BLACK/WHITE DIFFERENCES IN THE RELATIONSHIP OF MATERNAL AGE TO BIRTHWEIGHT: A POPULATION-BASED TEST OF THE WEATHERING HYPOTHESIS

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Abstract—This study seeks to explore if early health deterioration ('weathering') among young adult African American women contributes to observed increases with maternal age in the black/white disparity in birth outcome. Theoretically, 'weathering' is constructed as being a physical consequence of social inequality. Thus, we also examine whether African American mothers vary in their age trajectories of poor birth outcome with respect to social class. Black or white singleton first births to Michigan residents aged 15–34 in 1989 (N = 54,888 births) are analyzed, using data drawn from linked birth and infant death certificates augmented with census-based economic information. We find among blacks, but not whites, advancing maternal age above 15 years is associated with increased odds of LBW and VLBW. Among blacks in low-income areas, the odds of LBW increase 3-fold, and of VLBW 4-fold, between maternal ages 15 and 34. The findings suggest that African American women, on average, and those residing in low-income areas, in particular, experience worsening health profiles between their teens and young adulthood, contributing to their increasing risk of LBW or VLBW with advancing maternal age and to the black-white gap in this risk. The findings suggest the importance of comprehensive prevention strategies to improve the health of socioeconomically disadvantaged African American women prior to pregnancy and the reduction of social inequalities that impact health.

Key words—low birthweight, maternal age, race, socioeconomic status, smoking, risk factors

BACKGROUND

African American infants are more likely than white to be born preterm or low birthweight, and, on average, face twice the risk of death [1]. These differentials have persisted for decades, despite general and race-specific declines [2]. Closing this gap remains a high priority national public health objective [3]. However, the processes that result in this differential remain poorly understood [4, 5]. Many biobehavioral and medical risk factors have been identified including maternal age, hypertension, anemia, and tobacco use during pregnancy [4–8]. However, few investigators conceptualize these risk factors as part of a theory-based causal process linking social background factors to the biological mechanisms through which they are associated with poor birth outcome. An implicit but largely untested assumption is that risk factors operate the same way across populations; study of interaction effects is undeveloped [9]. The importance of returning to basic research approaches—even ones that may question the universal validity of previously identified risk factors—is highlighted by recent observations and research findings. For example, Schoendorf and colleagues [10] note that the size of the racial disparity in poor birth outcome is often greater among mothers with few traditional risk factors than others. In addition, clinical pregnancy risk-screening protocols based on traditional risk factors have been shown to have poor predictive validity, especially when applied to certain socioeconomic or ethnic subpopulations [11, 12]. These findings suggest the importance of moving beyond the identification of specific 'risk factors' apart from their social context and to consider the possibility that the effects of specific demographic or behavioral risk factors may not be invariant across populations [13–15]. In doing so, it is useful to consider psychosocial mechanisms that may vary across populations and heterogeneity within the African American population, as well as taking race comparative approaches [15, 16].

One traditional risk factor that merits reconsideration is maternal age. Maternal age has conventionally been seen as an important determinant of birth outcome and has most often been thought to represent a mother's biological or psychosocial preparedness for childbearing. Young maternal age, or teenage childbearing, has been a source of particular concern. However, the magnitude of the U.S. black/white disparity in neonatal mortality has been observed to widen with increasing maternal age, because risk among black infants increases between the late teens and the 20s, while risk for white
infants decreases between these maternal ages [13, 17, 18]. Geronimus [18] proposed the 'weathering' hypothesis, namely that the effects of social inequality on the health of populations may compound with age, leading to growing gaps in health status through young and middle adulthood that can affect fetal health. This hypothesis suggests that maternal age be reexamined as not only a developmental indicator but also a reflection of the ways in which social inequality, racial discrimination, or race bias in exposures to psychosocial or environmental hazards may, on a population level, affect differentially the health of black vs white women who will become mothers, not only in absolute terms, but also interactively with each other and cumulatively as women age.

Specific to the African American population, Geronimus [18] hypothesizes that the health status of women may begin to deteriorate in detectable ways in young adulthood as a response to perpetual social and environmental insult or prolonged active coping with stressful circumstances. Such insult may have negative implications for a woman's health or health behaviors and for the health of her infant, should she become a mother. Descriptive research provides indirect evidence consistent with this hypothesis. Among women of reproductive age, prevalence rates of health and behavioral characteristics that can complicate pregnancy are excessive among U.S. blacks compared to whites and the increase in prevalence rates with age is more rapid among blacks. Such patterns of increase among women characterize biomedical risk factors, such as hypertension, behavioral risks, such as smoking, as well as risks that result from environmental exposures, such as circulating blood lead levels [18]. However, it has yet to be determined whether these differential health trajectories among non-pregnant women accurately characterize women's health during pregnancy or explain the differential maternal age patterns of poor birth outcome. Furthermore, research to date has described national black or white averages. If social inequality, racial discrimination, or race bias in exposures to psychosocial or environmental hazards may, on a population level, affect differentially the health of black vs white women who will become mothers, not only in absolute terms, but also interactively with each other and cumulatively as women age.

DATA AND ANALYTIC APPROACH
We analyze all black or white singleton first births to Michigan residents aged 15-34 in 1989 (N=54,888; these represent 96% of all 1989 Michigan black or white first births) using linked birth and infant death certificate data combined with information from the 1980 census on the socioeconomic characteristics of the maternal residential area. We limit the sample to first births to control for the potentially confounding effects of maternal age and parity on the risk of poor birth outcome, and to 15-34 year olds due to the infrequency and extreme selectivity of first births to women at younger or older ages.

The birth certificate revisions implemented in 1989 provide enhanced maternal health information compared to vital statistics from earlier years including, for the first time, data on tobacco usage during pregnancy [19]. We have appended census information on the mean income of the maternal residential zip code area to each birth record as a proxy for maternal socioeconomic status. We chose this measure of socioeconomic group for theoretical and practical reasons. The measure of socioeconomic status that is available on the birth certificate, maternal education, is not reliably recorded. In addition, it is unsuitable for a study of the relationship of maternal age to birth outcome because it is correlated with age (e.g. 15 year olds have not had the opportunity to complete their educations) and with age at first birth (fertility-timing and educational attainment can be jointly determined). Further, geographically based measures more clearly match the construct implied by 'weathering' since they can encompass race bias in environmental exposures or in other health-related correlates of residential segregation.

When we began this investigation data from the 1980 census were the most recent available. Thus, we matched information to the birth record that described the 1980 economic characteristics of the mother's current (1989) zipcode area. Findings from a validation study suggest that using census data removed by as much as a decade from the primary data to which they are appended does not materially affect regression results [20]. This is because the relative ranking of geographic units typically remains stable over time, even in the face of some change in absolute income levels. That is, extremely poor areas typically remain poor.

The multilevel nature of the data introduces a potential complication to statistical inference. Because we observe more than one birth in a given zipcode, not all observations are independent. Such non-independence may imply that estimated
To test the research hypotheses, we describe maternal age patterns of low birth weight (LBW) (< 2500 grams) and very low birthweight (VLBW) (< 1500 grams) and of the prevalence of maternal health characteristics that are proximate determinants of poor birth outcome. We test models by estimating multivariate multinomial logistic regressions of the effects of maternal age, socioeconomic group, and maternal health characteristics during pregnancy on birthweight. By exponentiating the coefficients on the explanatory variables in specific regressions, we provide estimates of the relative odds of VLBW or LBW relative to a normal weight baby (2500–3999 grams). We estimate models separately for blacks and whites. To test the second set of hypotheses we include socioeconomic status (SES) x maternal age interaction terms. We define the explanatory variables as:

Maternal Age: Maternal age is coded in single years as a continuous variable.

Racial Identification: We code race as black or white according to the race of the mother.

SES: To proxy economic status, we construct a variable from 1980 census files that represents the average family income in the zipcode area. For all analyses, income values are transformed into their natural logarithms.

Maternal Health Characteristics: Smoking is measured as tobacco use during pregnancy (coded as 1 if yes, 0 if no). A separate category of those missing information on smoking behavior during pregnancy is maintained in the analyses. Hypertension includes dummy variables for mothers with either chronic hypertension or pregnancy induced hypertension. Records with no information on medical risk factors are placed in a separate ‘missing’ category. High Risk is a variable that indicates that a woman had an excess number of prenatal care visits, given the duration of her pregnancy. We include this as a maternal health characteristic because it indicates that in the clinician’s judgement the course of the pregnancy required a more intensive regimen of medical attention than normally recommended. In models where multiple maternal risk factors are controlled, we include a variable, Total Conditions, representing a tally of all medical risk factors, both previous and pregnancy induced conditions. Pregnancy-induced conditions include occurrences of non-hypertensive pregnancy-related disorders (diabetes, hydramnios/ oligohydramnios, incompetent cervix, Rh sensitization, uterine bleeding). Previous conditions include occurrences of other medical conditions (cardiac disease, lung disease, genital herpes, anemia, hemoglobinopathy, renal disease). The total conditions variable also includes counts of those for whom some ‘other’ condition was noted.

Prenatal Care Access: To control for prenatal care receipt we use the Kotelchuck Adequacy of Prenatal Care Utilization Index (APNCU) [22]. In the APNCU, the total number of prenatal visits reported is compared to the number which would be expected based on American College of Obstetricians and Gynecologists standards, given the date care began and the date of delivery. The proportion of observed to expected visits is then scaled: 0–49% of expected = Inadequate; 50–79% = Intermediate; 80–109% = Adequate; 110+ = Adequate Plus. We include those with missing information in the inadequate category. To control for prenatal care access, we include two dummy variables indicating whether the mother was coded as having either inadequate or intermediate care. The omitted category thus includes those with at least adequate care (the proportion of observed to expected visits is at least 80).

As implied above, we use information on the extent of prenatal care to measure access to care and pregnancy risk status. We do so because variation in prenatal care receipt occurs because women vary in their access to care and because women who perceive themselves or are perceived by physicians to be high risk may receive more care than others. Because obstetrics standards for adequate care apply to all women, regardless of their underlying health, we assume that whether a woman receives less than adequate care is largely a function of access rather than of perceived risk. Once we control for whether or not a woman has received at least adequate care, we view variation in whether or not she received ‘adequate plus’ care as being a function of risk status. In general, this approach appears reasonable in light of the observed data. For example, black mothers are more likely than white to be in both the inadequate care category and the adequate plus category, suggesting that black women may have less access to care than white, but once in care receive an intensive regimen because of worse health.

RESULTS

In Tables 1 and 2 observed rates of LBW or VLBW and of adverse maternal health characteristics, respectively, are reported by race and age of mother. For blacks, the maternal age patterns of rates of LBW or VLBW are upwardly sloping, with mothers aged 15–19 experiencing the lowest rates of poor birth outcome. Among whites, mothers in their teens and 30’s experience slightly elevated rates of poor birth outcome than white women in their 20’s. As a function of these different maternal age patterns, the size of the excess rate of LBW and VLBW to African Americans relative to whites is higher in the 20s and 30s than in the teens.
Table 1. Rates (per 100) and rate ratios of low birthweight and very low birthweight by maternal age, African American and white singleton first births, Michigan, 1989

<table>
<thead>
<tr>
<th>Maternal age</th>
<th>N</th>
<th>LBW rates and rate ratios</th>
<th>VLBW rates and rate ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black</td>
<td>White</td>
<td>Black/white</td>
</tr>
<tr>
<td>15-19</td>
<td>5244</td>
<td>8992</td>
<td>11.6</td>
</tr>
<tr>
<td>20-24</td>
<td>3384</td>
<td>14415</td>
<td>12.4</td>
</tr>
<tr>
<td>25-29</td>
<td>1482</td>
<td>14541</td>
<td>14.0</td>
</tr>
<tr>
<td>30-34</td>
<td>608</td>
<td>6172</td>
<td>17.8</td>
</tr>
<tr>
<td>Total</td>
<td>10718</td>
<td>44120</td>
<td>12.5</td>
</tr>
</tbody>
</table>

Table 2 shows that maternal age patterns of smoking also vary by race. Rates of smoking during pregnancy increase among African American mothers from the teens through the 30s, while those for whites decrease. African American mothers in their teens and early 20's are less likely to smoke during pregnancy than their white counterparts, but they are more likely to smoke during pregnancy by the latter half of the 20s than are whites. For both blacks and whites, the rates of hypertension during pregnancy are higher among older compared to younger mothers, but the increase in hypertension prevalence is steeper among blacks. Similarly, the percentage of mothers who are 'high risk' increases with age among both blacks and whites, but more steeply for blacks. There is a 14.5 percentage point rise between the ages of 15-19 and 30-34 for blacks, but only a 7% rise for whites. The black/white gap increases accordingly.

In Table 3, we report the distribution of black or white mothers by maternal age who reside in areas with mean family incomes below the black median. Within either racial group younger mothers are more likely to live in socioeconomically disadvantaged areas than older mothers. Within each age group black mothers are far more likely than white to live in such areas. These differences are statistically significant ($P<0.001$). Thus, the effects on poor birth outcome of maternal age or race are potentially confounded by socioeconomic group.

MULTINOMIAL LOGISTIC MODELS

For blacks the estimated effect of maternal age on LBW or VLBW is positive, statistically significant, and of substantial magnitude. For example,

Table 3. Percent of mothers living in zipcodes with mean family incomes below African American median,* by race and age, singleton first births, Michigan, 1989

<table>
<thead>
<tr>
<th>Maternal age</th>
<th>% below</th>
<th>% below</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-19</td>
<td>56.5</td>
<td>26.1</td>
</tr>
<tr>
<td>20-24</td>
<td>51.2</td>
<td>21.2</td>
</tr>
<tr>
<td>25-29</td>
<td>45.2</td>
<td>12.5</td>
</tr>
<tr>
<td>30-34</td>
<td>42.5</td>
<td>10.5</td>
</tr>
</tbody>
</table>

*$20,215.

Table 4. Odds (95% confidence intervals) of low birthweight or very low birthweight for mothers aged 25 relative to mothers aged 15, adjusted for maternal health characteristics, African American or white singleton first births, Michigan, 1989

<table>
<thead>
<tr>
<th>Maternal health characteristics</th>
<th>African Americans</th>
<th>Whites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prenatal care</td>
<td>1.32 (1.14, 1.53)</td>
<td>1.78 (1.41, 2.26)</td>
</tr>
<tr>
<td>Smoking*</td>
<td>1.21 (1.04, 1.41)</td>
<td>1.66 (1.30, 2.12)</td>
</tr>
<tr>
<td>High blood pressure*</td>
<td>1.29 (1.12, 1.50)</td>
<td>1.73 (1.36, 2.19)</td>
</tr>
<tr>
<td>High risk*</td>
<td>1.30 (1.13, 1.52)</td>
<td>1.75 (1.38, 2.22)</td>
</tr>
<tr>
<td>All conditions**</td>
<td>1.17 (1.00, 1.36)</td>
<td>1.55 (1.21, 1.97)</td>
</tr>
</tbody>
</table>

*Prenatal care is also controlled in these models.
†Maternal health characteristics controlled include hypertensive disease (chronic or pregnancy associated), smoking, diabetes, hydramnios/oligohydramnios, incompetent cervix, Rh sensitization, uterine bleeding, cardiac disease, lung disease, genital herpes, anemia, hemoglobinopathy, renal disease, or other conditions.
Table 5. Selected odds ratios (95% confidence intervals) of low birthweight by maternal age and socioeconomic status, unadjusted and adjusted for maternal health characteristics, African American singleton first births, Michigan, 1989

<table>
<thead>
<tr>
<th>Maternal age</th>
<th>Low SES*</th>
<th>Average SES†</th>
<th>High SES‡</th>
<th>Maternal age</th>
<th>Low/high</th>
</tr>
</thead>
<tbody>
<tr>
<td>15/15</td>
<td>1.00 (1.00, 1.00)</td>
<td>1.00 (1.00, 1.00)</td>
<td>1.00 (1.00, 1.00)</td>
<td>15</td>
<td>0.85 (0.65, 1.10)</td>
</tr>
<tr>
<td>16/15</td>
<td>1.04 (1.02, 1.07)</td>
<td>1.02 (1.00, 1.03)</td>
<td>0.99 (0.97, 1.02)</td>
<td>16</td>
<td>0.90 (0.71, 1.14)</td>
</tr>
<tr>
<td>20/15</td>
<td>1.52 (1.23, 1.89)</td>
<td>1.19 (1.01, 1.39)</td>
<td>0.93 (0.74, 1.18)</td>
<td>20</td>
<td>1.11 (0.95, 1.31)</td>
</tr>
<tr>
<td>25/15</td>
<td>1.22 (1.48, 3.53)</td>
<td>1.38 (1.03, 1.86)</td>
<td>0.87 (0.56, 1.37)</td>
<td>25</td>
<td>1.42 (1.17, 1.73)</td>
</tr>
</tbody>
</table>

Odds ratios (CFs) for selected maternal ages relative to age 15

Adjusted for maternal health characteristics

<table>
<thead>
<tr>
<th>Maternal age</th>
<th>Low SES*</th>
<th>Average SES†</th>
<th>High SES‡</th>
<th>Maternal age</th>
<th>Low/high</th>
</tr>
</thead>
<tbody>
<tr>
<td>15/15</td>
<td>1.00 (1.00, 1.00)</td>
<td>1.00 (1.00, 1.00)</td>
<td>1.00 (1.00, 1.00)</td>
<td>15</td>
<td>0.87 (0.67, 1.14)</td>
</tr>
<tr>
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<td>1.04 (1.02, 1.07)</td>
<td>1.02 (1.00, 1.03)</td>
<td>0.99 (0.97, 1.02)</td>
<td>16</td>
<td>0.92 (0.72, 1.16)</td>
</tr>
<tr>
<td>20/15</td>
<td>1.52 (1.23, 1.89)</td>
<td>1.19 (1.01, 1.39)</td>
<td>0.93 (0.74, 1.18)</td>
<td>20</td>
<td>1.14 (0.97, 1.34)</td>
</tr>
<tr>
<td>25/15</td>
<td>1.22 (1.48, 3.53)</td>
<td>1.38 (1.03, 1.86)</td>
<td>0.87 (0.56, 1.37)</td>
<td>25</td>
<td>1.53 (1.27, 1.85)</td>
</tr>
<tr>
<td>30/15</td>
<td>2.33 (1.69, 3.22)</td>
<td>1.48 (1.17, 1.87)</td>
<td>0.96 (0.67, 1.36)</td>
<td>30</td>
<td>2.06 (1.51, 2.82)</td>
</tr>
<tr>
<td>34/15</td>
<td>2.92 (1.94, 4.40)</td>
<td>1.64 (1.22, 2.21)</td>
<td>0.95 (0.60, 1.48)</td>
<td>34</td>
<td>2.62 (1.70, 4.02)</td>
</tr>
</tbody>
</table>

*The typical pattern of odds ratios for black mothers living in zipcode areas with mean incomes in the bottom 20% of mean incomes of all zipcodes where black study mothers reside (median income = $20,215).
†The typical pattern of odds ratios for black mothers living in zipcode areas with mean incomes at the median of mean incomes of all zipcodes where black study mothers reside (median income = $25,606).
‡The typical pattern of odds ratios for black mothers living in zipcode areas with mean incomes in the top 20% of mean incomes of all zipcodes where black study mothers reside (median income = $25,606).
§Maternal health characteristics and prenatal care are controlled in these models.

25 year old black mothers experience a 28% increased odds of low birth weight and a 70% increased odds of VLBW relative to 15 year old black mothers. In contrast, among whites maternal age is not significantly related to VLBW or LBW. In Table 4 we report odds ratios of the effect of postponing childbirth from age 15 to age 25 on LBW and VLBW, controlling for prenatal care receipt and adjusted for specific maternal health characteristics. Among blacks, when only prenatal care receipt is controlled, 25 year old black mothers experience a 28% increase in the odds of LBW and a 70% greater odds of VLBW than 15 year old black mothers. Controlling for smoking reduces this increase in the odds of LBW by one-third and in the odds of VLBW by 15%. Controlling for either hypertension or high risk status accounts for only a small share (5-10%) of the increased odds of LBW or VLBW with advancing maternal age. Controlling for all of the measured maternal health characteristics reduces the increased odds of LBW almost in half and the effect of maternal age is no longer statistically significant. For VLBW, the increased odds with older maternal age is reduced by 30% when all measured health characteristics are controlled, but the maternal age effect remains sizeable and statistically significant.

For whites we estimated linear and curvilinear functions of the effects of maternal age on poor birth outcome. For ease of presentation, we report results from the linear regressions, but in both cases we find little evidence of any effect of postponing childbirth on the risk of LBW or VLBW. However, controlling for smoking during pregnancy strengthens the (small) positive relationship between maternal age and the odds of LBW among whites. The estimated age effect becomes statistically significant and implies a five-fold increase in the odds of LBW when childbirth is postponed from age 15 to 25.

Although the unadjusted estimates suggest very different maternal age patterns of LBW or VLBW for blacks and whites, when all measured maternal health characteristics are controlled the racial difference in the effects on LBW of postponing childbirth from age 15 to 25 narrows by 80% and is statistically insignificant. The difference in VLBW narrows by 20%, but remains substantial.

HETEROGENEITY AMONG AFRICAN AMERICANS

To illustrate the implications of the study findings for differences in 'weathering' among blacks by socioeconomic group (i.e. to address our second working hypothesis), we calculated selected odds ratios of LBW or VLBW from models including SES x maternal age interactions. We limit this exercise to African Americans also because, using these data, there is no evidence of important maternal age or SES x maternal age effects among whites.

Estimated odds ratios among African Americans by socioeconomic group (low, average, or high) for selected maternal ages relative to age 15 are shown for LBW in Table 5, and for VLBW in Table 6. The final bank of columns in each table lists the odds ratios (low-SES vs high-SES) of LBW or VLBW at selected maternal ages. The top half of each table shows odds ratios unadjusted for maternal health characteristics, while the bottom half shows odds ratios adjusted for maternal health characteristics.
The odds of LBW among blacks increase with maternal age, but the pattern is not uniform with respect to socioeconomic group. The increase is more dramatic for women in the lower SES category than at the median; while in the high SES category, there is essentially no change with maternal age in the odds of low birthweight. Among those in the lower SES category, by age 20 black mothers experience 1.33 times the odds of LBW as black 15 year old mothers; by age 30, the odds are 2.33 times larger than at age 15; and by age 34 the odds are almost 3 times the odds at age 15. Adjusting for maternal age and poor infant outcome is stronger among blacks in low socioeconomic groups than among the advantaged, and contributes to their increasing risk with age of low and very low birthweight. The relationship between advancing maternal age and poor infant outcome is stronger among black mothers in low socioeconomic groups than in others, with a notable share of this interaction effect explained by the measured maternal health characteristics. These findings are consistent with the theoretical perspective that among the socioeconomically disadvantaged, black women’s health deteriorates more rapidly over the young adult ages than among the advantaged, and contributes to their increasing risk with age of low and very low birthweight. While the study design cannot provide a direct test of the mechanisms that link socioeconomic group to poor maternal health, the fact that this pattern is more pronounced among members of low socioeconomic groups than on average, suggests their adverse health characteristics may be related to hardships associated with social inequality.

On average, rates of maternal health characteristics that are risk factors for poor birth outcome increase with age more rapidly among black com-

**Table 6. Selected odds ratios (95% confidence intervals) of very low birthweight by maternal age and socioeconomic status, unadjusted and adjusted for maternal health characteristics, African American singleton first births, Michigan, 1989**

<table>
<thead>
<tr>
<th>Maternal age</th>
<th>Low SES*</th>
<th>Average SES†</th>
<th>High SES‡</th>
<th>Maternal age</th>
<th>Low-high</th>
</tr>
</thead>
<tbody>
<tr>
<td>15/15</td>
<td>1.00 (1.00, 1.00)</td>
<td>1.00 (1.00, 1.00)</td>
<td>1.00 (1.00, 1.00)</td>
<td>15</td>
<td>0.93 (0.59, 1.46)</td>
</tr>
<tr>
<td>16/15</td>
<td>1.07 (1.04, 1.11)</td>
<td>1.06 (1.03, 1.08)</td>
<td>1.04 (1.01, 1.08)</td>
<td>16</td>
<td>0.96 (0.63, 1.44)</td>
</tr>
<tr>
<td>20/15</td>
<td>1.43 (1.20, 1.70)</td>
<td>1.32 (1.17, 1.48)</td>
<td>1.22 (1.02, 1.46)</td>
<td>20</td>
<td>1.08 (0.82, 1.44)</td>
</tr>
<tr>
<td>25/15</td>
<td>2.04 (1.43, 2.90)</td>
<td>1.74 (1.37, 2.20)</td>
<td>1.49 (1.05, 2.12)</td>
<td>25</td>
<td>1.27 (0.95, 1.69)</td>
</tr>
<tr>
<td>30/15</td>
<td>2.91 (1.71, 4.93)</td>
<td>2.29 (1.61, 3.26)</td>
<td>1.82 (1.07, 3.08)</td>
<td>30</td>
<td>1.48 (0.92, 2.36)</td>
</tr>
<tr>
<td>34/15</td>
<td>3.86 (1.98, 7.55)</td>
<td>2.85 (1.83, 4.46)</td>
<td>2.13 (1.09, 4.16)</td>
<td>34</td>
<td>1.68 (0.88, 3.20)</td>
</tr>
</tbody>
</table>

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‡The typical pattern of odds ratios for black mothers living in zipcode areas with mean incomes in the top 20% of mean incomes for all zipcode areas where black study mothers reside (median income = $25,606).
§Maternal health characteristics and prenatal care are controlled in these models.

**SUMMARY AND DISCUSSION**

Among African American mothers in Michigan, but not whites, maternal age is statistically significantly positively related to the odds of LBW and VLBW. The relationship between advancing maternal age and poor infant outcome is stronger among black mothers in low socioeconomic groups than in others, with a notable share of this interaction effect explained by the measured maternal health characteristics. These findings are consistent with the theoretical perspective that among the socioeconomically disadvantaged, black women’s health deteriorates more rapidly over the young adult ages than among the advantaged, and contributes to their increasing risk with age of low and very low birthweight. While the study design cannot provide a direct test of the mechanisms that link socioeconomic group to poor maternal health, the fact that this pattern is more pronounced among members of low socioeconomic groups than on average, suggests their adverse health characteristics may be related to hardships associated with social inequality.
pared to white mothers. Moreover, almost all of the maternal age dimension to black/white differences in the odds of LBW is explained by these adverse maternal health characteristics. Such findings suggest an important social dimension to black/white differences in rates of poor birth outcome that is mediated through differences in the health or health behaviors of young women.

Among whites, there is little evidence to suggest weathering. Several factors may explain this. In Michigan, white mothers of any age are much less likely than blacks to live in very low-SES areas. Even among teen mothers, almost three-quarters of whites live in areas with family incomes above the black median. This suggests the possibility that few whites may be exposed to the same degree of health insult as blacks. Methodologically, it raises the question of whether the census-based approach for measuring socioeconomic group is adequate for the study of disadvantaged whites. Alternatively, important contributors to weathering may not be captured by income variables alone that may differentially affect blacks and whites. Lower purchasing power at specific incomes among blacks, racism, or race bias in exposures to childbearing hazards are examples of reasons why African Americans may exhibit greater evidence of weathering than whites [14, 23]. The differential maternal age patterns of smoking between blacks and whites also help explain why the findings are consistent with weathering among blacks, but not whites, at least for patterns of LBW. As we later discuss, whether smoking should be thought of as an isolable 'risk factor' or also as a symptom of or response to underlying social processes is, itself, open to question and merits further investigation.

Due to data constraints, the effects of deteriorating maternal health on poor birth outcome among low-SES African Americans may be underestimated. First, underreporting of adverse health conditions on birth certificates is likely to be excessive among black or socioeconomically disadvantaged mothers relative to others [19]. The effect of differential underreporting would be to dampen estimated differences in risk by race or socioeconomic status. To mitigate this limitation, we controlled for prenatal care receipt in all models that included maternal health characteristics. However, our approach to using the prenatal care information, itself, may result in downwardly biased estimates of the effects of maternal health characteristics on birth outcome. To the degree that obtaining adequate care will reflect not only access, but also the propensity of mothers in ill health to seek medical care, including prenatal care in the model may represent over-control. To the extent that receipt of adequate-plus care represents not only need, but also access, the association between poor health and birth outcome may be understated.

Among African Americans, the maternal age and social gradients in risk appear to be more severe for VLBW than for LBW and less of them is explained by the measured maternal health characteristics. Given the estimated severity of these gradients for VLBW; the fact that VLBW infants account for over 60% of the black/white disparity in infant mortality [24], and their disproportionate risk of early childhood morbidity and functional impairment [25], determining whether these findings imply that VLBW and LBW have different etiologies with respect to maternal health characteristics and socioeconomic disadvantage is important. Progress in answering this question must await further analysis with larger samples or better measures. It may be that the information on maternal health characteristics was less reliable for mothers of VLBW infants than for others, because of their greater likelihood of being from low socioeconomic groups or of experiencing preterm birth. While unable to shed clear light on the mechanisms, the study findings do indicate that, contrary to conventional wisdom, the odds of VLBW among African American women in Michigan are substantially higher among older compared to younger mothers, especially in low socioeconomic groups.

As is true nationally, black and white women in Michigan have different fertility-timing distributions with blacks relatively more likely to experience early first births and whites more likely to experience births at relatively older ages. Thus, differential selection into age at first birth may provide an alternative interpretation of the results. However, if the age patterns of maternal health characteristics only reflected such selection, one would expect to find qualitatively different age patterns of adverse health characteristics among the population of reproductive age women as a whole. This is not the case. In national samples, the prevalence of hypertension or cigarette smoking follow the same age patterns by race among non-pregnant women of reproductive age as those observed in this study of population of mothers [18].

The maternal age/race smoking patterns showing older black mothers to be more apt to smoke during pregnancy than black teen mothers are also consistent with those found in a national sample of mothers [17] and in a hospital sample in Baltimore [26]. In part, these patterns may represent cohort effects, as smoking prevalence among teenagers appears to have decreased in recent years [27]. While absolute proportions of women smoking by given ages may have changed over time, the general differential age patterns of smoking by race have been confirmed across cohorts [18].

The extent to which smoking during pregnancy explains the differential maternal age patterns of LBW or VLBW between blacks and whites is notable. Black mothers are more likely to smoke at older ages than at younger ones, and smoking
accounts for one-third of the estimated maternal age effect on LBW and 15% of the effect for VLBW. The lack of an overall maternal age effect among whites appears to be due to the greater prevalence of cigarette smoking among white teen mothers relative to older mothers. Once smoking is accounted for, the odds of bearing LWB babies are statistically significantly lower among younger white mothers than among older ones.

Taken at face value, these results suggest that reducing cigarette smoking among white teen or older black mothers could greatly diminish the differential maternal age patterns of low birth weight, highlighting the need for age-appropriate anti-tobacco interventions. Many anti-tobacco interventions target youth or are school-based [28]. However, among black women, additional components of an effective anti-smoking strategy are necessary that target young adults.

From the weathering conceptual perspective, it is also important to learn what psychosocial processes result in different age patterns of smoking exhibited by black vs white women or mothers. One might wonder whether in social or cultural context, smoking uptake among black women in their 20’s has a rationale. One speculation is that excessive rates of smoking among African American women in their 20’s and early 30’s may be indicative of excessive rates of psychosocial stress to which smoking may be a response [18]. Advertising strategies by tobacco companies targeting female, working class and minority audiences may also augment the chances that African American women use smoking as one way to alleviate stress [29]. The structural sources of the stress, the stress itself, or the physical toll taken by actively coping with stress over a prolonged period may be unobserved factors that also contribute to the maternal age patterns of poor birth outcome among African Americans [15, 18]. If this were the case, the smoking coefficient could be capturing some of these effects as well as any effects of smoking, per se. Qualitative or survey research strategies may be critical sources of information on these or alternative possibilities.

Unlike smoking or all adverse health characteristics combined, accounting only for the specific risk factor of hypertension or ‘high risk’ status does not alter the estimated maternal age effect appreciably. The lack of explanatory power attributed to hypertension or being ‘high risk’ is surprising. It may reflect general or differential underreporting of medical conditions on birth certificates [19]. For example, hypertension prevalence rates for the study population are noticeably lower than national averages for reproductive-age women [30]. In addition, because we control for prenatal care receipt in our models and define ‘high risk’ according to intensive prenatal care receipt, it may be due to the fact that current prenatal care regimens are able to avert the worst sequelae of these risks, but are not as effective in addressing the risk imposed by smoking. That is, the effects of the health conditions are most appropriately interpreted as estimates of their effects given adequate prenatal care. These effects may understate the contribution of these health conditions to poor birth outcome among the medically underserved.

The study findings also contribute to ongoing discussion of the relationship of older maternal age to birth outcome. Berkowitz et al. [31] found that among predominantly white, private patients at a tertiary hospital, advanced maternal age was associated with a somewhat higher rate of pregnancy and delivery complications, but not with a statistically significantly increased rate of poor neonatal outcome. The current study results raise questions about the generalizability of these results to socioeconomically disadvantaged African American women or to women who do not give birth at tertiary centers. Overall, these findings suggest limitations to the conceptual approach that treats maternal age as if it represents primarily a universal developmental process rather than also being reflective of social processes that either affect selection into age at first birth or the impact of social inequality on women’s health over time—that is, with age. For example, the results suggest that whether older maternal age is higher or lower risk than younger maternal age varies by race and socioeconomic status. In addition, maternal age appears to be a marker for different health and behavioral risk profiles in different populations. Of interest, the populations in which early births are most common are those where early births are the lowest risk, raising questions about the social construction of teen childbearing as a universally deleterious behavior [18, 32, 33].

Clinically, these findings raise questions about the validity of routine clinical screening protocols that apply demographic risk characteristics uniformly to estimate risk status in pregnancy. The findings suggest the potential importance of targeting clinical interventions to the needs of socioeconomically disadvantaged African American primiparous women in their 20’s and early 30’s as one means to reduce the racial disparity in low and very low birthweight and infant mortality. More fundamentally, the study findings suggest the importance of comprehensive prevention strategies to improve the general health of socioeconomically disadvantaged women before they become pregnant, perhaps with special emphasis on smoking prevention and cessation, and of social change strategies that reduce social inequalities that impact health.

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