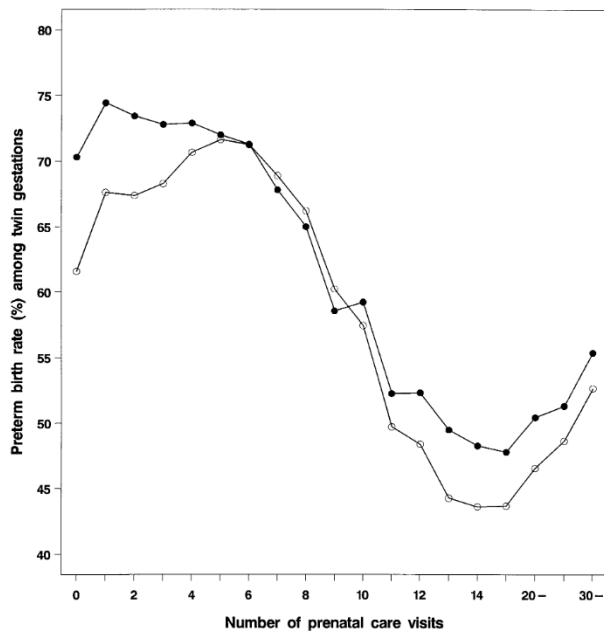


**Table I.** Association between prenatal care and twin preterm birth among white and black women: United States 1989-2000

Group	Prenatal care present			Prenatal care absent			Adjusted RR (95% CI)	Adjusted population attributable risk (%)
	Total twin births	Twin preterm birth		Total twin births	Twin preterm birth			
		N	%		N	%		
White women								
<37 wks gestation	633,560	342,300	51.2	5299	3264	61.6	1.22 (1.06, 1.44)	10.1
<32 wks gestation	363,642	54,382	15.0	3403	1368	40.2	2.65 (2.07, 3.28)	19.8
Black women								
<37 wks gestation	136,119	77,628	57.0	4409	3100	70.3	1.24 (1.10, 1.37)	12.0
<32 wks gestation	79,333	20,843	26.3	2907	1598	55.0	2.11 (1.73, 2.47)	22.6

Relative risks were adjusted for birth cohort (year), maternal age, gravidity, maternal education, marital status, smoking and alcohol use during pregnancy, and the antenatal high-risk conditions listed in Table II.

RR, Relative risk; CI, confidence interval.



**Fig 1.** Relationship between the number of prenatal care visits and twin preterm birth (<37 weeks' gestation) rates: United States twin live births 1989 through 2000. Closed circles, Black women; open circles, white women.

included intrapartum fever, bleeding of unknown cause, chronic hypertension, and maternal anemia. The strength of association between no prenatal care and preterm birth in the presence and absence of antenatal high-risk conditions was fairly similar among black and white women.

Among twin births that ended at <32 weeks' gestation, at least one high-risk pregnancy condition was present in 22.2% of black women and 10.8% of white women. Table III shows adjusted RRs for the preterm births at <32 weeks' gestation in the presence of each antenatal high-risk condition and the absence of all high-risk conditions among black and white women. Women without any

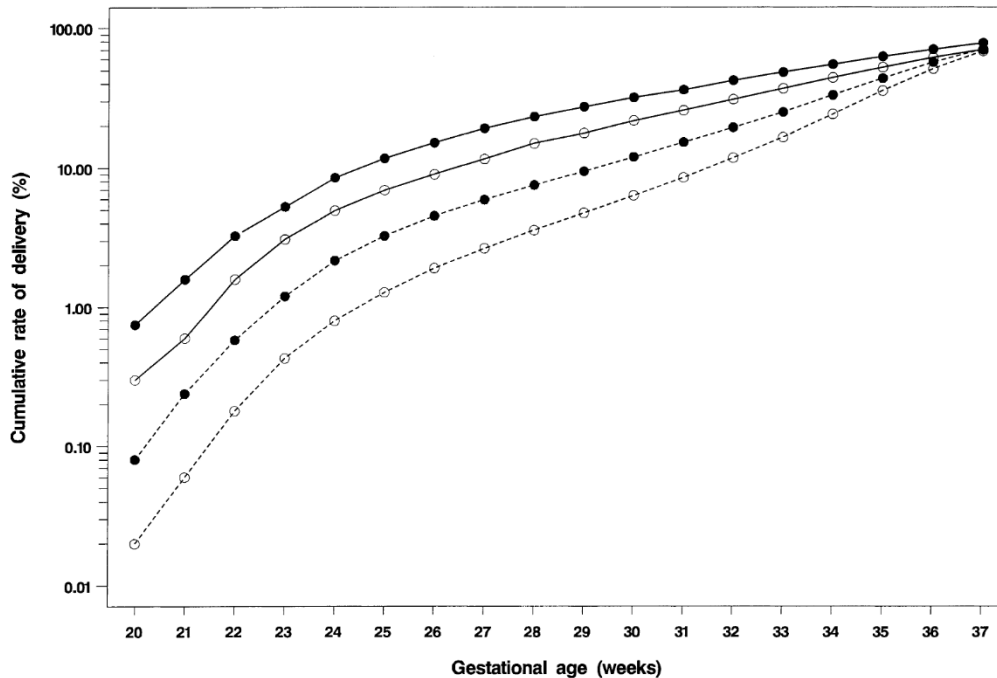
prenatal care were more likely to be delivered at <32 weeks' gestation in the presence of every high-risk condition and in the absence of all high-risk conditions.

### Comment

In our previous study on singleton births, we reported that a lack of prenatal care was associated with a 2.8-fold increased preterm birth (<37 weeks' gestation) rate among both black and white women.<sup>6</sup> In the current study, we found that a lack of prenatal care among twin gestations was associated with a 1.24-fold increased preterm birth rate among black women and 1.22-fold increased rate among white women, with much stronger associations between lack of prenatal care and births at <32 completed weeks' gestation. The role of prenatal care in reducing preterm birth rate in twin gestations was less, compared with singleton gestations.<sup>6</sup> Furthermore, among twin gestations, the role of prenatal care in reducing preterm birth rate among black women was less, compared with white women. These are not unexpected findings because twin gestations have almost a 5-fold higher overall rate of preterm births (52%) than among singleton births. Furthermore, among twin gestations, the overall rate of preterm births among black women is greater than among white women.

Lack of prenatal care was associated with an excess of preterm births among twins in both black women and white women. The impact of twin preterm births that were attributable to a lack of prenatal care was considerable (12.0% among black women and 10.1% among white women). The excess number of preterm births among black women compared with white women among those who had prenatal care was 6.2%; whereas among those without prenatal care, it was 8.7% (Table I). This suggests that prenatal care reduced the disparity in preterm birth rate among black women by 28.7% compared with white women. Because black women were 6.1-fold more likely to have no prenatal care than white women, increased





**Fig 2.** Relationship between gestational age-specific cumulative rates of twin delivery by maternal race and prenatal care status: United State twin live births 1989 through 2000. *Closed circle-continuous line*, black women with no prenatal care; *open circle-continuous line*, white women with no prenatal care; *closed circle-dashed line*, black women with prenatal care; *open circle-dashed line*, white women with prenatal care.

**Table II.** Association between prenatal care and preterm birth <37 weeks' gestation among twin live births, based on the presence and absence of antenatal high-risk conditions: United States 1989-2000

Antenatal high-risk condition	Twin preterm birth < 37 weeks' gestation		Adjusted RR (95% CI)		
	Prenatal care present (n [%])	Prenatal care absent (n [%])	Overall	White women	Black women
Intrapartum fever	5,316 (57.3%)	136 (82.4%)	1.46 (1.28, 1.58)	1.51 (1.33, 1.62)	1.44 (1.10, 1.63)
Bleeding (unknown cause)	7,253 (58.4%)	147 (79.5%)	1.39 (1.22, 1.57)	1.43 (1.26, 1.54)	1.34 (1.06, 1.53)
Chronic hypertension	4,282 (61.2%)	70 (78.7%)	1.28 (1.04, 1.44)	1.19 (0.81, 1.45)	1.31 (1.00, 1.51)
Maternal anemia	13,542 (54.9%)	295 (64.8%)	1.19 (1.07, 1.31)	1.15 (1.01, 1.28)	1.20 (1.02, 1.36)
Previous preterm/small-for-gestational-age birth	10,622 (72.0%)	276 (85.7%)	1.18 (1.09, 1.25)	1.20 (1.10, 1.29)	1.16 (1.00, 1.26)
Placental abruption	6,567 (78.5%)	213 (86.2%)	1.10 (1.01, 1.17)	1.10 (1.01, 1.17)	1.07 (0.89, 1.18)
Renal disease	1,390 (59.1%)	27 (71.1%)	1.23 (0.83, 1.49)	1.26 (0.91, 1.50)	1.14 (0.46, 1.57)
Diabetes mellitus	12,475 (57.4%)	65 (69.2%)	1.19 (0.93, 1.40)	1.20 (0.99, 1.37)	1.25 (0.57, 1.63)
Oligo/polyhydramnios	8,712 (73.0%)	137 (79.7%)	1.08 (0.94, 1.18)	1.05 (0.93, 1.15)	1.15 (0.92, 1.27)
Placenta previa	2,662 (76.4%)	65 (83.3%)	1.08 (0.87, 1.20)	1.12 (0.90, 1.23)	1.04 (0.66, 1.23)
Small-for-gestational-age birth	36,987 (51.1%)	935 (52.9%)	1.05 (0.97, 1.13)	1.01 (0.93, 1.09)	1.08 (0.96, 1.20)
Pregnancy-induced hypertension	40,370 (61.3%)	312 (62.3%)	1.00 (0.98, 1.10)	1.01 (0.90, 1.10)	1.04 (0.86, 1.19)
None of the above	453,428 (47.7%)	4,794 (63.9%)	1.31 (1.24, 1.37)	1.15 (1.08, 1.23)	1.24 (1.12, 1.35)

Relative risks were adjusted for birth cohort (year), maternal age, gravidity, maternal education, marital status, smoking and alcohol use during pregnancy, and the antenatal high-risk conditions listed.

RR, Relative risk; CI, confidence interval.

prenatal care participation, especially among black women, may decrease the number of twin preterm births. The association between the lack of prenatal care and preterm births was the greatest in cases of extreme prematurity (Fig 2).

In the presence of certain antenatal high-risk conditions, prenatal care was associated with a decreased incidence of preterm birth. These conditions included intrapartum fever, bleeding of unknown cause, chronic hypertension, diabetes mellitus, maternal anemia, pre-





**Table III.** Association between prenatal care and preterm birth <32 weeks' gestation among twin livebirths based on the presence and absence of antenatal high-risk conditions: United States 1989-2000

Antenatal high-risk conditions	Twin preterm birth < 32 weeks' gestation		Adjusted RR (95% CI)		
	Prenatal care present (n [%])	Prenatal care absent (n [%])	Overall	White women	Black women
Intrapartum fever	5,826 (32.7%)	110 (73.6%)	2.24 (1.92, 2.49)	2.51 (2.03, 2.84)	1.65 (1.35, 1.85)
Bleeding (unknown cause)	7,159 (26.9%)	119 (68.1%)	2.54 (2.18, 2.86)	2.85 (2.31, 3.26)	1.77 (1.42, 2.05)
Chronic hypertension	3,533 (23.4%)	43 (55.8%)	2.12 (1.46, 2.77)	2.24 (0.96, 3.72)	1.80 (1.21, 2.32)
Maternal anemia	13,977 (20.5%)	274 (43.8%)	2.05 (1.75, 2.35)	2.16 (1.68, 2.67)	1.78 (1.46, 2.11)
Previous preterm/small-for-gestational-age birth	7,032 (41.4%)	233 (80.3%)	1.87 (1.72, 2.00)	2.02 (1.75, 2.22)	1.49 (1.35, 1.61)
Placental abruption	4,662 (61.7%)	187 (82.9%)	1.31 (1.20, 1.40)	1.35 (1.20, 1.46)	1.20 (1.04, 1.31)
Renal disease	1,292 (25.6%)	28 (60.7%)	2.52 (1.77, 3.13)	2.77 (1.79, 3.48)	1.91 (0.94, 2.65)
Diabetes mellitus	11,159 (17.1%)	54 (46.3%)	2.71 (1.93, 3.54)	3.13 (2.22, 4.03)	—
Oligo/polyhydramnios	6,033 (46.8%)	117 (70.1%)	1.46 (1.25, 1.63)	1.34 (1.09, 1.57)	1.85 (1.49, 2.10)
Placenta previa	1,569 (48.1%)	58 (77.6%)	1.53 (1.23, 1.74)	1.70 (1.24, 1.97)	1.21 (0.92, 1.38)
Small-for-gestational-age birth	41,461 (14.7%)	1,138 (26.9%)	1.71 (1.54, 1.90)	1.80 (1.52, 2.10)	1.56 (1.34, 1.79)
Pregnancy-induced hypertension	30,033 (15.1%)	281 (33.5%)	2.07 (1.72, 2.46)	2.04 (1.56, 2.60)	2.01 (1.55, 2.50)
None of the above	271,481 (12.6%)	3,019 (42.6%)	2.43 (2.32, 2.55)	2.46 (2.29, 2.64)	2.01 (1.90, 2.12)

Relative risks were adjusted for birth cohort (year), maternal age, gravidity, maternal education, marital status, smoking and alcohol use during pregnancy, and the antenatal high-risk conditions listed.

RR, Relative risk; CI, confidence interval.

vious preterm or small-for-gestational-age birth, placental abruption, and small-for-gestational-age birth. Reasons for a reduced preterm birth rate in the presence of intrapartum fever or bleeding of unknown cause among women with prenatal care may have been related to better patient education for bed rest and timely symptom recognition. The beneficial effects of prenatal care in cases of chronic hypertension and placental abruption may be related to tighter control of blood pressure, early recognition, and prompt intervention in cases with progressive maternal disease. Maternal anemia and diabetes mellitus are best treated by appropriate diet with iron supplementation and blood sugar control, which are provided to patients with prenatal care. The beneficial effects of prenatal care in patients with a history of preterm or small-for-gestational-age birth or small-for-gestational-age fetus in the present pregnancy may be due to better patient education with particular emphasis to adequate bed rest, appropriate diet, and fetal surveillance.

In the current study, we used prenatal care as a categorical variable (present vs absent) because patients with preterm birth have shorter gestations and, therefore, are expected to have fewer prenatal visits. The rationale for this definition of prenatal care was the possibility that fewer numbers of prenatal visits may be the result of rather than the cause for shortened gestation. One of the strengths of the current study is the large number of patients who were included, based on the national data. This study, as with any population-based study, suffers from a few limitations. Foremost among them is the impact of errors in the estimation of gestational age, especially among women with no prenatal care. Because anovulation and long cycles are the most frequent causes for the wrong

estimation of gestational age, it is likely that an overestimation of gestational age may have occurred in the no prenatal care group. However, such an estimation of gestational age in the group with no prenatal care would have attenuated the strength of associations noted here, thereby strengthening our conclusions even more.

A second limitation of the current analysis pertains to the methods of data analysis. Twin births form a natural cluster (because outcomes that are examined between two fetuses from a twin pregnancy are more likely to be "alike" in comparison with outcomes in two fetuses from different singleton pregnancies). Failure to account (or adjust) for this clustering phenomenon will result in imprecise variance estimates of effect measures (ie, RR) and CIs (although the RRs themselves will remain unaffected).<sup>11</sup> The US natality data files that were used in the current study, unfortunately, do not identify the twins within a sibship. A third limitation of the study is the possible underreporting of certain risk factors and complications and the unavailability of several known risk factors in the vital statistics data. Such factors include maternal stress, suboptimal weight gain during pregnancy, strenuous physical activity, drug use, and other factors that are associated with increased preterm birth rates. Therefore, it is possible that a lack of prenatal care among women with twin gestations may be a marker rather than a cause for high-risk behaviors and medical and obstetric complications.

Although we recognize these limitations, it is our opinion that, in the United States, prenatal care is associated with fewer preterm births among women with twin gestations in the presence and the absence of high-risk conditions among both black and white women.



These findings underscore the need to develop strategies to increase prenatal care participation, especially among black women, to achieve a reduction in the number of preterm births among twin gestations. Studies aimed at understanding the reasons for the persistence of the black-white disparity in preterm birth rates, not only among singleton but also among twin gestations, are encouraged strongly.

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