

# Associations of Maternal Age- and Parity-Related Factors With Trends in Low-Birthweight Rates: United States, 1980 Through 2000

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Rates of low birthweight (LBW) in the United States increased from 1980 through 2000.<sup>1,2</sup> During the same period, percentages of births among teenage mothers declined, whereas percentages among mothers 35 years or older increased.<sup>2-5</sup> Because there is a U-shaped relationship between maternal age and LBW,<sup>6-10</sup> the decreasing percentages observed among teenage mothers should have lowered crude LBW rates over the period, and the increasing percentages among older mothers should have led to a rise in these rates. A number of studies<sup>4,6,8,9,11-19</sup> have examined changes in maternal age, parity status, and LBW separately; in the present investigation, we assessed changes in these factors simultaneously.

The relationships between maternal age, parity status, and LBW are important. If age- and parity-specific LBW rates are constant over time, changes in secular LBW trends may predominantly reflect changes in maternal age and parity, and there may be little intervention potential apart from preventing teenage pregnancies. However, if age- and parity-specific LBW rates change over time, this may reflect shifts in medical practice, environmental exposures, socioeconomic status, or personal lifestyles. We assessed these 2 possible sources of change separately because age- and parity-specific rates are the primary target of public health interventions (e.g., prenatal care clinics) and can be used to assess racial disparities.

## METHODS

We analyzed National Center for Health Statistics (NCHS) natality files for the period 1980 through 2000. We restricted the analysis to singleton live-born infants of mothers who: (1) were aged 15 to 49 years, (2) had delivered fewer than 16 infants, and

**Objectives.** We assessed the effects of changes in the maternal age–parity distribution and age- and parity-specific low-birthweight rates on low-birthweight trends in the United States.

**Methods.** We used natality file data from 1980 through 2000 to assess very-low-birthweight and low-birthweight rates among singleton live-born infants.

**Results.** Changes in age- and parity-specific low-birthweight rates were the main contributor to the overall trend in rates. However, changes in the age–parity distribution, primarily delayed childbearing, had a smaller but noticeable impact. The very-low-birthweight rate increased 27% among Black women, and changes in the age–parity distribution were associated with, on average, more than 20% of the increased rate during the 1990s. Among Hispanic and non-Hispanic White women, on average, more than 10% of the rate increase observed during the 1990s was associated with changes in the age–parity distribution.

**Conclusions.** Assuming minimal changes in age-specific rates, delayed childbearing may play an increasingly important role in low-birthweight trends in the United States. (*Am J Public Health.* 2006;96:856–861. doi:10.2105/AJPH.2004.049312)

(3) had complete information on birthweight, parity, race, and age. In the NCHS natality files, birthweights below 1500 g are classified as very low, and birthweights below 2500 g are classified as low. We calculated, separately for Black women and White women, rates for each age (15–49 years), calendar year (1980–2000), and parity level (0–15).

In conducting our analyses, we used a standardization and decomposition method introduced 50 years ago in the social sciences<sup>20</sup> but as yet little used in epidemiology. This method can be used to factor the difference between 2 observed rates in a population at 2 separate time points into 2 components. Here one of these components reflected differences in age- and parity-specific LBW rates, and the other reflected differences in age–parity distribution.<sup>20</sup> The former component addressed the extent to which rates would have changed if age- and parity-specific rates had changed as in fact observed but the age–parity distribution had

remained constant (as, e.g., in the 1980 population); the latter component addressed the extent to which rates would have changed if the age–parity distribution changed as observed but age- and parity-specific LBW rates had remained constant. The first component indicates the effects of changes in age- and parity-specific LBW rates, and the second indicates the effects of changes in the age–parity distribution (of course, age–parity distribution “effects” include effects of factors associated with age and parity as well as age and parity themselves).

Our goal was to separate the difference between 2 given crude LBW rates into components associated with changes in the age–parity distribution and changes in age- and parity-specific LBW rates. The decomposition method can be described as follows: Let  $L_1$  and  $L_2$  be 2 crude rates for 1980 and 1990, respectively; let  $R_{ij1}$  and  $R_{ij2}$  be age- and parity-specific rates for 1980 and 1990 ( $i=15, 16, 17, \dots, 49$  years of age and  $j=$ parity 1, 2, 3,  $\dots, 15$ ); let  $N_{ij1}$  and  $N_{ij2}$  be the

number of births at the *i*th age and *j*th parity in 1980 and 1990; and let  $N_{+1}$  and  $N_{+2}$  be the total number of births in 1980 and 1990. Then  $L_1$  and  $L_2$  equal

$$(1) \quad L_1 = \sum_{ij} \frac{N_{ij1}}{N_{+1}} R_{ij1}$$

$$(2) \quad L_2 = \sum_{ij} \frac{N_{ij2}}{N_{+2}} R_{ij2}$$

A crude rate can be expressed as a weighted average of category-specific rates with a weight equal to the actual population studied.<sup>21</sup> Thus, the difference between 2 LBW rates can be separated into differences resulting from changes in age- and parity-specific rates and differences resulting from changes in age-parity distributions<sup>20,22</sup>:

$$(3) \quad L_2 - L_1 = \sum_{ij} \frac{N_{ij1}}{N_{+1}} (R_{ij2} - R_{ij1}) + \sum_{ij} R_{ij2} \left( \frac{N_{ij2}}{N_{+2}} - \frac{N_{ij1}}{N_{+1}} \right)$$

Equation 3 is obtained via adding and subtracting

$$\sum_{ij} \frac{N_{ij1}}{N_{+1}} R_{ij2}$$

from the difference  $L_2 - L_1$ . The proportions  $N_{ij1}/N_{+1}$  and  $N_{ij2}/N_{+2}$  for ages  $i=15, 16, 17, \dots, 49$  years and parity  $j=1, 2, 3, \dots, 15$  represent the age-parity distributions in 1980 and 1990, respectively. The first term on the right-hand side of Equation 3 is the 1980-weighted average difference in rates within each age-parity subgroup. It represents the LBW rate change from 1980 to 1990 that would have ensued from the observed changes in age- and parity-specific rates if the age-parity distribution

had remained the same as in 1980 ( $N_{ij1}/N_{+1}$ ) (i.e., using the 1980 population as a standard). The second term is the difference in one rate standardized to the 1980 age-parity distribution and the same rate standardized to the 1990 distribution. It represents the LBW rate change from 1980 to 1990 that would have ensued from the observed changes in the maternal age-parity distribution if age- and parity-specific LBW rates had remained constant ( $R_{ij1}=R_{ij2}$ ).

Because both LBW and very-low-birthweight (VLBW) rates among White women increased after 1990 and the LBW rate among Blacks decreased after 1990, we applied the decomposition approach from 1980 through 1990 using the 1980 population as the standard; for 1990 through 2000, we used the 1990 population as the standard. From 1990 through 2000, when natality file data were available on Hispanic origin of mothers, we calculated results for non-Hispanic White women and Hispanic women separately.

## RESULTS

The NCHS natality files for the period 1980 through 2000 contain records on 78 023 668 singleton births. As mentioned, we excluded births missing information on birthweight (0.12%) and parity (0.33%), as well as births among mothers who were younger than 15 or older than 49 years (0.28%), had delivered more than 15 infants (0.96%), and whose race/ethnicity was classified as “other” (4.7%). These exclusions left 73 628 288 births for the analysis. Of the 33 533 795 infants included in the 1980

through 1989 period, 83% were White and 17% were Black. Of the remaining infants included during 1990 through 2000, 65.0% were non-Hispanic White, 16.4% were Black, and 18.6% were Hispanic.

### Very-Low-Birthweight Rates

Among non-Hispanic White women, the VLBW rate increased 2% from 1980 through 1990 and increased 11% from 1990 through 2000; among Black women, it increased 27% from 1980 through 2000 (from 2.06% to 2.61%); and, among Hispanic women, it increased 10% from 1990 through 2000 (Table 1). Rates of teenage births declined 21% (from 13.6% to 10.7%) among Whites and 26% (from 26.9% to 20.0%) among Blacks from 1980 through 2000. From 1980 to 2000, birth rates among White women 35 years or older increased 3-fold (from 4.5% to 13.6%), and rates among Black women 35 years or older more than doubled (from 4.0% to 9.6%).

As can be seen in Table 1, the percentage point difference between the VLBW rate in 1990 and 2000 among non-Hispanic Whites was 0.08 (0.73% vs 0.81%). The (percentage point) portion of this difference due to changes in the maternal age-parity distribution was 0.005 (6% of the total difference), whereas the portion due to changes in the age- and parity-specific LBW rate was 0.074 (94% of the total difference). Among Blacks, the VLBW rate increased 18% from 1980 through 1990, and about 16% of the increase was attributable to changes in the age-parity distribution (Table 1).

Among non-Hispanic Whites, the portion of the increased VLBW rate between 1990

**TABLE 1—Differences in Very-Low-Birthweight (VLBW) Rates, by Race/Ethnicity: United States, 1980, 1990, and 2000**

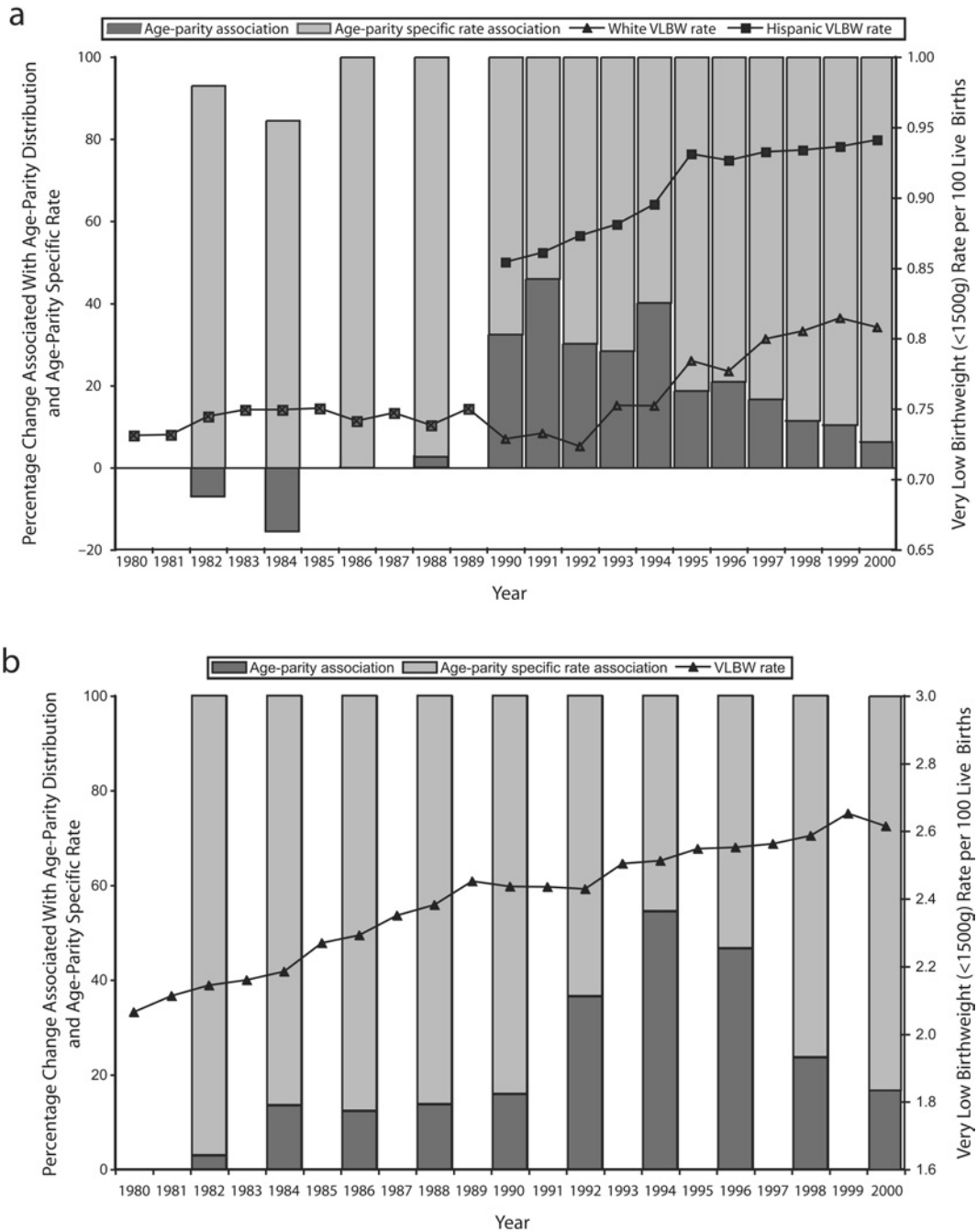
	1980 VLBW Rate, %	1990 VLBW Rate, %	2000 VLBW Rate, %	Percentage Point Change in Rate	Change, %	Change Associated With Age- and Parity-Specific Rate <sup>a</sup>	Change Associated With Age-Parity Distribution <sup>a</sup>	Change Associated With Age- and Parity-Specific Rate, %	Change Associated With Age-Parity Distribution, %
White	0.731	0.745	...	0.015	2.0	0.010	0.005	67.6	32.5
Black	2.064	2.436	...	0.371	18.0	0.312	0.059	84.1	15.9
Non-Hispanic White	...	0.728	0.808	0.080	11.0	0.074	0.005	93.7	6.3
Hispanic	...	0.854	0.941	0.087	10.2	0.078	0.009	90.1	9.9
Black	...	2.436	2.614	0.178	7.3	0.148	0.030	83.2	16.8

<sup>a</sup>Values in this column represent decomposed total percentage points.

and 2000 due to changes in the age-parity distribution declined from a peak of 40% in 1994 to approximately 9% in 1999 (Figure 1a). Among Hispanics, changes in the

age-parity distribution were associated with 10% (2000) to 46% (1991) of the increased VLBW rate (Figure 1a). The portion of the increased VLBW rate due to changes in the

age-parity distribution among Blacks declined from a peak of 55% in 1994 to about 17% in 1999 (Figure 1b). Between 1980 and 2000, more than 90% of the increased



Note. For 1990 through 2000, the odd-year percentage distribution bars associated with changes in the age-parity distribution and changes in age- and parity-specific rates refer to Hispanics, and the even-year bars refer to non-Hispanic Whites.

**FIGURE 1—Trends in very-low-birthweight (VLBW) rates and percentage distributions associated with changes in the age-parity distribution and changes in age- and parity-specific rates among Whites and Hispanics (a) and Blacks (b): United States, 1980-2000.**

**TABLE 2—Differences in Low-Birthweight (LBW) Rates, by Race/Ethnicity: United States, 1980, 1990, and 2000**

	1980 LBW Rate, %	1990 LBW Rate, %	2000 LBW Rate, %	Percentage Point Change in Rate		Change Associated With Age- and Parity-Specific Rate <sup>a</sup>	Change Associated With Age-Parity Distribution <sup>a</sup>	Change Associated With Age- and Parity-Specific Rate, %	Change Associated With Age-Parity Distribution, %
White	4.876	4.642	...	-0.234	-4.8	-0.217	-0.017	92.6	7.4
Black	11.242	11.510	...	0.268	2.4	0.166	0.102	61.8	38.2
Non-Hispanic White	...	4.554	4.879	0.325	7.1	0.295	0.030	90.8	9.2
Hispanic	...	5.178	5.336	0.158	3.1	0.160	-0.002	101.2	-1.18
Black	...	11.510	11.147	-0.363	-3.2	-0.406	0.043	111.9 <sup>b</sup>	-11.9 <sup>b</sup>

<sup>a</sup> Values in this column represent decomposed total percentage points.

<sup>b</sup> Reflects a net decline in LBW prevalence.

VLBW rate due to changes in the age–parity distribution was a result of the increased proportion of births among mothers in all racial/ethnic groups who were 35 years or older (data not shown).

### Low-Birthweight Rates

Similar to the patterns evident in VLBW rates, the relationships between age and LBW were U-shaped among both White and Black women. The percentage of LBW babies born to teenage mothers declined from 1980 through 2000 and increased among mothers 35 years or older during the same period.<sup>23</sup>

Among Whites, LBW rates declined between 1980 and 1990 and increased thereafter (Table 2). The latter trend was primarily a result of the 91% increase in the age- and parity-specific rate. Among Hispanics, the 3% increase in the LBW rate between 1990 and 2000 was entirely attributable to the change in the age- and parity-specific rate (Table 2). Among Blacks, LBW rates declined slightly between 1990 and 2000 (from 11.5% to 11.1%) (Table 2). If the age–parity distribution among Black women had remained the same in 2000 as in 1990, the decline would have been 3.6% instead of the 0.04% observed.

Among Whites, changes in the age–parity distribution were associated with more than 25% of the increased LBW rate during the mid-1990s (Figure 2a). Among Hispanics, changes in the age–parity distribution were associated with more than a 10% increase during the 1990s (Figure 2a). Among Blacks, the increased proportion of mothers 35 years or older had an effect opposite that of declining age- and parity-specific LBW rates between

1990 and 2000 (Figure 2b). The slight increase in the LBW rate between 1990 and 1994 among Blacks (from 11.5% to 11.6%) was due to changes in the age–parity distribution (Figure 2b).

### DISCUSSION

Changes in age- and parity-specific rates were the main contributor to increases in VLBW rates among both White and Black women during the study period, as well as increases in LBW rates among non-Hispanic White and Hispanic women between 1990 and 2000 and decreases in the LBW rate among Black women during the same interval. Changes in the age–parity distribution made smaller but important contributions to the secular trends observed, especially the VLBW trend among Blacks, for whom more than 20% of the increase in the VLBW rate was due to changes in the age–parity distribution between 1990 and 2000. Among non-Hispanic Whites, VLBW rates increased approximately 11% from 1990 through 1998, and more than 10% of this increase was due to changes in the age–parity distribution (Figure 1a).

Similar to the results among non-Hispanic Whites, VLBW rates increased about 10% from 1990 through 2000 among Hispanics, and more than 10% of the increase was due to changes in the age–parity distribution (Figure 1a). A major contributor to the age–parity distribution was the increased proportion of births to mothers 35 years or older; the frequency of such births increased 3-fold among Whites and more than doubled among Blacks between 1980 and 2000.<sup>23</sup>

The expected impact of this increase in births to older mothers appeared to be partially offset by a decrease in the proportion of babies born to teenagers.

LBW infants have greatly elevated risks of morbidity and mortality.<sup>24–26</sup> Mortality among LBW infants, who represented 7.6% of infants in the United States in 2000, accounted for 66% of overall infant mortality during that year.<sup>26</sup> In addition, LBW infants, and especially VLBW infants, are at heightened risk of growth and developmental problems.<sup>27–30</sup> Despite the risks associated with older maternal age at birth (including LBW), more women are delaying having children until relatively late in life,<sup>3,5,19,31,32</sup> and the percentage of first births in which the mother was 30 through 40 years of age more than doubled from 1970 to 1990.<sup>5</sup> Factors that have contributed to delayed childbearing include an aging population, women's pursuit of advanced education, expanded roles for women in the workplace, advances in contraceptives, delayed and second marriages, and financial concerns.

Our results revealed that the LBW rate among Blacks was about twice that among Whites but that this racial disparity diminished between 1990 and 2000 as the LBW rate declined among Blacks and increased among Whites (Figure 2). The decline among Blacks apparently would have been greater if the age–parity distribution had remained constant from 1990 through 2000 (Table 2).

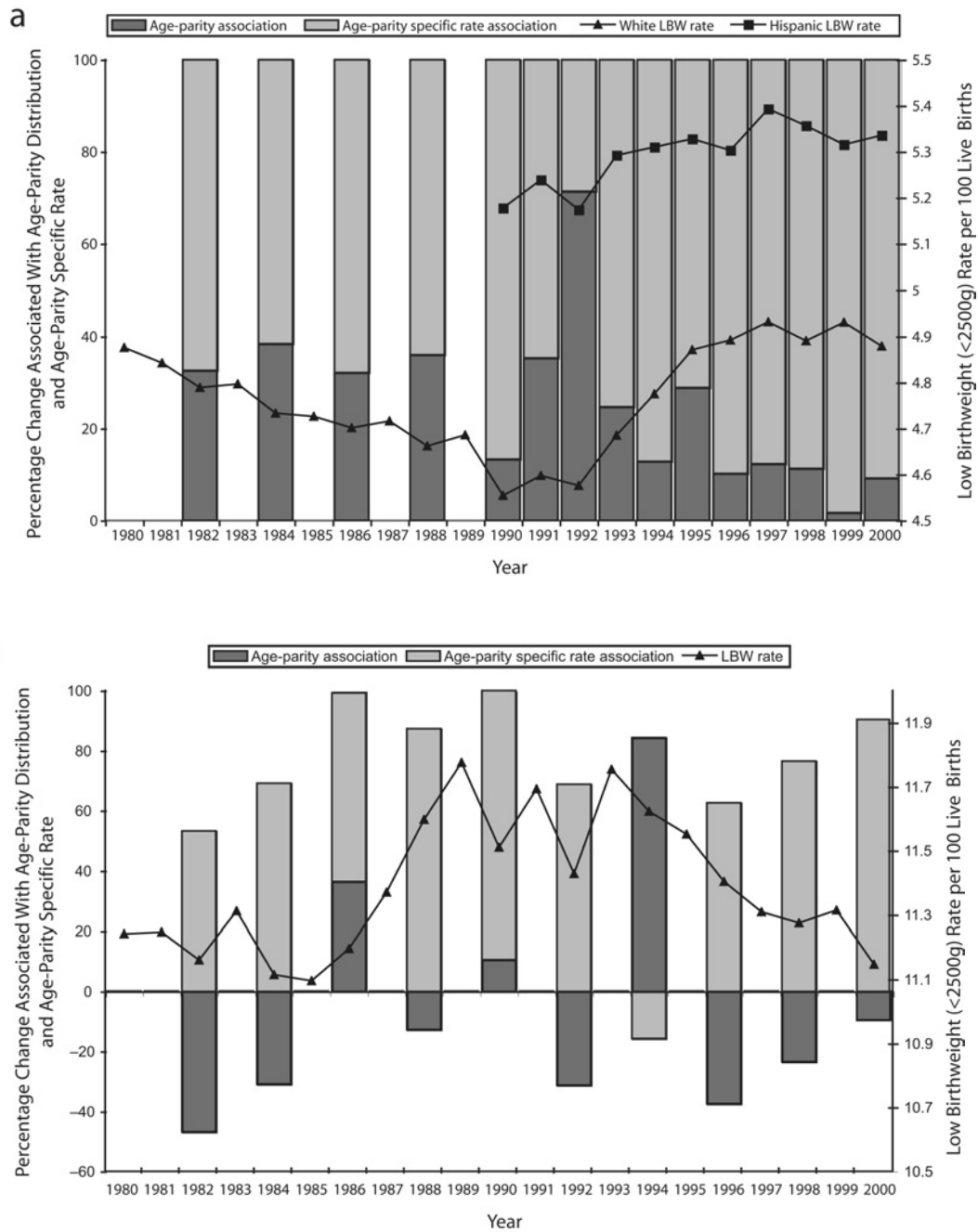
The NCHS natality files do not include data on other risk factors for LBW. We were not able to address potential causes of increased age- and parity-specific LBW rates, but possibilities are changes in lifestyles, environmental

exposures, or obstetrical practices and decreases in the frequency of fetal deaths (leading to increases in preterm live births). Part of the increased LBW rate observed during the

study period, especially in the 1990s, might be attributable to the increased use of assisted reproductive therapies, which, especially among women at relatively advanced ages,

have been shown to be associated with increased LBW risk.<sup>33</sup>

The decomposition approach used in this study allowed us to separate the difference



Note. For 1990 through 2000, the odd-year percentage distribution bars associated with changes in the age-parity distribution and changes in age- and parity-specific rates refer to Hispanics, and the even-year bars refer to non-Hispanic Whites.

**FIGURE 2—Trends in low-birthweight rates (LBW) and percentage distributions associated with changes in the age-parity distribution and changes in age- and parity-specific rates among Whites and Hispanics (a) and Blacks (b): United States, 1980-2000.**

between 2 rates into additive components, and the approach is easy to use and interpret. Compared with statistical techniques such as linear regression analysis, it is less model dependent and involves fewer assumptions.<sup>34</sup> Although it can be combined with statistical modeling,<sup>22</sup> this approach seemed unnecessary here owing to the large numbers available. Of course, this decomposition does not necessarily reflect causal relationships; instead, it reflects the relative contribution of factors associated with standardization variables (here, age and parity) as opposed to other factors, as well as the changes in these factors over time. Also, the relative sizes of the components associated with the age–parity distribution and with age- and parity-specific rates are not unique; they depend on the choice of standard, which should reflect the targeted population of interest.<sup>20–22</sup>

As more women choose to delay childbearing, this trend will continue to play an important role in LBW rates. Nonetheless, it appears that trends in age- and parity-specific rates, which might involve much more intervention potential, are the largest contributor to recent changes in LBW rates. This finding underscores the importance of improvements in prenatal care, nutrition programs, and health education for pregnant women. It also suggests the value of programs aimed at older pregnant women, who may have heretofore received less attention than teenage mothers. ■

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### Contributors

Q. Yang and W.D. Flanders originated and designed the study. S. Greenland provided critical reviews and recommendations on the study design and data analysis. Q. Yang carried out the data analyses and wrote the

drafts of the article. All of the authors contributed to interpretation of results and to article revisions.

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### Human Participant Protection

No protocol approval was needed for this study.

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