

# Risk of Low Birth Weight Associated with Advanced Maternal Age Among Four Ethnic Groups in the United States

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**Objectives:** To examine and compare the risk of low birth weight associated with delayed childbearing in four ethnic groups using nationally representative data in the United States. **Methods:** We compared the risk of low (<2.5 kg) birth weight among African Americans, Mexican Americans, Puerto Ricans, and non-Hispanic whites using birth data for the United States obtained from the National Center for Health Statistics. Comparisons were done separately for first births and births of second or higher order and in terms of odds ratios, risk differences and attributable fractions of very low (<1.5 kg), middle low (1.5–2.5) and overall low birth weight. Statistical analysis included use of logistic regression models with likelihood ratio tests for interaction effects. **Results:** African Americans and Puerto Ricans, and to a lesser extent Mexican Americans, had higher risk differences associated with advanced maternal age. For first births, the risk differences associated with advanced maternal age ( $\geq 35$  years) in low birth weight were 5.3% (95% CI, 4.7–6.0), 4.3% (95% CI, 1.7–6.9), and 3.7% (95% CI, 2.8–4.5) for African Americans, Puerto Ricans, and Mexican Americans, respectively, as compared with 2.6% (95% CI, 2.4–2.7) for non-Hispanic whites. On the other hand, the odds ratios associated with advanced maternal age were more similar across the four ethnic groups. Differences were greater for all ethnic groups in the case of first births as compared with births of second or higher order. **Conclusions:** Advanced maternal age appears to be associated with for the most part similarly increased odds of low birth weight for African Americans, Mexican Americans, Puerto Ricans, and non-Hispanic whites. However, the age-related increments in the risk of low birth associated with advanced maternal age are greater for African Americans, Puerto Ricans and, to a lesser extent, Mexican Americans, as compared with non-Hispanic whites.

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**KEY WORDS:** low birth weight; maternal age; ethnicity; delayed childbearing.

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## INTRODUCTION

There has been a consistent trend toward delayed childbearing in the United States in the past three decades (1–5). Substantial ethnic differences

exist, however, in the pace of childbearing in general and in the trends towards delayed childbearing in particular (3, 6, 7). An extensive literature has also documented ethnic differences in birth outcomes and specifically in the risk of low birth weight (8–11). However, the specific impact of delayed childbearing on the risk of low birth weight has not been adequately studied among different ethnic groups in the United States.

At least two distinct, though possibly related, mechanisms might result in differences in the age-related increases in the risk of low birth weight associated with advanced maternal age. First, ethnic

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groups might differ in the frequency of voluntary vs. involuntary delayed childbearing and the risk of low birth weight associated with advanced maternal age might be greater in the case of involuntary delayed childbearing (e.g., due to subfecundity (12)). Second, it is possible that “weathering” with advancing maternal age might be greater for some ethnic groups vs. others, as has been suggested by Geronimus in the case of African Americans vs. whites (13–15). Such weathering effect is due to the fact that the health of African American women might begin to deteriorate earlier and at a greater rate as a consequence of cumulative socioeconomic disadvantage.

In this study, we examine and compare the risk of low birth weight associated with delayed childbearing in four ethnic groups using nationally representative data in the United States. Using national birth cohort data, the association of advanced maternal age with low birth weight is evaluated in terms of both odds ratios and risk differences. The ethnic groups in the study included African Americans, Mexican Americans, Puerto Ricans, and non-Hispanic whites and the analyses were done separately for first births and births of second or higher order.

## MATERIALS AND METHODS

Data for the study were obtained from the National Center for Health Statistics (16). The study population comprised singleton births to African American ( $N = 1,020,335$ ), Mexican American ( $N = 834,534$ ), Puerto Rican ( $N = 82,727$ ) and non-Hispanic white ( $N = 6,496,339$ ) women who gave birth in the period 1989–1991. We assessed the effects of advanced maternal age (35 years of age and greater) in terms of odds ratios and risk differences of very low (<1.5 kg), moderately low (1.5–2.5 kg) and overall low birth weight. First births and births of second or higher order were analyzed separately. In addition to the analyses of maternal age presented here, a more detailed set of analyses using several categories of maternal age were conducted. The results of these analyses are available elsewhere (17) and were essentially in agreement with the main findings presented here on the effect of advanced maternal age categorized as a binary variable (35 years of age or more vs. 20–34 years) in order to simplify the presentation of results.

Statistical analysis included calculation of odds ratios and risk differences together with 95% con-

fidence intervals (CI). Mantel–Haenszel odds ratios (18) were also computed to assess the overall impact of delayed childbearing for the four ethnic groups combined. Logistic regression models were used to assess the independent effect of advanced maternal age on odds of low birth weight in each of the four ethnic groups after taking into account the potentially confounding effects of maternal education, marital status, prenatal care, and smoking. In addition, for births of second or higher order, we also adjusted the effect of advanced maternal age for parity (births of fourth or higher order), the interval between pregnancies, and previous preterm delivery. Interactions between the effects of maternal age and ethnicity on the odds of low birth weight were tested using the likelihood ratio test.

## RESULTS

### First Births

The proportion of first births born to women 35 years of age and greater was 5.6% for non-Hispanic whites, 3.2% for African Americans, 1.9% for Puerto Ricans, and 1.4% for Mexican Americans. Overall, the low birth weight rate for first births was 10.6% for African Americans, 7.6% for Puerto Ricans, 5.3% for Mexican Americans, and 4.9% for non-Hispanic whites.

Table I shows the association of delayed childbearing with low birth weight. For all four ethnic groups, maternal age  $\geq 35$  years at first birth was associated with higher odds of low (<2.5 kg) birth weight. This effect of maternal age was fairly similar across the four groups. Overall, compared with mothers 20–34 years of age, mothers  $\geq 35$  years were at 82% increased odds of very low (<1.5 kg) birth weight (Mantel–Haenszel odds ratio: 1.82, 95% CI: 1.75–1.90) and 55% increased odds of moderately low (1.5–2.5 kg) birth weight (Mantel–Haenszel odds ratio: 1.55, 95% CI: 1.52–1.58).

Table II shows the risk differences in very low, moderately low and low birth weight that were associated with advanced maternal age at first birth for the four ethnic groups. The highest risk differences in very low and moderately low birth weight, and hence the highest overall risk differences in low birth weight, pertained to African Americans and Puerto Ricans and the lowest to non-Hispanic whites. Specifically, among first births, the risk differences associated with advanced maternal age for

**Table I.** Odds Ratios<sup>a</sup> for the Association of Delayed Childbearing (Maternal Age  $\geq 35$  years) with Low (<2.5 kg) Birth Weight Among Four Ethnic Groups—First Births

Ethnic group	VLBW <sup>b</sup> (<1.5 kg)	MLBW <sup>b</sup> (1.5–2.5 kg)	LBW <sup>b</sup> (<2.5 kg)
African Americans	1.80 (1.63–1.99) <sup>c</sup>	1.54 (1.45–1.63)	1.61 (1.53–1.70)
Mexican Americans	2.17 (1.68–2.79)	1.70 (1.51–1.91)	1.77 (1.59–1.97)
Non-Hispanic whites	1.81 (1.72–1.90)	1.54 (1.51–1.58)	1.59 (1.55–1.62)
Puerto Ricans	2.74 (1.64–4.57)	1.48 (1.11–1.96)	1.66 (1.28–2.14)
All <sup>d</sup>	1.82 (1.75–1.90)	1.55 (1.52–1.58)	1.60 (1.57–1.63)

<sup>a</sup>Reference group for calculation of odds ratios: women 20–34 years of age.

<sup>b</sup>VLBW: very low birth weight; MLBW: moderately low birth weight; LBW: low birth weight.

<sup>c</sup>95% CI.

<sup>d</sup>The odds ratios for All are the Mantel–Haenszel estimates of the combined odds ratios for all four ethnic groups.

low birth weight were 5.3% (95% CI, 4.7–6.0) for African Americans, 4.3% (95% CI, 1.7–6.9) for Puerto Ricans, 3.7% (95% CI, 2.8–4.5) for Mexican Americans, and 2.6% (95% CI, 2.4–2.7) for non-Hispanic whites.

Table III presents results of logistic regression models of low birth weight that adjusted the effect of maternal age  $\geq 35$  years at first birth for maternal education, marital status, prenatal care, and tobacco use. For all groups, the adjusted effects of advanced maternal age remained significant and of the same or increased magnitude after adjusting for other factors. Likelihood ratio tests showed that overall the interaction effects between maternal ethnicity and age were statistically significant ( $p < 0.001$ ).

### Births of Second or Higher Order

The proportion of births of second or higher order born to women 35 years of age and greater were 13.4% for non-Hispanic whites, 10.1% for African Americans, 10.1% for Mexican Americans, and 7.5% for Puerto Ricans. The low birth weight rate for births of second or higher order was 11.6% for African Americans, 7.6% for Puerto Ricans, 3.9%

for Mexican Americans, and 3.7% for non-Hispanic whites.

Table IV shows the association of advanced maternal age in births of second or higher order with low birth weight. For all four ethnic groups, maternal age  $\geq 35$  years for births of second or higher order was associated with statistically significant increases in the odds of low (<2.5 kg) birth weight. However, these increases tended to be less than were the case for first births (cf. Table I). Overall, compared with mothers 20–34 years of age, mothers  $\geq 35$  years were at 29% increased odds of very low (<1.5 kg) birth weight (Mantel–Haenszel Odds Ratio: 1.29, 95% CI: 1.26–1.32) and 14% increased odds of moderately low (1.5–2.5 kg) birth weight (Mantel–Haenszel odds ratio: 1.14, 95% CI: 1.12–1.15) for births of second or higher order. The effects of maternal age  $\geq 35$  years on births of second or higher order tended to be slightly more for Mexican Americans and Puerto Ricans as compared with non-Hispanic whites and African Americans (Table IV).

Table V shows risk differences in very low, moderately low and low birth weight that were associated with advanced maternal age for births of second or higher order. Compared with non-Hispanic whites, Puerto Ricans, African Americans, and

**Table II.** Risk Differences<sup>a</sup> for the Association of Delayed Childbearing (Maternal Age  $\geq 35$  years) with Low (<2.5 kg) Birth Weight Among Four Ethnic Groups—First Births

Ethnic group	VLBW <sup>b</sup> (<1.5 kg)	MLBW <sup>b</sup> (1.5–2.5 kg)	LBW <sup>b</sup> (<2.5 kg)
African Americans	1.1 (1.0–2.1) <sup>c</sup>	3.9 (3.3–4.5)	5.3 (4.7–6.0)
Mexicans	0.8 (0.4–1.1)	2.9 (2.1–3.7)	3.7 (2.8–4.5)
Non-Hispanic whites	0.5 (0.5–0.6)	2.1 (2.0–2.2)	2.6 (2.4–2.7)
Puerto Ricans	1.7 (0.4–3.0)	2.8 (0.4–5.2)	4.3 (1.7–6.9)

<sup>a</sup>Expressed per 100 compared with the reference group of women 20–34 years of age in the same ethnic group.

<sup>b</sup>VLBW: very low birth weight; MLBW: moderately low birth weight; LBW: low birth weight.

<sup>c</sup>95% CI.

**Table III.** Logistic Regression Analysis of the Association Between Delayed Childbearing (>35 years) and Odds of Low (<2.5 kg) Birth Weight Among Four Ethnic Groups—First Births

Ethnic group	Adjusted odds ratios <sup>a</sup> (95% CI)		
	VLBW <sup>b</sup> (<1.5 kg)	MLBW <sup>b</sup> (1.5–2.5 kg)	LBW <sup>b</sup> (<2.5 kg)
African Americans	1.80 (1.63–1.99)	1.61 (1.52–1.71)	1.67 (1.59–1.76)
Mexican Americans	2.18 (1.69–2.81)	1.73 (1.54–1.95)	1.80 (1.62–2.01)
Non-Hispanic whites	1.94 (1.85–2.04)	1.68 (1.64–1.72)	1.73 (1.69–1.76)
Puerto Ricans	2.69 (1.60–4.52)	1.49 (1.12–1.98)	1.66 (1.29–2.15)

<sup>a</sup>Adjusted odds ratios obtained for women  $\geq 35$  years of age in each ethnic group compared to women in the same ethnic group 20–34 years of age—separate logistic models which included maternal age, education, marital status, prenatal care, and smoking were estimated for each of the ethnic groups.

<sup>b</sup>VLBW: very low birth weight; MLBW: moderately low birth weight; LBW: low birth weight.

Mexican-Americans had higher risk differences associated with delayed childbearing for very low and moderately low birth weight. Risk differences for low birth weight were 1.4% (95% CI, 1.2–1.6) for African Americans, 1.7% (95% CI, 1.1–2.4) for Puerto Ricans, 1.4% (95% CI, 1.3–1.6) for Mexican Americans, and 0.5% (95% CI, 0.4–0.5) for non-Hispanic whites.

For all four ethnic groups the risk differences associated with advanced age were approximately four- to five fold greater in first births as compared with births of second or higher order (Tables II and V). For African Americans, the risk difference for low birth weight that was associated with maternal age  $\geq 35$  years was 5.3% (95% CI, 4.7–6.0) in first births as compared with 1.4% (95% CI, 1.2–1.6) in births of second or higher order. Similarly, for non-Hispanic whites, the risk difference for low birth weight that was associated with maternal age  $\geq 35$  years was 2.6% (95% CI, 2.4–2.7) in first births as compared with 0.5% (95% CI, 0.4–0.5) in births of second or higher order.

Table VI presents results of logistic regression models of low birth weight that adjusted the effect of maternal age  $\geq 35$  years for births of second or higher

order for maternal education, marital status, prenatal care, and tobacco use. For all ethnic groups, the adjusted effects of advanced maternal age remained significant and of the same or increased magnitude after adjusting for other factors. Furthermore, likelihood ratio tests showed that the interaction effects between maternal ethnicity and age were statistically significant ( $p < 0.001$ ).

## DISCUSSION

In summary, our results suggest that delayed childbearing results in increased odds of low birth weight for African Americans, Mexican Americans, Puerto Ricans, and non-Hispanic whites with fairly similar odds ratios for the four ethnic groups. However, the effects of advanced maternal age on the likelihood of low birth weight as measured in terms of risk differences are substantially greater for African Americans and Puerto Ricans, who have greater "baseline" risks of low birth weight. In addition, Mexican Americans also appear to have higher risk differences associated with advanced maternal age as compared with non-Hispanic whites. Finally,

**Table IV.** Odds Ratios<sup>a</sup> for the Association of Delayed Childbearing (Maternal Age  $\geq 35$  years) with Low (<2.5 kg) Birth Weight Among Four Ethnic Groups—Parity >1

Ethnic group	VLBW <sup>b</sup> (<1.5 kg)	MLBW <sup>b</sup> (1.5–2.5 kg)	LBW <sup>b</sup> (<2.5 kg)
African Americans	1.20 (1.15–1.25) <sup>c</sup>	1.13 (1.10–1.15)	1.14 (1.12–1.16)
Mexican Americans	1.60 (1.47–1.75)	1.37 (1.31–1.42)	1.41 (1.36–1.46)
Non-Hispanic whites	1.29 (1.25–1.34)	1.11 (1.09–1.12)	1.13 (1.12–1.15)
Puerto Ricans	1.67 (1.40–1.99)	1.18 (1.08–1.29)	1.26 (1.16–1.36)
All <sup>d</sup>	1.29 (1.26–1.32)	1.14 (1.12–1.15)	1.16 (1.15–1.17)

<sup>a</sup>Reference group for calculation of odds ratios: women 20–34 years of age.

<sup>b</sup>VLBW: very low birth weight; MLBW: moderately low birth weight; LBW: low birth weight.

<sup>c</sup>95% CI.

<sup>d</sup>The odds ratios for All are the Mantel–Haenszel estimates of the combined odds ratios for all four ethnic groups.

**Table V.** Risk Differences<sup>a</sup> for the Association of Delayed Childbearing (Maternal Age  $\geq 35$  years) with Low ( $< 2.5$  kg) Birth Weight Among Four Ethnic Groups—Parity  $> 1$ 

Ethnic group	VLBW <sup>b</sup> ( $< 1.5$ kg)	MLBW <sup>b</sup> (1.5–2.5 kg)	LBW <sup>b</sup> ( $< 2.5$ kg)
African Americans	0.4 (0.3–0.5) <sup>c</sup>	1.1 (0.9–1.3)	1.4 (1.2–1.6)
Mexican-Americans	0.3 (0.3–0.4)	1.1 (1.0–1.3)	1.4 (1.3–1.6)
Non-Hispanic whites	0.1 (0.1–0.2)	0.3 (0.3–0.4)	0.5 (0.4–0.5)
Puerto Ricans	0.7 (0.4–1.0)	1.1 (0.5–1.7)	1.7 (1.1–2.4)

<sup>a</sup>Expressed per 100 compared with the reference group of women 20–34 years of age in the same ethnic group.

<sup>b</sup>VLBW: very low birth weight; MLBW: moderately low birth weight; LBW: low birth weight.

<sup>c</sup>95% CI.

our results showed that the effects of delayed childbearing on the risk of low birth weight were about four-to fivefold greater for first births as compared with births of second or higher order and that these effects were somewhat greater in the case of very low ( $< 1.5$  kg) birth weight than moderately low (1.5–2.5 kg) birth weight.

As in previous reports (3, 6), we found delayed childbearing to be more pronounced for non-Hispanic whites; however, this difference was much less for births of second or higher order as compared with first births. Our results imply that with the continuing trends toward delayed childbearing (5), approximately 10–12% of all low birth weight and 15–18% of all very low birth weight singleton births might be due to the advanced maternal age in women who delay their childbearing. These figures might overstate the true effects of advanced maternal age to the extent that causes of involuntary delayed childbearing such as subfecundity might also increase the risk of low birth weight (12). However, previous studies suggest that the dominant empirical component of birth timing for young women is timing plans or expectations (19). Moreover, our estimates do not take into account the important effects of advanced maternal age on multiple births or the effects of infertility treatments that are more common among older women (5, 20).

Our results suggest that the effects of advanced maternal age are substantially greater for first births than for births of second or higher order in all four ethnic groups. This might be explained at least in part by the presumably higher frequency of involuntary delayed childbearing in the case of first births as compared with births of second or higher order. However, for reasons that are not completely understood, first births are in general at higher risk of low birth weight and other adverse pregnancy outcomes. Therefore, mechanisms other than involuntary childbearing may also play a role in the higher risk of low birth weight associated with advanced childbearing for first births as compared with births of second or higher order.

Our findings on the effects of advanced maternal age in *relative* terms (i.e., odds ratios of low birth weight) for the most part did not show substantial ethnic differences in the effects of delayed childbearing on low birth weight. However, in *absolute* terms (risk differences) we did find evidence in favor of the “weathering hypothesis” for African Americans, Puerto Ricans, and to a lesser extent, Mexican Americans in the United States. An alternative explanation for the higher increments in the risk of low birth weight associated with advanced maternal age among minority ethnic groups might be related to ethnic differences in the frequency of voluntary vs.

**Table VI.** Logistic Regression Analysis of the Association Between Delayed Childbearing ( $> 35$  years) and Odds of Low ( $< 2.5$  kg) Birth Weight Among Four Ethnic Groups—Parity  $> 1$ 

Ethnic group	Adjusted odds ratios <sup>a</sup> (95% CIs)		
	VLBW <sup>b</sup> ( $< 1.5$ kg)	MLBW <sup>b</sup> (1.5–2.5 kg)	LBW <sup>b</sup> ( $< 2.5$ kg)
African Americans	1.32 (1.24–1.40)	1.27 (1.24–1.31)	1.29 (1.25–1.32)
Mexican Americans	1.77 (1.59–1.96)	1.44 (1.37–1.51)	1.50 (1.43–1.56)
Non-Hispanic whites	1.52 (1.46–1.59)	1.39 (1.37–1.41)	1.41 (1.39–1.44)
Puerto Ricans	1.82 (1.36–2.43)	1.33 (1.16–1.52)	1.40 (1.24–1.58)

<sup>a</sup>Adjusted odds ratios obtained for women  $\geq 35$  years of age in each ethnic group compared to women in the same ethnic group 20–34 year of age—separate logistic models which included maternal age, education, marital status, prenatal care, and smoking were estimated for each of the ethnic groups.

<sup>b</sup>VLBW: very low birth weight; MLBW: moderately low birth weight; LBW: low birth weight.

involuntary delayed childbearing (e.g., due to differences in subfecundity). Note however that we found evidence in favor of weathering in the effects of advanced maternal age on the risk of low birth weight for both first births, and births of second or higher order, in African Americans, Puerto Ricans, and Mexican Americans.

The weathering effects presumably begin in early adulthood. Hence, our inclusion of women 20–34 years of age as the reference group can result in underestimates of the overall weathering effect associated with advancing maternal age. However, more detailed analyses using more refined categories for maternal age essentially showed the same set of results in terms of relative vs. absolute effects of aging (17); i.e., odds ratios of advanced maternal age with low birth weight were fairly similar across ethnic groups but risk differences were substantially greater for African Americans and Puerto Ricans, and also Mexican Americans in the case of births of second or higher order.

A priori, it is not obvious to us what should be the (one) “right” way of comparing the effects of aging on adverse outcomes across ethnic or other groups; i.e., whether relative effects, measured by relative risks or odds ratios, or absolute effects, measured by risk differences, should be used (21). It seems important to us to show both sets of effects. One can further argue however, that risk differences might indeed be more relevant both to parents and to policy makers as they represent the net additional risks associated with advancing maternal age.

The weathering hypothesis, as formulated by Geronimus (22) maintains that the effects of social inequality on the health of populations may compound with age leading to growing gaps in health status of women through young and middle adulthood that can affect their pregnancy outcomes. Indeed, Geronimus has shown that the racial disparity between African Americans and whites in birth outcomes widens with advancing maternal age from teenage years to young and middle adulthood (13, 22). This increasing disparity is in turn attributed to the accumulating deleterious effects of discriminatory and hazardous socioeconomic and environmental circumstances of African American women.

In addition, it has been suggested that advancing maternal age is associated with lower birth weight among infants born to African American women and that this age effect is exacerbated by individual poverty (23). In particular, the effect of mater-

nal aging on middle low birth, a category of births that often reflect fetal growth problems, was found to be highest for poor African American women. On the other hand, findings on the effects of community poverty, over and beyond those of individual poverty have not been consistent (22, 23). It is clear however, that especially for poor African American women, weathering effects presumably due to chronic exposure to health-eroding factors result in increased risk for adverse birth outcomes associated with advancing maternal age.

Our findings suggest that such weathering effects may not be limited to African American women and might also apply to other groups that have disadvantaged socioeconomic circumstances. Puerto Ricans constitute a high-risk group for adverse birth outcomes (24) and are also likely to face disadvantaged or discriminatory socioeconomic circumstances, which might have accumulating deleterious effects with advancing maternal age. We also found evidence of weathering with advanced maternal age for Mexican Americans. Previous studies have shown an apparently protective effect of ethnicity on pregnancy outcomes in Mexican Americans (24), who on average have lower economic resources than non-Hispanic whites. The favorable pregnancy outcomes of Mexican Americans remain to be adequately explained and have been termed “epidemiological paradox.” Palloni and Morenoff argue that the paradox may indeed be the consequence of ignoring social selection processes (25). In any case, our findings suggest that the case of advanced maternal age may not necessarily fit the “paradox” paradigm in reference to Mexican Americans. Indeed, advanced maternal age was associated with significantly higher increments in the risk of low birth weight for Mexican Americans as compared with non-Hispanic whites.

In conclusion, advanced maternal age appears to be associated with for the most part similarly increased odds of low birth weight for African Americans, Mexican Americans, Puerto Ricans, and non-Hispanic whites. However, the age-related increments in the risk of low birth associated with advanced maternal age are greater for African Americans, Puerto Ricans, and to a lesser extent, Mexican Americans, as compared with non-Hispanic whites; this is true for both first births and births of second and higher order. Hence, our results suggest that weathering hypothesis might be applicable to ethnic groups other than African Americans.

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