RACE AND PREGNANCY OUTCOMES IN THE TWENTIETH CENTURY: A LONG-TERM COMPARISON

by

Dora L. Costa
MIT and NBER
costa@mit.edu

February 6, 2003

I gratefully acknowledge the support of the Robert Wood Johnson Foundation and NIH grants R01 AG19637 and AG10120.

Race and Pregnancy Outcomes in the Twentieth Century: A Long-Term Comparison

ABSTRACT

JEL Classifications: I1, N3

Differentials between blacks and whites in birth weights and prematurity and stillbirth rates have been persistent over the entire twentieth century. Differences in prematurity rates explain a large proportion of the black-white gap in birth weights both among babies born under Johns Hopkins physicians in the early twentieth century and babies in the 1988 National Maternal and Infant Health Survey. In the early twentieth century untreated syphilis was the primary observable explaining differences in black-white prematurity and stillbirth rates. Today the primary observable explaining differences in prematurity rates is the low marriage rate of black women. Maternal birth weight accounts for 5-8 percent of the gap in black-white birth weights in the recent data, suggesting a role for intergenerational factors. The Johns Hopkins data also illustrate the value of breast-feeding in the early twentieth century – black babies fared better than white babies in terms of mortality and weight gain during the first ten days of life spent in the hospital largely because they were more likely to be breast-fed.

Dora L. Costa
MIT
50 Memorial Drive
Cambridge, MA 02142
costa@mit.edu
and NBER

1 Introduction

In the United States today, African-Americans at all ages are in worse health than whites. They are more likely to be born premature and with lower birth weights for gestational age. They are more likely to die in infancy, in large part because they are born prematurely (Copper et al. 1993). At older ages a greater proportion of African-Americans are likely to report themselves in fair or poor health than whites in the same age group; a greater proportion report limits on activities of daily living; and a greater proportion report having specific chronic conditions, particularly hypertension, diabetes, and arthritis (Manton and Stallard 1997; Smith and Kington 1997). Explanations for black-white health differentials include the greater early life environmental stress faced by African-Americans, lifestyle differences in exercise and diet, differential access to medical care, and differences in income and education.

This paper documents the differential twentieth century trends in black and white pregnancy outcomes and examines what socioeconomic and maternal health factors explained these differentials in the past and in recent times. Examining pregnancy outcomes is important because health differentials in early life may have a long reach. Barker (1994) argued that measures of fetal and maternal malnutrition are related to such adult chronic conditions as ischaemic heart disease, adult-onset diabetes, and thyroid conditions. Doblhammer and Vaupel (2001) found that month of birth, a proxy for the disease and nutritional environment faced by the mother, influences adult life expectancy at ages greater than 49. Preston, Hill, and Drevenstedt (1998) found that among African-Americans survival to age 85 is best predicted by a farm background, having literate parents, and being from a two-parent household. Emmanuel et al. (1999) found that among all ethnic and racial groups studied in Washington state, there is an inverse relationship between maternal birth weight and infant low birth weight. They noted that the birth weights of black mothers were markedly lower than those of white mothers and suggested that racial differences in pregnancy outcomes may be related to maternal prenatal factors. Thus a first-generation college-educated woman may still be carrying the risks of generations of poverty and this risk may be preprogrammed in utero in her children. This paper will use recent data to examine whether black-white differences in maternal birth weight can account for any of the black-white birth weight gap.

Relatively little is known about long-trends in birth weight and even less about racial differentials in prematurity and stillbirth rates. Ward (1993) reported that black babies born at Boston Lying-In in the late nineteenth century were roughly 200 grams smaller than white babies, but that black babies' weight was comparable to that of babies born in Europe. Steckel (1986) used height at young ages to infer that at birth the mean slave baby weighted less than 2500 grams, suggesting severe deprivation. This paper uses records from Johns Hopkins Hospital in the first third of the century and recent data to analyze differential trends not only in birth weights, but also in prematurity and stillbirth rates, the probability of surviving the first ten days of life, and weight gain in the first ten days of life.

2 Producing Healthy Babies

Maternal nutrition and health is an important determinant of birth weight. Women with low prepregnancy weights and with inadequate weight gain tend to have smaller babies. But, the relationship between maternal nutrition and fetal growth is nonlinear; deprivation must pass a threshold level before birth weight is significantly affected because the fetus is protected at the expense of the mother (Tanner 1978). Infectious disease, alcohol or drug use, smoking, and heavy physical work can also reduce birth weight. The impact of these factors varies during gestation. Some are felt most strongly in the third semester, when fetal weight gain is greatest; others are felt most strongly during the first trimester when cell growth is the greatest. Inadequate prenatal care will also affect the development of the fetus, but in the past prenatal care was certainly less effective.[1]

The effects of maternal nutrition and health may extend across generations. Mother's birth weight predicts children's birth weight. Using all births from the 1958 British birth cohort, Emanuel, Alberman, and Evans (1992) find that each 100 grams of maternal birth weight increases the birth weight of singleton births by 12 grams. Studies of maternal and paternal half-siblings find that the intrauterine environment accounted for more of the variance of birth weight than genetics (Morton 1955). Emanuel et al. (1999) argue that the lower birth weights of African-American compared to white mothers may explain the persistence of black-white birth weight differentials.

Maternal infection predicts prematurity and stillbirths. Pre-term births are associated with bacterial vaginosis and previous genital infections. Such maternal infections as syphilis, toxoplasmosis, parvovirus B-19, chorioamnionitis, and Listeria monocytogenes have been implicated in intrauterine deaths. Other medical factors such as hemoglobinopathies and Rh sensitization also play a role (Copper et al. 1994). Mother's health may also play a role in stillbirths through placental insufficiency and intrauterine growth restriction (Petersson et al. 2002). Smoking is associated with both prematurity and stillbirths.

Other important determinants of stillbirths, prematurity, and birth weight are the factors that are specific to a pregnancy, such as the age of the mother, parity, the sex of the child, and the number of births. Birth weight rises at a decreasing rate with the age of the mother, parity, the spacing interval, and gestational age. Taller mothers have larger babies, male newborns tend to weigh about one hundred grams more than females, and multiple births are lighter than single

[1] In the first third of this century prenatal care was common only after the seventh month and consisted largely of instruction of the patient in diet, exercise, and hygiene; arrangements for confinement; desirability of nursing; the importance of regular medical exams to detect abnormalities, toxaemia, and eclampsia; and the danger signs of pregnancy (Speert 1980).

births. In recent populations, prematurity is associated with teen births and with births to mothers older than 34. A high maternal age is also associated with intrauterine fetal death. Congenital malformations also predict stillbirths.

Today death in the first ten days of life is mainly due to congenital factors. At the beginning of the twentieth century babies faced a high risk of death from birth injuries. Based upon data from New York Lying-In, Costa (1998) estimated that at least one third of deaths were from birth injuries, often cerebral hemorrhage, suggesting that the fetal head was large in proportion to the size of the mother's pelvic outlet. Babies at New York Lying-In also failed to regain their birth weight by the tenth day, largely because they were fed only every four hours, sometimes even only every eight, rather than every two as recommended today.

Race plays a role in the determination of pregnancy outcomes as a proxy for income, acting as an enabling variable, that is one which permits the purchase of better nutrition or medical care. It may also be a proxy for health habits, for familial support, for exposure to stress, or for maternal health endowments. Researchers who regress pregnancy outcomes on race and omit these or other inputs will overestimate the impact of race.

Although race may partially proxy for unobservable income characteristics or for maternal nutrition and health, it is still of interest to establish the long-term trend in birth weight by race. In addition, I also examine whether once I control for all observable factors, differences in pregnancy outcomes by race still persist. This enables me to determine what some of the sources of pregnancy outcome inequality by race are.

3 The Records of Johns Hopkins

The proportion of births attended by physicians was rising rapidly in the United States at the beginning of the twentieth century, with most deliveries in the major cities attended by a physician even before 1920. In Baltimore in 1915, 74 percent of births to black married mothers were attended by a physician as were 73 percent of births to white, native-born married mothers (Rochester 1923).[2] By 1935 for the country as a whole only 6 percent of white births were not attended by physicians. However, among blacks 55 percent of births were not attended by physicians, mainly because most births to blacks in rural areas (places less than 2,500 in population) were not physician attended. Thus in 1940 71 percent of rural black births were not attended by a physician compared to 19 percent of urban black births. Virtually all white births in 1940 in urban areas were physician attended. In cities of 250,000 or more, such as Baltimore, differences between black and white rates of physician attendance by 1940 and 1950 were small and most births were overseen by a physician (*Vital Statistics of the United States, 1950*).

Johns Hopkins Hospital was one of the foremost teaching hospitals in the country. It ministered to a wide population within Baltimore and the surrounding area, drawing from the nearby neighborhoods for within hospital births and from a wider area for home births supervised by Johns Hopkins physicians. The records of both the indoor and outdoor departments have been preserved in the hospital archives and the construction of the sample used in this research is described in the Data Appendix.

The sample used in this research spans the years 1897 to 1935. Fifty-three percent of the sample consists of births to black mothers. Black and white births were roughly proportionately divided between the indoor and outdoor departments. However, babies born in the indoor department were almost 300 grams lighter, were more likely to be premature, and had stillbirth rates that were more than twice as high. It was common practice for hospitals to bring abnormal or complicated cases into the hospital, even when they occurred in the outdoor service (Louden 1992). As discussed in the Data Appendix, hospital births are undersampled. However, because

[2]Rates among the foreign-born were lower, ranging from a high of 65 percent among Jews to a low of 22 percent among Poles (Rochester 1923).

the undersampling is too small to affect the results, unweighted results are presented.

The clientele of Johns Hopkins was predominately upper working class. In the late 1910s and 1920s, when some socio-economic data are available, 22 percent of white fathers and 63 percent of black fathers were laborers. No father held a professional occupation. Weekly earnings (in current dollars) were $20 for white fathers and $16 for black fathers. In contrast, in the United States as a whole 20 percent of all non-farm male workers were laborers and average weekly earnings in manufacturing were $22 (United States Bureau of the Census, Series D 182-238: 139 and Series D 802-810: 170). A negligible portion of mothers of either race worked.

The records of Johns Hopkins show no evidence of unequal surgical treatment by race. Despite the trend in American obstretics towards prophylactic forceps operation, the employment of version as a routine method of delivery, routine episotomy, induction of labor, and Caesarian sections, interference in the labor process at Johns Hopkins was not the norm.[3] A negligible portion of mothers of either race were given any type of pain relief such as chloroform or ether. Forceps were used in roughly 10 percent of all births, regardless of race. Caesarian section rates were also comparable across races: roughly 1 percent of white births and 2 percent of black births.

The 1988 National Maternal and Infant Health Survey (NMIHS) is used to investigate black-white differentials in a modern population.[4] This survey is a random sample of 1988 births and contains both birth and death certificate and interview information. It oversamples low-birth-weight babies and all population means estimated from this survey are adjusted using the sampling weights. In the regressions (but not the sample means), only those observations for

[3] J. Whitridge Williams, a member of the Johns Hopkins faculty since 1896 who later became chairman of the obstretics department, denounced this trend at the annual meeting of the Medical Society of the State of New York in 1922 (Louden 1992: 352).

[4] Sanderson, Emanuel, and Holt (1995) used this survey to examine the effect of maternal birth weight on child birth weight among blacks and whites separately.

which maternal birth weight is known are used. Mothers who did not know their own birth weight tended to be older, unmarried, of higher parity, shorter, and less educated. Child characteristics did not predict the mother's knowledge of her own birth weight controlling for the mother's characteristics.

4 Pregnancy Outcome Trends

Table 1 illustrates that although the birth weights of both black and white babies born in hospitals in the early 1900s compare favorably to those of modern populations, the gap in black and white birth weights is persistent. There was roughly a 200 gram difference in the mean birth weight of black and white babies born at Johns Hopkins and at Boston Lying-In. There was a 240 gram difference in the median birth weight of black and white babies born at Johns Hopkins, compared to a 210 gram difference in 1998 for the United States as a whole.[5] The proportion of babies weighing less than 2500 grams at birth has historically been roughly double among blacks.[6]

Less is known about long-run racial trends in prematurity and in stillbirths. Since 1945, when national data on fetal deaths by race became available, fetal death rates have been falling for both races, but the black rate has been roughly twice that of whites (*Vital Statistics of the United States*, various issues). In 1960, 6 percent of white births were premature (less than 37 weeks gestation) compared to 12 percent of black births. By 1998 10 percent of white births and 17 percent of black births were premature (*Vital Statistics of the United States*, various issues). Tables 2 and 3 use the Johns Hopkins data and the 1988 NMIHS to illustrate even longer run trends. The tables show a persistent gap in black and white prematurity rates. The tables also

[5]In 1950, the black-white birth weight difference was only 70 grams and black births were up to 100 grams higher than in subsequent years. Why black babies fared so much better in 1950 is unclear.

[6]The weight of black babies was similar to that of babies born in Europe. For example, the mean weight of babies born at the Allgemeines Krankenhaus in Vienna between 1910 and 1930 was 3,143 grams (Ward 1993).

show that intrauterine deaths are rare today, but that in the past they averaged 12 percent among blacks and 6 percent among whites. Death in the first ten days of life is also rare today. In the past, these early deaths were more common among whites than among blacks and white full-term babies who survived lost weight by day 10 whereas black babies gained weight.

5 Empirical Framework

I examine the factors that mediate the effects of race on birth outcomes by running regressions of the form,

$$y_i = \alpha_i + \delta W_i \tag{1}$$

$$y_i = \alpha_i + \delta W_i + \beta X_i + u_i\,, \tag{2}$$

where y_i is the dependent variable, W is a dummy equal to one if the child was white, X is a vector of control variables, and u is an error term. For the Johns Hopkins sample, I estimate probit regressions where the dependent variables are indicator variables equal to one if the child was born premature, was born stillborn, or died within 10 days of birth and I estimate OLS regressions where the dependent variables are equal to birth weight or weight gain during the ten days spent in the hospital. For the 1988 NMIHS, I estimate a probit regression where the dependent variable is an indicator variable equal to one if the child was born premature and I estimate OLS regressions where the dependent variable is birth weight. All regressions using the NMIHS are weighted.

I will examine how δ, the coefficient on the white dummy, changes as I control for additional characteristics. Because the order in which additional characteristics are controlled for will determine whether controlling for one specific characteristic has a large effect, I will test for robustness by varying the order in which characteristics are controlled for. Note that this methodology assumes that the black and white birth weight production functions are the same. Running separate regressions for blacks and whites did not reveal any significant differences in the black and white birth weight production functions.

Table 4 lists the control variables in the Johns Hopkins sample used in the regressions and shows how they differ by race. Black births were of lower gestational age, were more likely to be home births, were somewhat more likely to be to unmarried mothers, were to younger mothers, and were to mothers who were more likely to have syphilis. Black mothers were in labor longer and were more likely to breast-feed their children. The higher propensity of black mothers to breast-feed their children relative to white, native-born mothers in Baltimore was noted in the Children's Bureau study of infant mortality among babies born in 1915 (Rochester 1923).

The differences in maternal syphilis rates shown in Table 4 are particularly striking. During World War I the annual rate of rate of men infected with syphilis entering the army was 5 percent and that of men infected with gonorrhea was 23 percent (Brandt 1987: 231). A study of six southern rural counties by the Julius Rosenwald Fund and by the United States Public Health Service just before the Great Depression reported that in the richest county and the one with the best medical care (provided by the University of Virginia Hospital), syphilis rates among African-Americans were 8.9 percent whereas in the poorest county (which was also home of the later notorious Tuskegee Institute) syphilis rates were 39.8 percent (Parran 1937: 161-174). A widely advertised public health campaign carried out in Chicago between 1937 and 1940 which provided free syphilis tests and free treatment showed that syphilis rates could be sharply lowered with treatment. More than 60 percent of all cases treated under the Chicago program came from the city's black wards where health facilities were grossly inadequate and infection rates were high (Brandt 1987: 152).

Table 5 shows how black and white mothers differ in terms of their characteristics in the 1988 NMIHS. Black mothers are of higher parity, are much less likely to be married, are younger, are less likely to be smokers, are less well-educated, are taller, gain less weight during their pregnancies, were born with a lower birth weight, and are less likely to breast-feed their children.

The two samples show a large increase in the proportion of unmarried black mothers. This trend mirrors that for the nation as a whole. Ruggles (1994) reports that in 1910 95 percent of white children and 80 percent of black children age 0-4 were living with both parents. In 1980 87 percent of white children in that age group were living with both parents, but only 46 percent of their black counterparts were doing so.

In the Johns Hopkins sample, control variables in the preterm, stillbirth, and birth weight regressions include parity, parity squared, dummy variables equal to one if the child was male, if it was a home birth, and if the mother was married, the number of prenatal visits, the mother's age, a dummy equal to one if the mother was foreign-born, a dummy equal to one if the mother had syphilis, dummies indicating whether the birth was in the summer (June-August), fall (September-November), winter (December-February), and spring (March-May), and dummies indicating the decade of birth (before 1910, in the 1910s, and in the 1920s or later). The stillbirth and birthweight regressions also control for prematurity using a dummy variable or gestational age in weeks. Control variables in the death by day 10 regressions include birth weight, either a dummy variable for prematurity or gestational age in weeks, a dummy equal to one if the child was breast-fed, parity, parity squared, a dummy equal to one if the child was male, a dummy equal to one if the mother was married, the number of prenatal visits, the mother's age, dummy variables equal to one if the mother was foreign-born, if the mother had syphilis, if forceps were used, or if extraction was used, the observed length of labor in hours, seasonal dummies, and a dummy equal to one if the child was born in the 1920s or later. Control variables in the weight gain regressions include dummy variables indicating if the child was fed breast-milk only, breast-milk and formula, or formula only, gestational age in weeks, parity, parity squared, a dummy equal to one if the child was male, a dummy equal to one if the mother was married, the number of prenatal visits, the mother's age, a dummy equal to one if the mother was foreign-born, a dummy equal to one if the mother had syphilis, seasonal dummies, and a dummy equal to one if the birth was in the 1920s or later.

In the NMIHS, control variables in the prematurity regressions are parity, parity squared, dummies equal to one if the child was male or the mother was married, the mothers' age, dummies equal to one if the mother ever had a prenatal visit, was foreign-born, was a smoker, had high alcohol use (more than 8 drinks a week in the 3 months before finding out about the pregnancy), dummies for educational level (less than high school, high school, some college, and college), mother's height, and mother's birth weight. The birth weight regressions control for these factors as well as prematurity, gestational age, mother's weight gain, and mother's birth weight.

6 Birth Outcomes and Race at Johns Hopkins

Table 6 shows that maternal syphilis explains thirty-three percent of the difference in prematurity rates between black and white babies. Although maternal syphilis significantly predicts stillbirths, it does not explain differences in black-white stillbirth rates. Differences in black-white prematurity rates explain thirty-three percent of the difference in black-white stillbirth rates. No other observable factors explained differences in black-white prematurity or stillbirth rates.

The only observable characteristic that predicted differences in black-white birth weights was prematurity or gestational age. For all births, black-white differences in prematurity rates explained 18 percent of the difference in birth weights controlling for all other observables. Once prematurity was controlled for, maternal syphilis no longer had a statistically significant effect on birth weight. For full-term births controlling for gestational age explained 9 percent of the difference between black-white birth weights controlling for all other observables.

A strongly significant predictor of birth weight was season of birth. Babies born in the spring (March-May) weighted 73 to 81 grams less than babies born in the summer (June-August), perhaps because of the nutritional stress their mothers experienced during the winter months. A study of a rural North Carolina mill town begun in 1939 found that in spring vitamin levels were at their lowest point (Beardsley 1987: 204). When season of birth was defined by quarter, then babies born during the second quarter (April-June) were significantly more likely to be born prematurely than babies born in other quarters. Season of birth did not predict stillbirth.[7]

Low birth weight babies were more likely to die within 10 days of birth (see Table 8). Each additional kilogram raised the probability of survival of full-term babies by 0.003. But, despite their higher birth weights, full-term white babies were significantly more likely to die within 10 days of birth than black babies (see Table 8). Being white lowered a full-term baby's probability of survival by 0.005 controlling for birth weight, gestational age, and other characteristics. However, once I control for breast-feeding, being white lowered a baby's probability of survival by the statistically insignificant amount of 0.002, suggesting that differences in breast feeding practices explain at least 60 percent of the difference in black-white survival rates.

The relationship between birth weight and death was not strictly linear.[8] Compared to babies weighing over 2500 but less than 4500 grams, babies weighing more than 4500 grams had a probability of dying within the first 10 days of life that was greater by 0.29. Babies weighing less than 2500 grams had a probability of death that was greater by 0.14. The use of forceps was associated with a higher risk of death of the child, raising the probability of death by 0.01. The results suggest that birth injury was an important determinant of surviving the first ten days of

[7]Goldin and Margo (1989) did not find a statistically significant effect of season of birth on birth weight in the Philadelphia Almshouse. Ward (1993: 62) found that babies born in Vienna in the fall during the crisis years of 1916-1922 had higher birth weights than those born in other months.

[8]Controlling for non-linearities does not affect black-white survival differences.

life, consistent with evidence from New York Lying-In (Costa 1998) and from the Philadelphia Almshouse (Goldin and Margo 1989).

The effects of feeding practices are evident in weight gain in the first 10 days of life. White babies gained less weight than black babies, even controlling for birth weight (not shown). But, controlling for feeding practices explains 21 percent of the difference in black-white weight gain. Babies fed formula only lost 247 grams relative to babies fed breast-milk only. Babies fed a combination of breast-milk and formula lost 130 grams relative to babies fed breast-milk only. At the beginning of the century, the prevalence of breast feeding was falling both in the Johns Hopkins sample and in the United States as a whole (Apple 1987), thereby leading to less weight gain among babies born in the 1920s or later relative to babies born earlier.

The data do not allow me to determine whether it was breast feeding per se that was beneficial to children or whether breast feeding was associated with more frequent feeding. At New York Lying-In insufficient feeding, not the type of feeding, predicted poor weight gain (Costa 1998). Babies born in the winter experienced poorer weight gain compared to babies born in the summer. When the seasons are divided into quarters, babies born in the second and third quarters (April-September) fare better than babies born in the fourth quarter (October-December).

A relatively large proportion of the black-white gap in prematurity rates, stillbirth rates, and birth weights still remains unexplained – two-thirds of the black-white prematurity gap, 59 percent of the black-white stillbirth gap, and 91 percent of the black-white full-term birth weight gap. These differences cannot be explained by socioeconomic differentials. Using the small subsample that contains socioeconomic information shows that controlling for either father's occupational status or income does not affect differences in prematurity or stillbirth rates. Controlling for father's occupational status or income increases the unexplained birth weight advantage of full-term white babies.

7 Birth Outcomes and Race in 1988

Such social factors as the mother's marital status play a much more important role today than in the past in explaining black-white differences in rates of prematurity and in birth weight. Table 10 shows that differences in marital status explain 16 percent of the black-white difference in prematurity rates. Other observable factors have very little effect on prematurity rates. Marital status is also a statistically significant predictor of birth weight and an important explanation for black-white differences in birth weights (see Table 11). Controlling for parity, the sex of the child, the mother's age, her use of prenatal care, whether the mother was foreign-born, maternal smoking and alcohol use, maternal education, and maternal height has no effect on the black-white birth weight gap (not shown). However, once I control for marital status, the birth weight gap falls from 307 to 280 grams for all births and from 210 to 188 grams for full-term births. Differences in marital status explain about 10 percent of the black-white birth weight differential.

Maternal birth weight has a statistically significant on the child's birth weight. An extra 100 grams in maternal birth weight increases child birth weight by 16 grams for all births and by 14 grams for full-term births. In a probit in which the dependent variable is whether the full-term child weighed less than 2500 grams at birth, each kilogram of maternal birth weight lowers the probability of low birth weight by 0.008. In the OLS regressions racial differences in maternal birth weight explain roughly 5 percent of the difference in black-white birth weights both for all births and for full-term births. If I control for maternal birth weight prior to controlling for marital status, prematurity or gestational age, or maternal weight gain, then birth weight accounts for 8 percent of the difference in black-white birth weights. Maternal birth weight was not a statistically significant predictor of prematurity.

Prematurity was the most important predictor of birth weight for all births. Differences in prematurity rates explain roughly 32 percent of the black-white weight gap for all births. For full-term births, gestational age explains only 7 percent of the black-white gap (regression not shown), roughly comparable to the 8 percent that is explained by differences in maternal weight gain.

Including the logarithm of total household income (not shown) can further explain the black-white birth weight difference. (Controlling for income in the prematurity regressions yields a small and insignificant coefficient on income and only a very small reduction in the black-white birth prematurity gap.) For all births, the coefficient on income was insignificant ($\hat{\beta}$ =19.557, $\hat{\sigma}$ =14.889) and reduced the coefficient on the white dummy from 165.9 to 159.1, thus suggesting that income differences explain only up to 2 percent of the black-white birth weight difference. For full-term births, the coefficient on income was statistically significant at the 10 percent level ($\hat{\beta}$ =22.414, $\hat{\sigma}$ =13.743) and reduced the coefficient on the white dummy from 146.4 to 139.4, thus implying that income differences account for 3 percent of the black-white birth weight differential.

The richer control variables available in the NMIHS compared to the Johns Hopkins data do not permit me to explain a greater proportion of the black-white gap in prematurity rates. Two-thirds of the gap is still unexplained. However, because I can control for maternal weight gain and maternal birth weight in the NMIHS, I can explain up to 30 percent of the black-white difference in birth weights, leaving only 70 percent unexplained compared to 91 percent unexplained in the Johns Hopkins sample.

8 Conclusion

Trends in birth weight imply that African-Americans experienced rapid improvement in pregnancy outcomes after the abolition of slavery, but that over the twentieth century the differential in black-white pregnancy outcomes has been persistent. Differences in prematurity rates account for the biggest observable share of the black-white gap in birth weights, both in the past and today. In the early twentieth century untreated syphilis was the primary observable explaining differences in black-white prematurity and stillbirth rates. Today the primary observable explaining differences in prematurity rates is the low marriage rate of black women, a significant social change that dates from the 1960s. Differential marriage rates also play an important role in explaining the recent black-white birth weight gap.

Intergenerational factors, as proxied by maternal birth weight, accounted for 5 to 8 percent of the gap in recent data, implying that the role of maternal birth weight is as important as that of maternal weight gain and is much larger than that of family income. Much of the gap in black-white birth weights and in prematurity rates still remains unexplained. Future research may need to focus on better measures of the mother's early life and current health status, on her current nutritional status, and on her sources of familial support. For example, among low-income pregnant women, zinc intake is lower among blacks than among whites (Neggers et al. 1998). Racial differences in ascending infection and upper genital tract colonization of the chorioamnionic interface may help explain racial differences in premature births (Goldenberg et al. 1996).

The prematurity and low birth weight of black babies born at Johns Hopkins put them at greater risk of death during the first 10 days of life in the hospital. But, even though black babies received a worse start in life, at Johns Hopkins they fared better than white babies in terms of mortality and weight gain during the first ten days of life largely because they were more likely to be breast-fed. The good fortune of black babies in the hospital probably did not outlast their stay. The Children's Bureau study of infant mortality in Baltimore in 1915 revealed a steep gradient between infant mortality and family income, because a higher income enabled families to buy lower room congestion, sanitary equipment, and less work away from home for the pregnant mother (Rochester 1923).

Data Appendix

The Johns Hopkins sample consists of 1911 births, including still-births and infant deaths. The first step in the construction of the sample was the creation of indexes of births that occurred at the Johns Hopkins Hospital or through the Johns Hopkins Out-door Obstretical Department between 1897 and 1935. Random samples of births were then drawn from the two indexes in proportion to the size of the two indexes. 1472 hospital births and 990 out-door births were selected for a total sample size of 2462 births. However, only 1911 births were then found among the births records because all births for the same mother at Johns Hopkins Hospital are filed together with that mother's last birth. Thirty-seven percent of births from the hospital sample could not be found and two percent of births from the home births sample could not be found. First-born children whose siblings were also born at Johns Hopkins Hospital have a lower probability of being found. Two hundred sibling birth records were also collected for mothers who delivered other children through Johns Hopkins Hospital, but these records were not used in the analysis.

Using sample weights that account for the over-representation of home births in the Johns Hopkins sample does not materially change the results. Mean birth weights are lower by only 20 to 30 grams. Table 1 presented both the unweighted and weighted results. The other tables are all unweighted.

The 1988 National Maternal and Infant Health Survey consists of separate random samples of national live birth, fetal deaths, and infant deaths linked to questionnaires mailed to mothers. The response rate on questionnaires was 74 percent for live births, 69 percent for fetal deaths, and 65 percent for infant deaths. Because fetal and infant deaths are over-sampled sample weights must be used to obtain national estimates.

References

[1] Apple, Rima D. 1987. *Mothers and Medicine: A Social History of Infant Feeding, 1890-1950.* Madison, WI: University of Wisconsin Press.

[2] Barker, D.J.P. (Ed.) 1994. *Mothers, Babies, and Disease in Later Life*. London: British Medical Journal.

[3] Beardsley, Edward H. 1987. *A History of Neglect: Health Care for Blacks and Mill Workers in the Twentieth Century South*. Knoxville, TN: University of Tennessee Press.

[4] Brandt, Allan M. 1987. *No Magic Bullet, A Social History of Venereal Disease in the United States Since 1880*. New York-Oxford: Oxford University Press.

[5] Copper, Rachel L., Robert L. Goldenberg, Robert K. Creasy, Mary B. DuBard, Richard O. Davis, Stephen S. Entman, Jay D. Iams, and Suzanne P. Cliver. 1993. "A multicenter study of preterm birth weight and gestational age-specific neonatal mortality." *American Journal of Obstetrics and Gynecology*. 168(1): 78-84.

[6] Copper, R.L., R.L. Goldenberg, M.B. Dubard, and R.O. Davis. 1994. "Risk factors for fetal death in white, black, and Hispanic women. Collaborative Group on Preterm Birth Prevention." *Obstetrics and Gynecology*. 84(4): 490-5.

[7] Costa, Dora L. 1998. "Unequal at Birth: A Long-Term Comparison of Income and Birth Weight." *Journal of Economic History*. 58(4): 987-1009.

[8] Doblhammer, Gabriele and James W. Vaupel. 2001. "Lifespan depends on month of birth." *Proceedings of the National Academy of Sciences*. 98(5): 2934-9.

[9] Emanuel, Irvin, Haroulla Filakti Eva Alberman, and Stephen J.W. Evans. 1992. "Intergenerational studies of human birth weight from the 1958 birth cohort. 1. Evidence for a multigenerational effect." *British Journal of Obstetrics and Gynaecology*. 99: 67-74.

[10] Emanuel, Irvin, Wendy Leisenring, Michelle A. Williams, Christy Kimpo, Sharon Estee William O'Brien, and Christiane B. Hale. 1999. "The Washington State Intergenerational Study of Birth Outcomes: methodology and some comparisons of maternal birthweight and infant birthweight and gestation in four ethnic groups." *Paediatric and Perinatal Epidemiology*. 13: 352-71.

[11] Goldenberg, Robert L., Suzanne P. Cliver, Francis Mulvihill, Carol A. Hickey, Howard J. Hoffman, Lorraine V. Klerman, and Marilyn J. Johnson. 1996. "Medical, psychosocial, and behavioral risk factors do not explain the increased risk of low birth weight among black women." *American Journal of Ostetrics and Gynecology*. 175(11): 1317-24.

[12] Goldin, Claudia and Robert A. Margo. 1989. "The Poor at Birth: Birth Weights and Infant Mortality at Philadelphia's Almshouse Hospital, 1848-1873." *Explorations in Economic History*. 26(3): 360-79.

[13] Louden, Irvine. 1992. *Death in Childbirth: An International Study of Maternal Care and Mortality, 1800-1950*. Oxford: Clarendon Press.

[14] Manton, Kenneth G. and Eric Stallard. 1997. "Health and Disability Differences Among Racial and Ethnic Groups." In Linda G. Martin and Beth J. Soldo, Editors, *Racial and Ethnic Differences in the Health of Older Americans*. Washington DC: National Academy Press: 43-104.

[15] Morton, Newton E. 1955. "The inheritance of human birth weight." *Annals of Human Genetics*. 20: 125-134.

[16] Neggers, Y.H., R.L. Goldenberg, S.P. Cliver, and R.L. Copper. 1998. "Determinants of zinc intake in low-income black and white pregnant women." *Biological trace element research*. 64(1-3): 221-8.

[17] Parran, Thomas. 1937. *Shadow on the Land, Syphilis*. New York: The American Social Hygiene Association and Reynal and Hitchcock, Inc.

[18] Petersson, Karin, Katarina Bremme, Roger Bottinga, Alexandra Hofsjö, Ingela Hulthén-Varli, Marius Kublickas, Margareta Norman, Nikos Papadogiannakis, Kjell Wanggren, and Kerstin Wolff. 2002. "Diagnostic evaluation of intrauterine fetal deaths in Stockholm 1998-99." *Acta obstetricia et gynecologica Scandinavica*. 81(4): 284-92.

[19] Preston, S.H., M.E, Hill, and G.L. Drevenstedt. 1998. "Childhood conditions that predict survival to advanced ages among African-Americans." *Social Science and Medicine*. 47(9): 231-46.

[20] Rochester, Anna. 1923. *Infant Mortality: Results of a Field Study in Baltimore, MD. Based on Births in One Year.* U.S. Department of Labor. Children's Bureau. Bureau Publication No. 119. Washington DC: Government Printing Office.

[21] Ruggles, Steven. 1994. "The Origins of African-American Family Structure." *American Sociological Review*. 59(1): 136-51.

[22] Sanderson, Maureen, Irvin Emanuel, and Victoria L. Holt. 1995. "The intergenerational relationship between mother's birthweight, infant's birthweight, and infant mortality in black and white mothers." *Paediatric and Perinatal Epidemiology*. 9: 391-405.

[23] Smith, James P. and Raynard S. Kingston, 1997. " Race, Socioeconomic Status, and Health in Later Life." In Linda G. Martin and Beth J. Soldo, Editors, *Racial and Ethnic Differences in the Health of Older Americans*. Washington DC: National Academy Press: 105-62.

[24] Speert, Harold. 1980. *Obstetrics and Gynecology in America, A History*. Baltimore, MD: Waverly Press.

[25] Steckel, Richard H. 1986. "Birth Weights and Infant Mortality among American Slaves." *Explorations in Economic History*. 23: 173-98.

[26] Tanner, James M. 1978. *Fetus into Man: Physical Growth from Conception to Maturity*. London: Open Books.

[27] United States Bureau of the Census. *Historical Statistics of the United States, Colonial Times to 1970*. Washington DC: GPO, 1975. *Vital Statistics of the United States*. Various Issues.

[28] Ward, W. Peter. 1993. *Birth Weight and Economic Growth: Women's Living Standards in the Industrializing West*. Chicago: University of Chicago Press.

Table 1: Birth Weights (in Grams) by Race (Live Births), US

Sample	Year	Mean	Median	≤ 2500gm (%)
U.S. slaves (inferred)	1807-1864	2330		
Philadelphia Almshouse, white	1848-1873	3375	3453	8.1
Boston New England, white	1872-1900	3480		6.5
Boston Lying-In, white (indoors)	1886-1900	3330		6.9
Boston Lying-In, white (outdoors)	1884-1900	3479		4.7
Boston Lying-In, black (indoors)	1886-1900	3126		12.3
New York Lying-In, white (singletons)	1910-1931	3463	3467	5.5
Johns Hopkins, white (singletons)	1897-1935	3423	3443	6.0
weighted		3398	3415	6.4
Johns Hopkins, black (singletons)	1897-1935	3183	3175	11.4
weighted		3160	3175	11.9
US, white	1950		3320	7.2
US, nonwhite	1950		3250	10.4
US, white	1960		3340	6.8
US, nonwhite	1960		3150	12.8
US, white	1970		3330	6.9
US, black	1970		3120	13.9
US, white	1980		3410	5.7
US, black	1980		3170	12.5
US, white	1990		3410	5.7
US, black	1990		3170	13.3
US, white	1998		3390	6.5
US, black	1998		3180	13.0
National Maternal and Infant Health Survey, white (singletons)	1988	3426	3430	5.1
National Maternal and Infant Health Survey, black (singletons)	1988	3132	3203	12.3

Note. Slave birth weights are from Steckel (1986) and are inferred from height at young ages. The data for the Philadelphia Almshouse are from Goldin and Margo (1989). The data from Boston are from Ward (1993: 148-149). The data for New York Lying-In are from Costa (1998). The data for the US are from various issues of *Vital Statistics of the United States*. Race is determined by the race of the mother. The weighted Johns Hopkins birth weights are more representative of the Johns Hopkins clientele (see the Data Appendix for details).

Table 2: Differences in Outcomes at Johns Hopkins by Race

	All births		Full-term births	
	White	Black	White	Black
Fraction premature	0.065	0.130		
Fraction stillborn	0.062	0.117	0.049	0.063
Birth weight (gm), live and stillbirths	3395.611	3097.299	3473.496	3265.941
	(649.637)	(708.683)	(544.094)	(509.981)
Live births:				
Birth weight (gm)	3422.516	3182.896	3482.963	3270.997
	(621.017)	(599.366)	(536.784)	(491.470)
Fraction weighing less than 2500 gm	0.060	0.114	0.028	0.059
Fraction live hospital births dead by day 10	0.076	0.046	0.041	0.012
Weight by day 10 if born in hospital (gm)	3305.695	3102.520	3324.894	3140.677
	(508.536)	(536.166)	(489.175)	(491.249)
Weight gain by day 10 if born in hospital (gm)	-48.303	-31.516	-68.012	12.398
	(185.881)	(198.729)	(160.869)	(167.325)

The sample was restricted to singleton births. Standard errors in parentheses.

Table 3: Differences in Outcomes in National Maternal and Infant Health Survey by Race

	All births		Full-term births	
	White	Black	White	Black
Fraction premature	0.066	0.172		
Fraction stillborn	0.003	0.006	0.002	0.003
Birth weight (gm), live and stillbirths	3422.462	3126.461	3479.437	3254.671
	(581.535)	(671.314)	(502.541)	(535.000)
Live births:				
Birth weight (gm)	3425.943	3132.148	3480.418	3256.185
	(575.873)	(664.111)	(500.972)	(532.651)
Fraction weighing less than 2500 gm	0.051	0.123	0.028	0.067
Fraction dead by day 10	0.004	0.008	0.002	0.003

Standard errors in parentheses. Sample weights used in all calculations. The sample was restricted to singleton births.

Table 4: Differences in Characteristics at Johns Hopkins by Race

	All births		Full-term births	
	White	Black	White	Black
Gestational age (weeks)	39.452	37.804	39.869	38.605
Parity	2.097	2.046	2.099	2.136
Dummy=1 if				
child male	0.503	0.507	0.506	0.506
home birth	0.480	0.531	0.489	0.548
mother married	0.875	0.766	0.880	0.782
Number of prenatal visits	2.622	3.252	2.669	3.412
Mother's age	26.179	24.356	26.216	24.485
Dummy=1 if mother foreign-born	0.480	0.117	0.488	0.114
Dummy=1 if maternal syphilis	0.019	0.127	0.014	0.090
Dummy=1 if birth in				
summer	0.252	0.259	0.253	0.266
fall	0.204	0.253	0.207	0.255
winter	0.275	0.262	0.276	0.263
spring	0.269	0.226	0.264	0.216
Dummy=1 if birth				
before 1910	0.029	0.061	0.027	0.066
in 1910s	0.573	0.409	0.585	0.402
in 1920s or later	0.398	0.530	0.388	0.532
If hospital birth:				
Dummy=1 if forceps used	0.090	0.100	0.099	0.108
Dummy=1 if extraction	0.086	0.090	0.089	0.084
Observed length labor	13.610	15.575	13.687	15.626
Dummy=1 if fed				
breast-milk	0.704	0.774	0.714	0.806
breast-milk and formula	0.006	0.012	0.003	0.006
formula only	0.290	0.214	0.283	0.188

The sample was restricted to singleton births.

Table 5: Differences in Characteristics in National Maternal and Infant Health Survey by Race

	All births		Full-term births	
	White	Black	White	Black
Gestational age (weeks)	39.523	38.462	39.977	39.764
Parity	2.245	2.562	2.249	2.552
Dummy=1 if				
child male	0.527	0.503	0.527	0.499
mother married	0.820	0.368	0.826	0.382
ever had prenatal visit	0.989	0.966	0.989	0.970
Mother's age	26.543	24.369	26.596	24.478
Dummy=1 if mother foreign-born	0.102	0.078	0.100	0.081
Dummy=1 if mother				
smoker	0.322	0.258	0.321	0.251
high alcohol user	0.053	0.064	0.051	0.061
Dummy=1 if mother's education				
less than high school	0.120	0.259	0.117	0.250
high school	0.301	0.367	0.300	0.367
some college	0.175	0.143	0.177	0.150
college	0.135	0.064	0.136	0.069
Mother's height (cm)	188.967	194.872	189.586	194.711
Mother's weight gain during pregnancy (gm)	14428.63	13254.81	14596.10	13722.94
Mother's birth weight	3223.095	3088.193	3227.358	3100.966
Child ever breast-fed	0.581	0.268	0.590	0.283

Sample weights used in all calculations. The sample was restricted to singleton births.

Table 6: Correlates of Prematurity and Stillbirths

	Prematurity			Stillbirths		
	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$
Dummy=1 if premature						0.248‡
						(0.038)
Dummy=1 if white	-0.063‡	-0.064‡	-0.042‡	-0.049‡	-0.043‡	-0.029†
	(0.014)	(0.014)	(0.014)	(0.013)	(0.014)	(0.013)
Parity		-0.020‡	-0.019‡		-0.010	-0.006
		(0.008)	(0.007)		(0.008)	(0.007)
Parity squared		0.002†	0.002†		0.000	0.000
		(0.001)	(0.001)		(0.001)	(0.001)
Dummy=1 if						
child male		-0.005	-0.008		0.003	0.005
		(0.013)	(0.012)		(0.011)	(0.011)
home birth		-0.026*	-0.026*		-0.067‡	-0.059‡
		(0.014)	(0.014)		(0.014)	(0.013)
mother married		-0.028	-0.020		-0.003	0.001
		(0.019)	(0.018)		(0.015)	(0.014)
Number of prenatal visits		-0.025‡	-0.023‡		-0.009‡	-0.004*
		(0.003)	(0.003)		(0.003)	(0.002)
Mother's age		0.002	0.001		0.005	0.004‡
		(0.001)	(0.001)		(0.001)	(0.001)
Dummy=1 if mother foreign-born		-0.004	0.002		0.021	0.018
		(0.018)	(0.018)		(0.019)	(0.017)
Dummy=1 if maternal syphilis			0.226‡		0.232‡	0.137‡
			(0.042)		(0.042)	(0.036)
Dummy=1 if birth in						
summer						
fall		-0.004	-0.007		0.013	0.011
		(0.018)	(0.017)		(0.018)	(0.017)
winter		0.003	-0.001		-0.004	-0.005
		(0.018)	(0.017)		(0.016)	(0.014)
spring		0.026	0.024		0.027	0.014
Dummy=1 if birth		(0.020)	(0.019)		(0.019)	(0.016)
before 1910						
in 1910s	0.016	-0.004	-0.016	0.058	-0.002	0.002
	(0.035)	(0.033)	(0.031)	(0.043)	(0.036)	(0.034)
in 1920s or later	0.026	0.041	0.019	0.101†	0.040	0.037
	(0.035)	(0.036)	(0.033)	(0.045)	(0.039)	(0.037)
Psuedo R^2	0.019	0.093	0.144	0.027	0.161	0.249

1729 observations. The sample was restricted to singleton births. The dependent variable for the regressions labeled prematurity is a dummy equal to one if the child was born prematurely. The dependent variable for the regressions labeled stillbirths is a dummy variable equal to one if the child was stillborn. Standard errors are in parentheses. The symbols $*$, $\dagger$, and $\ddagger$ indicate significance at the 10, 5, and 1 percent level, respectively. Derivatives are from a probit model. Derivatives for dummy variables give the change from 0 to 1.

Table 7: Correlates of Birth Weight (Live Births), Johns Hopkins

	All births			Full-term births	
Dummy=1 if premature			-1225.459‡		
			(54.637)		
Gestational age (weeks)					21.518‡
					(3.659)
Dummy=1 if white	238.725‡	247.692‡	204.102‡	187.386‡	170.758‡
	(31.346)	(33.789)	(29.383)	(28.420)	(30.501)
Parity		108.169‡	87.502‡		87.272‡
		(17.891)	(15.552)		(15.902)
Parity squared		-6.951‡	-5.115‡		-4.744‡
		(1.655)	(1.439)		(1.482)
Dummy=1 if					
child male		99.454‡	96.134‡		102.291‡
		(29.252)	(25.383)		(26.187)
home birth		145.409‡	121.731‡		119.939‡
		(33.523)	(29.108)		(30.047)
mother married		35.115	-2.985		17.912
		(42.934)	(37.293)		(38.617)
Number of prenatal visits		29.067‡	7.541		-2.544
		(6.940)	(6.098)		(6.323)
Mother's age		-1.204	0.157		0.333
		(3.364)	(2.920)		(3.030)
Dummy=1 if mother foreign-born		-16.819	0.565		-1.877
		(39.228)	(34.048)		(35.235)
Dummy=1 if maternal syphilis		-195.136‡	-79.993		-66.098
		(65.745)	(57.279)		(61.259)
Dummy=1 if birth in					
summer					
fall		-19.592	-49.699		-10.459
		(42.129)	(36.581)		(37.462)
winter		-51.752	-58.759*		-25.957
		(40.217)	(34.898)		(36.096)
spring		-86.381†	-80.751†		-73.102‡
		(41.542)	(36.047)		(37.779)
Dummy=1 if birth					
before 1910					
in 1910s	-40.271	63.658	63.411	-50.857	73.861
	(75.139)	(73.365)	(63.660)	(68.504)	(66.076)
in 1920s or later	-84.438	-4.870	41.706	-53.755	132.464*
	(74.986)	(77.897)	(67.624)	(68.365)	(70.664)
Constant	3243.942‡	2840.130‡	3009.661‡	3327.021‡	2111.418‡
	(72.030)	(105.889)	(92.192)	(65.730)	(175.892)
Adjusted R^2	0.039	0.138	0.351	0.031	0.156

The entire sample contains 1546 observations and the sample of full-term births 1324 observations. The sample was restricted to singleton births. The dependent variable is birth weight. Coefficients are from an ordinary least squares regression. Standard errors are in parentheses. The symbols ∗, †, and ‡ indicate significance at the 10, 5, and 1 percent level, respectively.

Table 8: Correlates of Death by Day 10 in Johns Hopkins Hospital Sample

	All births		Full-term births			
	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err	$\frac{\partial P}{\partial x}$	Std Err
Dummy=1 if white	0.0352	0.0278	0.0046*	0.0045	0.0021	0.0029
Birth weight (kg)	-0.0601‡	0.0221	-0.0051†	0.0047	-0.0031†	0.0036
Dummy=1 if premature	0.4086‡	0.0828				
Gestational age (weeks)			-0.0002	0.0003	-0.0001	0.0002
Dummy=1 if breast-fed					-0.0048†	0.0061
Parity	0.0005	0.0147				
Parity squared	0.0003	0.0016				
Dummy=1 if						
child male	0.0386	0.0238	0.0017	0.0025	0.0012	0.0019
mother married	-0.0388	0.0308	-0.0005	0.0023	0.0000	0.0013
Number of prenatal visits	-0.0013	0.0049	0.0003	0.0005	0.0002	0.0004
Mother's age	0.0054†	0.0024	-0.0001	0.0002	-0.0001	0.0001
Dummy=1 if						
mother foreign-born	0.0076	0.0381				
maternal syphilis	0.1298‡	0.0599	0.0187	0.0286	0.0165	0.0265
forceps used	0.0370	0.0465	0.0154*	0.0181	0.0146†	0.0176
extraction	0.2923‡	0.0700	-0.0001	0.0024	-0.0006	0.0010
Observed length labor (hours)	0.0031‡	0.0008	0.0000	0.0001	0.0000	0.0000
Dummy=1 if birth in						
summer						
fall	-0.0076	0.0339	0.0008	0.0038	0.0013	0.0039
winter	-0.0116	0.0318	0.0017	0.0042	0.0025	0.0047
spring	0.0244	0.0343	0.0014	0.0038	0.0019	0.0040
Dummy=1 if birth in 1920s or later	0.1089‡	0.0241	0.0012	0.0025	0.0002	0.0015
Pseudo R^2	0.352		0.278		0.321	

The sample of all births contains 789 observations and the sample of full-term births contains 577 observations. The sample was restricted to live, singleton births born in the hospital. The dependent variable is a dummy equal to one if the child died by day 10. The symbols ∗, †, and ‡ indicate significance at the 10, 5, and 1 percent level, respectively. Derivatives are from a probit model. Derivatives for dummy variables give the change from 0 to 1.

Table 9: Correlates of Weight Gain by Day 10 in Johns Hopkins Hospital Sample

	Coef-icient	Std Err	Coef-icient	Std Err	Coef-icient	Std Err
Dummy=1 if white	-86.541‡	14.767	-76.183‡	16.566	-60.032‡	15.659
Dummy=1 if fed						
breast-milk						
breast-milk and formula					-130.278‡	16.200
formula only					-246.556‡	89.840
Gestational age (weeks)			2.566	2.236	1.375	2.101
Parity			18.309*	9.555	12.810	9.076
Parity squared			-2.232†	1.075	-1.374	1.019
Dummy=1 if						
child male			-4.334	14.477	-7.093	13.613
mother married			-2.919	17.589	-7.065	16.512
Number of prenatal visits			2.272	3.253	1.276	3.053
Mother's age			-2.100	1.676	-1.065	1.585
Dummy=1 if						
mother foreign-born			-24.637	22.180	-36.125*	20.832
maternal syphilis			10.972	34.013	7.789	31.895
Dummy=1 if birth in						
summer						
fall			-4.022	20.150	-9.617	18.901
winter			-38.351*	19.913	-40.879†	18.682
spring			-4.022	20.577	-16.166	19.339
Dummy=1 if birth in 1920s or later	-32.732†	14.852	-34.781*	18.133	-14.898	17.158
Constant	34.613†	14.566	-20.612	96.878	32.907	91.017
Adjusted R^2	0.061		0.066		0.180	

511 observations. The sample was restricted to live, singleton births born in the hospital. The dependent variable is weight gain (gm) during the first ten days. Coefficients are from an ordinary least squares regression. The symbols $*$, †, and ‡ indicate significance at the 10, 5, and 1 percent level, respectively.

Table 10: Correlates of Prematurity, 1988 National Maternal and Infant Health Survey

	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$	$\frac{\partial P}{\partial x}$
Dummy=1 if white	-0.117‡	-0.112‡	-0.094‡	-0.091‡
	(0.014)	(0.015)	(0.017)	(0.016)
Parity		0.003	0.003	0.003
		(0.006)	(0.006)	(0.006)
Parity squared		0.000	0.000	0.000
		(0.001)	(0.001)	(0.001)
Dummy=1 if				
child male		0.004	0.003	0.003
		(0.009)	(0.009)	(0.009)
mother married			-0.027*	-0.027*
			(0.016)	(0.016)
Mother's age		0.001	0.002	0.002
		(0.001)	(0.001)	(0.001)
Dummy=1 if mother				
ever had prenatal visit		-0.052*	-0.043	-0.045
		(0.037)	(0.035)	(0.035)
foreign-born		-0.010	-0.011	-0.010
		(0.010)	(0.010)	(0.010)
smoker		0.008	0.005	0.005
		(0.010)	(0.011)	(0.010)
high alcohol use		0.022	0.017	0.019
		(0.024)	(0.022)	(0.022)
Dummy=1 if mother's education				
less than high school				
high school		0.003	0.004	0.004
		(0.012)	(0.012)	(0.012)
some college		-0.009	-0.006	-0.006
		(0.012)	(0.013)	(0.013)
college		-0.017	-0.015	-0.014
		(0.013)	(0.013)	(0.013)
Mother's height (cm)		0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)
Mother's birth weight (kg)				-0.013
				(0.008)
Pseudo R^2	0.026	0.033	0.036	0.038

4528 observations used in the regressions. Sample weights used in all calculations. The sample was restricted to singleton births. The dependent variable is a dummy equal to one if the child was born before 37 weeks of gestation. Derivatives are from a probit model. Derivatives for dummy variables give the change from 0 to 1. Standard errors in parentheses. The symbols $*$, †, and ‡ indicate significance at the 10, 5, and 1 percent level, respectively.

Table 11: Correlates of Birth Weight (Live Births), 1988 National Maternal and Infant Health Survey

	All births				Full-term births			
Dummy=1 if premature			-900.755‡	-889.006‡				
			(60.494)	(58.958)				
Gestational age (weeks)							51.994‡	52.157‡
							(6.026)	(6.042)
Dummy=1 if white	307.050‡	280.038‡	180.561‡	165.917‡	210.326‡	187.798‡	155.963‡	146.428‡
	(24.469)	(28.609)	(29.907)	(29.227)	(25.113)	(28.829)	(27.716)	(27.419)
Parity		104.488‡	110.856‡	108.322‡		107.043‡	138.127‡	134.811‡
		(23.702)	(22.635)	(22.381)		(22.078)	(21.749)	(21.477)
Parity squared		-9.765‡	-10.346‡	-9.929‡		-8.917‡	-13.356‡	-12.818‡
		(3.317)	(2.991)	(2.976)		(2.841)	(2.911)	(2.894)
Dummy=1 if								
child male		114.425‡	116.863‡	115.176‡		125.227‡	127.758‡	126.244‡
		(22.809)	(22.988)	(22.544)		(23.216)	(22.210)	(21.815)
mother married		71.677†	44.670	34.621		59.945*	81.101‡	68.874†
		(32.986)	(33.621)	(33.140)		(33.833)	(33.062)	(32.789)
Mother's age		-3.873	-2.241	-1.771		-2.146	-0.375	-0.315
		(2.476)	(2.525)	(2.501)		(2.549)	(2.449)	(2.433)
Dummy=1 if mother								
ever had prenatal visit		254.459*	175.035*	201.455		56.161	70.926	106.807
		(137.545)	(116.299)	(113.637)		(127.928)	(112.359)	(111.502)
foreign-born		-21.031	-61.255	-83.718		-44.219	-65.482	-87.285*
		(49.133)	(48.447)	(46.958)		(49.331)	(50.187)	(48.936)
smoker		-177.385‡	-172.325‡	-167.710‡		-173.963‡	-177.863‡	-174.571‡
		(25.488)	(26.182)	(25.662)		(26.388)	(25.614)	(25.195)
high alcohol use		-57.050	-38.380	-53.090		-24.549	-37.984	-51.259
		(58.573)	(58.015)	(57.256)		(60.306)	(54.772)	(53.805)
Dummy=1 if mother's education								
< high school								
high school		-47.371	-44.355	-43.938		-50.488	-49.916*	-50.626*
		(30.280)	(30.929)	(30.286)		(31.066)	(29.959)	(29.412)
some college		42.584	37.042	35.597		33.072	18.749	16.685
		(32.542)	(32.462)	(31.981)		(33.029)	(31.863)	(31.424)
college		7.537	-5.641	-9.770		-1.718	10.719	8.202
		(34.368)	(33.764)	(32.945)		(34.499)	(33.095)	(32.264)
Mother's height (cm)		0.992‡	0.943‡	0.744‡		0.936‡	0.850‡	0.670‡
		(0.128)	(0.129)	(0.744)		(0.131)	(0.124)	(0.127)
Mother's weight gain (gm)							0.015‡	0.014‡
							(0.002)	(0.002)
Mother's birth weight (gm)				0.159‡				0.144‡
				(0.022)				(0.021)
Constant	3125.260‡	2604.668‡	2812.499‡	2326.617‡	3275.256‡	2906.299‡	532.710‡	95.951‡
	(20.804)	(151.923)	(135.029)	(147.278)	(21.467)	(144.462)	(273.513)	(282.485)
R^2	0.021	0.101	0.249	0.273	0.012	0.120	0.202	0.229

4203 observations in the all births sample and 2365 observations in the full-term births sample. The samples were restricted to live, singleton births. The dependent variable is birth weight. Coefficients are from an ordinary least squares regression. Sample weights used in all calculations. Standard errors in parentheses. The symbols ∗, †, and ‡ indicate significance at the 10, 5, and 1 percent level, respectively.