

Birth Weight and Income: Interactions across Generations*

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This paper attempts to answer a series of questions regarding the interaction of income and birth weight across generations. First, does the effect of the income of a mother during her pregnancy on her infant's birth weight depend on the family's birth weight history (genetic predisposition)? Second, does the effect of low birth weight status on adult life chances depend on income during early childhood? These questions have implications for the way we envision the biological and social worlds as interacting across generations. To address these issues, this study uses intergenerational data from the Panel Study of Income Dynamics, survey years 1968 through 1992. Results of sibling comparisons (family-fixed-effects models) demonstrate that maternal income has a significant impact on birth weight for those infants who are already at high risk hereditarily (i.e., who have a low birth weight parent). However, it is not clear whether income acts as a developmental buffer for low birth weight infants as their lives progress. These findings suggest the existence of biosocial interactions between hereditary predisposition and socio-economic environment.

In recent research, Conley and Bennett (2000) examined the association between birth weight and life chances in a bidirectional framework, finding that the relationship between income and low birth weight may be counterintuitive. Specifically, they find that income during pregnancy has no effect on the risk of delivering a low birth weight (less than 2,500 grams, or five pounds, eight ounces) baby when hereditary risk is controlled, either through inclusion of parental birth weight status or by deployment of family fixed-effects models. However, using the same methods, they argue that being born of low birth weight detrimentally affects one's life chances (as

measured by timely high school graduation). From the combination of these two findings, Conley and Bennett (2000) conclude that previous studies, which have documented a causal effect of maternal income on the risk of low birth weight, may in fact be reporting spurious findings: The actual causal direction may work from infant health status to adult income.

The current paper builds on this work in two significant ways. First, we ask whether the effect of income on birth weight depends on hereditary risk. Specifically, Conley and Bennett (2000) did not find an effect of maternal income on low birth weight; however, they did not model the interaction of income and hereditary risk. It is reasonable to assume that income may only matter for those mothers who fall into a biologically high-risk category. This possibility is particularly intriguing since earlier work suggests that having other family members who were born of low birth weight is one of the best predictors of one's own risk (Wang et al. 1995). Second, we ask a converse question: Does the effect of low birth weight on adult outcomes (such as educational attain-

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ment) depend on the income of one's parents? It may be the case that families with higher incomes can provide buffers against the possible deleterious effects of low birth weight over the long run. The answers to each of these research questions are potentially of great import from a policy perspective. In both cases, the additional knowledge gained allows us to focus more precisely on those families at high risk and thus create greater efficiency in the efforts to address low birth weight and its harmful consequences.

It is important to note that much of the previous work in the area of the causes and consequences of low birth weight has been limited by its reliance on traditional regression approaches, which may be subject to unobserved variable bias. That is, in the traditional formulation it is less clear that the results are not really an artifact of the unmeasured characteristics of what types of families tend to have low income and low birth weight children. Family-fixed-effects approaches (sibling comparisons) offer a potential solution to this problem. Before we describe these methods in detail, below we review the previous literature on the causes and consequences of low birth weight.

THEORY AND EVIDENCE REGARDING LOW BIRTH WEIGHT

Social Determinants of Birth Weight

Researchers have documented several environmental factors that lead to an increased risk of delivering a low birth weight baby. Some are socio-economic while others are behavioral and personal in nature. Among the socio-economic and demographic factors affecting birth weight are maternal age (such that women under 20 and over 35 are at a higher risk of delivering a low birth weight infant), labor force status (working mothers tend to experience greater risks [Peoples-Sheps, Siegel, and Suchindran 1991], particularly in occupations that expose women to second-hand smoke [Bakketeig et al. 1993]), education level (higher education leads to lower rates of low birth weight [Duncan and Laren 1990]), parity (first births are more often of low birth weight [Helsel, Petitti, and Kunstader 1992]), birth spacing (pregnancies spaced close together are more likely to result in low birth weight

[Klebanoff 1988]), maternal stature, weight before pregnancy, and weight gain during pregnancy. Behavioral factors such as alcohol or drug use by the mother have long been known to increase the risk of low birth weight (Cornelius et al. 1995). Maternal smoking, too, has been well documented as a factor increasing the incidence of low birth weight (Overspect and Moss 1991; Bakketeig et al. 1993).

While these effects have been relatively well established in the literature, what remains less clearly understood is the nature of the effect of poverty (i.e., income) on birth weight (Aber et al. 1997). Many studies examine aggregate data (see Grossman and Jacobowitz 1981; Davis 1988; Stockwell, Goza, and Roach 1995), for example, documenting a statistical link between county-level poverty rates on the one hand and their percentages of low birth weight babies and infant mortality rates on the other. Other studies find an ecological relationship at the national level (Tresserras et al. 1992). Although these studies add to our knowledge base in meaningful ways, they cannot, by the very nature of the data analyzed, provide clues with respect to the influence of family-level poverty on birth weight. For example, they cannot tell us whether the impact of family poverty is linear or whether it is even a "true" effect and not the result of omitted variable bias.

Gortmaker (1979) laid the groundwork for modeling the effect of family-level poverty on birth weight by examining data collected by the National Center for Health Statistics in the National Natality and Infant Mortality Surveys. The purpose of these surveys was to expand the range of information on births and deaths that one would glean from birth and death certificates alone. He documented a negative effect of poverty on birth outcomes net of many of the other factors reviewed above. However, many unanswered questions remain regarding the relationship between poverty and birth outcomes. For example, Starfield et alia (1991) find that for children born to white mothers of the National Longitudinal Survey of Youth, poverty increases the incidence of low birth weight; by contrast, for blacks in the sample its effect is insignificant (although blacks have a higher risk at all socio-economic levels). In a similar vein, Collins and Shay (1994) find that for Hispanics, urban poverty is negatively associated with birth weight "only

when the mother is Puerto Rican or a U.S.-born member of another subgroup” (p. 184). By contrast, however, using data from the 1972–1985 waves of the Panel Study of Income Dynamics, Duncan and Laren (1990) find that among African-Americans, family poverty has a powerful effect on the risk of delivering a low birth weight baby net of family *and* neighborhood demographic factors.

Further obscuring these findings is the fact that poverty is associated with a host of other cofactors that themselves affect birth outcomes.¹ These include, but are not limited to, the factors listed above. Particularly salient to the current study is the issue of the mother’s own birth weight. Conley and Bennett (2000) argue that previously observed relationships between poverty during pregnancy and low birth weight may be spurious, resulting from the fact that those mothers who are low birth weight themselves also tend to be poor. In other words, poor, low birth weight mothers could be transmitting their biological propensities to be born of low birth weight to their offspring, while the fact that they are poor is merely coincidental (or is a result of their birth weight status). However, Conley and Bennett (2000) do not consider the possibility that an effect of maternal income and poverty may be contingent on the biological propensities (risk factors) of the parents. We might not expect income to matter much unless, from a health standpoint, a fetus is already at high risk of low birth weight. Before we discuss our research strategy to address this possibility, below we review the literature on the sequelae of low birth weight.

Birth Weight and the Lingering Effects of Poverty

Over the course of the twentieth century, infant mortality has steadily declined in the United States, largely as a result of reductions in the post-neonatal (ages 2–12 months) death rate. Birth weight is central to further reductions in the infant mortality rate since death rates for the neonatal period (first month of life) are quite sensitive to birth weight (Luke et al. 1993). For example, among babies born in 1996, the infant mortality rate for those who weighed over 2,500 grams at birth was 2.77 per 1,000; it was 17.45 per 1,000 babies born between 1,500 and 2,500 grams; meanwhile, a

staggering 259.35 per 1,000 very low birth weight infants (less than 1,500 grams, or three pounds, five ounces) died within the first year of life (National Center for Health Statistics 2001). Further bolstering the importance of studying low birth weight is research that demonstrates that both the neonatal and post-neonatal infant mortality rates are highly sensitive to the rate of low birth weight. Specifically, when the percentage of low birth weight births is reduced, a greater corresponding reduction in the percentage of infant deaths occurs (Johnson and Zaki 1988). In other words, the mortality “elasticity” for low birth weight is greater than one.

For those children who do survive past the first year of life, birth weight (and its interaction with subsequent poverty) is a very important predictor of multiple measures of development (Breslau et al. 1994). Most notable are the neurological deficits that low birth weight babies experience (Pena, Teberg, and Finello 1988). Minor neurological abnormalities have been detected in as many as 30 percent of low birth weight babies (Michaelis et al. 1993; Robertson et al. 1992). The development of language comprehension skills has been shown to be significantly related to birth weight and gestational age, while expressive skills were less affected by these factors. Visual recognition acuity has also been shown to be deficient in low birth weight infants (Getz, Dobson, and Luna 1994).

Pre-term and low birth weight infants may also suffer in their psychological and intellectual development. Holding other cofactors constant, there is a clear inverse relationship between gestational age at birth and developmental scores in a variety of tests at multiple ages (Breslau et al. 1994; Brooks-Gunn, Klebanov, and Duncan 1996). In one study, it was shown that at ages eight years, seven months to 11 years, two months, low birth weight children demonstrated consistently lower scores on the Wechsler Intelligence Scale for Children (WISC) and the Bruininks-Oseretscky test of motor proficiency than non-low-birth-weight children (Seidman et al. 1992). In another study, even controlling for current poverty, low birth weight babies exhibited greater classroom behavior problems than those born of normal weight (Klebanov, Brooks-Gunn, and McCormick 1994). Further complicating the issue is the fact that poverty and other socio-economic circumstances may

play a role in determining the sequelae of low birth weight. For example, Bradley et alia (1994) write that, "Overall, premature low birth weight children born into conditions of poverty have a very poor prognosis of functioning within normal ranges across all the dimensions of health and development assessed" (p. 346). They found that at age three only 12 percent of premature babies living in poverty functioned at the normal cognitive level. In this manner, poverty may not only determine birth outcomes, but also may interact with those very birth outcomes it has helped foster.

Some recent research has demonstrated that even into adulthood low birth weight may have detrimental effects. One study found that the average cognitive functioning (i.e., IQ) of Danish conscripts who were born of low birth weight was significantly lower than that of normal birth weight individuals (Sorensen et al. 1997). Another study, this one of nurses, showed that low birth weight led to an increased risk for cardiovascular disease in adulthood, that is, heart attack and stroke (Rich-Edwards et al. 1997). (However, as was the case with the prediction of birth weight, the issue of unobserved variable bias plagues this research.) Finally, Conley and Bennett (2000) argue that the deleterious effects of low birth weight on adult educational attainment survive the test of family-fixed-effects models. However, they fail to test whether the negative consequences of low birth weight are equal for all income strata. In other words, as in the case of predicting birth weight, it may be the case that biological health status interacts with the socio-economic conditions of the family. For example, high income may act as a buffer against damaging long-term effects of low birth weight while low income may exacerbate the risks. Addressing these possibilities is the task of the current study.

DATA AND METHODS

Sample

In order to examine the intergenerational interactions among income, birth weight, and life chances, we use long-term longitudinal data from the Panel Study of Income Dynamics. While not originally designed to address issues of infant morbidity, the Panel

Study of Income Dynamics is a nationally representative, longitudinal sample of American families starting in 1968. It began with a sample of 5,000 families, each of which has been followed every year since. The Panel Study of Income Dynamics has also grown since it follows new households that have formed out of the original 5,000. Among those tracked are the children in the initial sample (and those subsequently born or moved into a sample household). A full description of this rather complex data set is provided by Hill (1992).

Research Strategy

The overall approach is the following: First we present the effects of our variables of interest in a series of nested ordinary least squares models; then we employ fixed effects models in order to eliminate potentially biasing factors (observable or unobservable) (Conley and Bennett 2000). Family-fixed-effects models represent an effective way of factoring out unobserved differences between respondents that may be generating biased effects in standard regression models. As mentioned in the introduction, it may not be the effect of income, per se, that generates a significant coefficient with respect to some health or socio-economic outcome, but rather the unobserved characteristics of who tends to have high or low income. By contrasting individuals from the same family of origin, we eliminate most of the potentially biasing factors. These include genetic endowments, permanent income (expected lifetime earnings), and social class more generally (to the extent that it is shared by family members). In short, anything that is shared in common by family members is factored out. So the effect of income, for instance, is only the effect of the transient portion of income, the difference between two time periods (in the case of the birth weight analysis, years of pregnancies for different children). As such, fixed-effects coefficients represent lower-bound estimates of the "true" effect. However, any effect that is presented as significant in this framework has passed a very strict test, immune to most concerns of unobserved variable bias, to the extent that these results are from across-family factors. There still remains the possibility of spurious effects that appear due to associations of within family differences. Once again, fixed

effects models cannot incorporate the notion of interbirth changes in behavior with respect to those behaviors about which we have no data. We cannot address, for example, the possibility that changes in prenatal care took place from one birth to the next. We will address the possibility of spurious effects in the discussion section after presenting results.

The fixed effects approach differs from ordinary least squares approaches and so merits some elaboration here. The traditional ordinary least squares formulation is shown in equation (1) below:

$$Y = \alpha + X\beta + \varepsilon, \quad (1)$$

where X represents the matrix of variables and observations specified in the model and β represents its associated vector of coefficients. However, in the case of low birth weight and educational progress, for example, we can be fairly certain there are lurking variables; that is, that there is another matrix of unobserved characteristics that is biasing our estimates of β . There are a whole host of unobserved characteristics that affect both filial birth weight and parental socio-economic circumstances (or filial educational attainment and parental socio-economic circumstances). These include, but are not limited to, overall parental health status, genetic endowments, class or social status, environmental conditions (such as neighborhood quality), in short, anything that may affect both health *and* socio-economic status.

With this in mind, as shown in equation 2, we can explicitly incorporate such unobserved characteristics into a model. In our case, they break out into two parts: the unobserved factors that are common to families and those that are unique to individuals.

$$Y = \alpha + X\beta + FAM\gamma + IND\delta + \varepsilon' \quad (2)$$

Now we have made explicit the problem of the correlation between these unobserved sets of variables FAM and IND and our observed set of variables. When we have panel data, we can solve this problem, as shown in equation 3, by taking difference scores between our Y variable at times t_1 and t_2 (say birth weight) and regressing that against the difference in X variables at times t_1 and t_2 (say income). (For examples of this "first difference" method in very different contexts, see, e.g., Duncan et al. 1998 or

Firebaugh and Beck 1994.) In this equation, the unobserved family-level characteristics that are assumed to remain constant over time drop out in modeling the difference:

$$\Delta Y_{t_1,t_2} = \alpha + \Delta X_{t_1,t_2}\beta + \Delta IND_{t_1,t_2}\delta + \Delta \varepsilon'_{t_1,t_2} \quad (3)$$

In our case, however, times t_1 and t_2 actually represent the birth years of different, non-twin siblings. Thus, we have not eliminated unobserved characteristics that are unique to the individual siblings. For example, we cannot eliminate bias in our models that may be due to the fact that a mother smoked during one pregnancy and not during another, that she gained a lot of weight during one pregnancy and not during another, sought differing levels of prenatal care for the two pregnancies or that she used alcohol during one and did not during another. These are individual, unobserved differences. To the extent that these differences are correlated with our X variables, β will be biased. For example, to the extent that drinking or drug use during pregnancy (or in between pregnancies one and two) caused the mother's income to drop or her marital status to change, we would be overestimating the effect of these variables in our equations. However, to the extent that our X variables are causally prior to these unobserved, individual-level characteristics, their omission is not as troubling but merely suggests that part of the effects we report may work indirectly through such mechanisms (such as weight gain or prenatal care access).

One additional note: We do not restrict our analysis to two-sibling pairs, but rather allow varying numbers of siblings for each family. So our technique is not as straightforward as regressing a difference score. Rather, the fixed effects models we employ essentially regress the score on the Y variable against the scores on the vector of X variables while including indicator variables for all families save one (this is done implicitly by the STATA software). This is equivalent to taking out the mean value for each family of siblings (and losing a degree of freedom for each in the process). So, for example, in our fixed effects model of high school graduation, we have 1,388 valid responses of individuals from a total of 766 family units. We lose a degree of freedom for taking out the mean of 765 of those family

units (one is the suppressed category on mother's ID). It is conceptually equivalent to the two-sibling model, where, by calculating the difference in their scores, the sample size shifts from 1,000 individuals to 500 pairs.

Using the family-fixed effects approach described above, we develop regression models that assess the impact of maternal poverty and other cofactors on filial birth weight. Second, we use the same approaches to model the impact of maternal characteristics and the respondent's own birth weight status on his or her chances of graduating from high school in a timely fashion (by the end of the 19th year of life). Though this second outcome is temporally distal from the predictors of interest—birth weight and the conditions during pregnancy—it is important to note that the sibling comparisons factor out all of the intervening differences to the extent that they are shared within the family. While siblings of different ages pass through critical family points (such as income shocks or family structure transitions) at different ages, they pass through them together, nonetheless making the estimates of early-life effects on an adult outcome more certain than if we had used traditional regression techniques alone.

Our fixed effects models compare brothers or sisters (at the filial level), using their mother's ID as the grouping category.² Using this approach, the first part of the analysis addresses the issue of maternal poverty and its cofactors on birth outcomes. In order to investigate this relationship, we use a sub-sample of the Panel Study of Income Dynamics that includes children born between 1986 and 1992 for whom birth weight information is available and whose mothers were in the sample during their pregnancy. Among this group, the average birth weight is 119.5 ounces (7.5 pounds), a figure that corresponds to other national estimates. Other sample characteristics can be found in the first column of Table 1. The second sample—the one to be used for analysis of the effect of birth weight on high school graduation—includes only those individuals who had reached their 19th birthday by the end of 1992 and who have a valid indicator of birth weight status (a binary indicator of low birth weight, which was the form in which the information was obtained prior to 1986). A full description of the sample can be found in column 2 of Table 1. The reader should note that both samples include only singleton births.

The variables used in the various analyses are listed below along with a description and rationale for their inclusion into models. The weakest aspect of this data set is its lack of additional information regarding the etiology of the low birth weight. This is unfortunate since low birth weight (and preterm delivery) can be caused by a variety of underlying conditions ranging from preeclampsia (extremely low blood pressure in the mother) to nutritional deficits to cervical infection or even the onset of leukemia prenatally. That said, most cases are idiopathic in nature; that is, medical practitioners cannot locate a causal agent or exact mechanism by which it occurs. Nonetheless, by examining population statistics for low birth weight of all origins, we may obtain a general answer regarding the relative strengths of maternal factors in explaining its legacy from generation to generation. Also worth noting is the fact that other biological and behavioral variables are not present in this survey; thus, we cannot determine the extent to which effects work through biological or behavioral mechanisms such as maternal pre-gravid weight or smoking during pregnancy. These mechanisms are particularly important since they may vary from pregnancy to pregnancy and therefore may covary with pregnancy income and other factors in which we are interested.

Variables

Birth weight. This key measure serves as both a dependent and an independent variable. While for children born between 1986 and 1992, the Panel Study of Income Dynamics assessed their exact birth weight in ounces, for sample members who were born prior to 1986, only a dummy variable is available indicating whether or not an individual was less than 2,500 grams at birth. If the infant was less than this weight, then it received a score of 1 on this indicator, 0 otherwise. In the prediction of filial birth weight, we use actual ounces; this measure is recorded from the birth certificate and is more accurate than recalled birth weight. However, in predicting educational attainment we are constrained to using the pre-1986 measure, a dummy variable indicator for low birth weight status.

One final note regarding this variable: Recall issues and selection bias may be at issue

TABLE 1. Descriptive Statistics for Analyses of Low Birth Weight and Timely High School Graduation. Respondents Born to PSID Sample Members between 1986 and 1992. Means, standard deviations (in parentheses) and within-family [standard deviations]

	Low Birth Weight	High School
African American Race	.306 (.461) [—]	.331 (.471) [—]
Maternal Education in Years (by 1984)	12.484 (2.272) [—]	12.111 (2.178) [—]
Female Child	.483 (.500) [.345]	.477 (.500) [.343]
First Born Child	.392 (.488) [.395]	.431 (.495) [.389]
Income-to-Needs Ratio	2.975 (2.215) [.786]	3.303 (2.153) [.700]
Young Maternal Age (< 18 years) at Time of Birth	.013 (.115) [.078]	.035 (.183) [.112]
Mother Married at Time of Birth	.904 (.295) [.141]	.841 (.366) [.160]
Mother Low Birth Weight	.073 (.261) [—]	—
Father Low Birth Weight	.061 (.240) [—]	—
Individual's Birth Weight (ounces)	119.530 (20.568) [7.845]	—
Individual Low Birth Weight (1.0)	—	.067 (.250) [.146]
Individual Completes High School by Age 19	—	.445 (.497) [.309]
N	1,654	1,388

Note: The mean value of completion of high school by age 19 was significantly ($p < .05$) different for men (.402) and women (.494).

and readers should interpret our results with that caution in mind. This said, since it is the “less healthy” families that are least likely to appear in the analysis (and since they also score lower than the full sample on the dependent variable) we could anticipate that this would result in an underestimation of the effects we present here.

Sex. The respondent's sex is included because previous research has shown that the entire birth weight distribution of females is shifted to the left of that of males, and thus, females have a greater risk than males of being born at low birth weight. This variable is also included in the educational analysis because females have been shown to attain higher lev-

els of education than their male counterparts (U.S. Department of Education 1997).

Birth order. A dummy variable was constructed to indicate whether or not the individual was a first born (to his or her mother) due to the fact that prior research has shown that first borns may be at higher risk of low birth weight (see Miller 1994). For the prediction of educational attainment, this term was also included because researchers from Blau and Duncan (1967) onward have shown that children who come from smaller families and those who are first born tend to do better educationally than those from large families and those who are later in the birth order.

Mother's age. The literature has shown that children born to mothers who are under the age

of 18 or over the age of 34 are more likely to be of low birth weight. While the impact of age on low birth weight may be complex (i.e., some recent work shows that effects may be different for blacks and whites and non-linear in nature [Geronimus 1996]), the use of a dummy variable for young maternal age and one for advanced maternal age (age 35 and above) certainly captures the most important dynamics. It is also important to note that some researchers have found that, when family background is controlled using fixed effects models such as those employed in the current study, young maternal age demonstrates a positive impact on birth weight (Rosenzweig and Wolpin 1995).

In addition, children born to young mothers tend to demonstrate lower levels of educational achievement and attainment (see McLanahan and Sandefur 1994), and thus this indicator is included in the education analysis (advanced maternal age was not a factor among this second Panel Study of Income Dynamics subsample and is not presented). It is important to note, however, that some researchers, such as Geronimus, Korenman, and Hillemeier (1994), make a case that the effects of young maternal age on intellectual developmental measures are an artifact of unobserved family differences; these claims are a result of fixed effects analyses of cousin samples; the current sibling comparison offers another such test with respect to high school completion.

Marital status. In addition to maternal age, we include an indicator of whether the mother was married at the time of the birth of the individual. This is by no means a perfect indicator of the absence of an adult partner; however, mothers who are not married during their pregnancies are more likely than those who live in a married, two-parent household to spend a significant amount of time without the social or financial support of a partner. This lack of support may have an impact on both birth outcomes and the educational progress of children.

Income-to-needs ratio. This variable is constructed by dividing the total family income for a given year by the poverty threshold for the family size and type as determined by the U.S. Department of Agriculture and the U.S. Bureau of the Census. This "Orshansky ratio" is thus expressed as a "percentage of poverty" such that a value less than one means the

respondent's family lived in poverty for the given year (see Ruggles 1990 for a discussion). Total family income includes all forms of cash received ranging from labor market earnings of any member of the family unit to informal gifts to investment income to government transfers. In-kind benefits (such as Food Stamps) are not included, however. The time period for the birth weight analyses is the year prior to birth and thus includes the mother's pregnancy and the period immediately preceding it.

In the education models, we use income in the first five years of life.³ For these models, it is preferable to include a measure of income that serves as a stricter control than is the case with a single-year income variable. Researchers such as Mayer (1997) have demonstrated that a five-year income measure captures a good degree of variability and that the added predictive value of including additional years beyond five is not significant; further, Duncan et al. (1998) have shown that it is this period that has the greatest impact on the completion of high school. (This said, when we use the single-year income measure, it does not substantively affect our low birth weight coefficient.)

Race/ethnicity. A dummy variable term for African American race was introduced. The rationale behind this choice is that the greatest discrepancies in birth weight in the U.S. population are between blacks and whites (Wilcox and Russell 1990; Hummer 1993; Frisbie, Biegler, and de Turk 1997). Other groups demonstrate rates of low birth weight that vary widely; for example, overall, Latinos tend to display rates that are somewhere between those of blacks and whites. However, there is large variation within the Hispanic population, with Cubans experiencing a rate near that of non-Hispanic whites while Puerto Ricans suffer from an incidence of low birth weight that is considerably closer to that of African Americans (Frisbie, Forbes, and Hummer 1998; Kramarow et al. 1999). The particular case of Mexican Americans, whose socio-economic status mirrors that of African Americans, but whose rates of low birth weight are actually lower than those of non-Hispanic whites, points to the possible salience of inherited factors, be they genetic or cultural (Frisbie 1994; Guendelman and English 1995).

Maternal education. One of the strongest socio-economic predictors of rates of low birth

weight is maternal education. Maternal education, itself, is possibly a result of both genetic and environmental conditions. This issue aside, it is important to control for this measure when estimating the effects of other hereditary or environmental measures. We operationalize this variable as highest grade completed by the mother by 1984 (i.e., number of years of formal schooling). By doing this, we do not model the effects of changes in maternal educational status between pregnancies but rather leave its entire effect to the common family component in the fixed effects framework. It is worth noting, however, that Rosenzweig and Wolpin (1994) found that interpregnancy increases in maternal schooling have a positive impact on children's achievement test scores.

High school graduation. For the analysis of the effects of low birth weight on educational attainment, the dependent variable is having completed high school by their 19th birthday, that is, "on time." This outcome measure eliminates the issue of age differences between the siblings, which may yield differences in the level of educational attainment as measured by highest grade completed; it has the added feature of producing a distribution in which 23 percent of the respondents have at least one sibling with an outcome that is different from themselves while 35 percent have at least one cousin with a different score on this indicator. Such a distribution lends itself to fixed-effects modeling.

Graduation on time is also a substantively important variable with respect to the life chances of young adults. Those who graduate "late" are more likely to have received a high school equivalency diploma than those who finished their secondary schooling "on time" (Cameron and Heckman 1993). An equivalency diploma, in turn, results in poorer economic outcomes—as measured by hours worked or wages—when contrasted to actual high school attendance (Cameron and Heckman 1993). Finally, students who do not complete high school on time and thus are older when and if they continue their educational careers are less likely to attend four-year academic colleges than are "traditional" students (Horn and Carroll 1996).

FINDINGS

Our first objective is to determine—invoking an ordinary least squares approach—the impact of a variety of maternal socioeconomic characteristics on birth outcomes, in particular the birth weight of the infant. The strategy employed in Table 2 is to judge the influence of both income and maternal and paternal birth weight on an infant's birth weight, controlling for several variables that could potentially confound the relationships of interest. These control variables include young maternal age, marital status at the time of birth, maternal education, and the race, sex, and parity of the infant.

Net of the influence of these important factors, we find in the first column that income, in the form of the family's income-to-needs ratio, has no bearing on an infant's birth weight. In contrast, however, both the mother's and father's birth weight—specifically, whether each was born at a weight less than five pounds, eight ounces—have a substantial impact on their child's birth weight. For each parent, their low birth weight status is associated with about a one-pound reduction in the birth weight of the infant (14 ounces and 16 ounces for the mother and father, respectively).

In the second column of Table 2 we present the coefficients derived from a fixed-effects framework. Such a framework recognizes and addresses the fact that there are bound to be factors across families that we are simply unable to measure and that would serve to confound our findings to the extent that these unobservable factors are correlated with those we are able to include in our model. Examples of unobservable characteristics that are controlled for would include the smoking behavior of the parents, diet, or the degree to which the mother availed herself of prenatal care to the extent that they are consistent across pregnancies; to the extent that they are not, this approach does not pick up the variability.

In this framework we compare siblings from the same mother. The results indicate that none of the socioeconomic conditions during the mother's pregnancy is now significant. This includes the family's income-to-needs ratio at the time of the pregnancy. Indeed, only the sex of the child is now relevant to his or her birth weight. It is not surprising that sex maintains its significance, because it is the only variable that could sensibly be hypothesized to be

TABLE 2. Birth Weight in Ounces as Predicted by Maternal Socio-Economic Circumstances: Regression Models (with standard errors robust to clustering by mother's ID) [t-statistics in brackets]

	Ordinary Least Squares	Fixed Effects	Ordinary Least Squares	w/LBW Parent Fixed Effects	w/o LBW Parent Fixed Effects
<i>SES Conditions during Pregnancy</i>					
Income-to-Needs Ratio	.327 [1.711]	.539 [1.058]	.168 [.887]	8.555** [.887]	.109 [.224]
Young Maternal Age (< 18 years)	-3.982 [-.711]	5.724 [.526]	-3.994 [-.772]	—	5.480 [.538]
Married at time of Birth	5.031** [2.926]	-3.456 [-.780]	4.640** [2.713]	-16.374 [-1.222]	-3.328** [-.733]
<i>Controls</i>					
Female Child	-5.626*** [-5.722]	-3.704* [-2.512]	-5.530*** [-5.658]	18.681** [3.067]	-6.042*** [-5.726]
First Born Child	-1.424 [-1.489]	-1.685 [-1.239]	-1.302 [-1.367]	3.140 [.612]	-2.182 [-1.626]
African American Race	-5.840*** [-4.652]	—	-5.888*** [-4.683]	—	—
Maternal Education in Years (by 1984)	.359 [1.621]	—	.352 [1.603]	—	—
<i>Parental Infant Health History</i>					
Mother Low Birth Weight	-13.828*** [-4.593]	—	-23.179*** [-6.801]	—	—
Father Low Birth Weight	-16.396*** [-5.462]	—	-17.029*** [-3.250]	—	—
<i>Income-Health Interactions</i>					
Mother Low Birth Weight * Income-to-Needs	—	—	2.894*** [5.598]	—	—
Father Low Birth Weight * Income-to-Needs	—	—	.388 [.295]	—	—
Constant	115.886*** [39.386]	123.152*** [26.908]	116.816*** [40.029]	78.638*** [5.179]	127.840*** [27.241]
R ²	.134	.858	.142	.908	.136
N (clusters)	1,654 (1,216)	1,654 (1,216)	1,654 (1,216)	179 (136)	1,475 (1,080)
Group ID	—	F(1215, 433)***	—	F(135, 39)**	F(1079, 390)***
[F-statistic]	—	[1.975]	—	[2.151]	[1.861]

*p < .05, **p < .01, ***p < .001

orthogonal to any omitted, unobserved variables. It is important to note, however, that the coefficient associated with the income-to-needs ratio is measuring the effect of the differences in that ratio between the pregnancies resulting in the birth of the different siblings. If, in fact, there were no change in a family's income-to-needs ratio from one pregnancy to the next, we would not be able to determine any income effect, even though there may be a significant effect of income, due to differences across families.

It may be the case that the effect of income on the birth weight of an infant may differ according to whether his or her mother or father was born of low birth weight. We address this hypothesis in Table 2 by incorporating the appropriate interactions in the model appearing in column three. The most notable finding is that the effect of a family's income-to-needs ratio is indeed significant if the mother was born of low birth weight. In particular, for babies born to such mothers, each unit increase in the family's income-to-needs ratio is associated with a three-ounce boost in the child's birth weight. Thus, additional income appears to have beneficial effects for those babies who would logically be at greatest risk.

Invoking a fixed effects framework, thereby controlling to a greater extent the confounding influence of unobserved variables, we find that the interaction effect observed in the ordinary least squares model is supported. Specifically, we see that if a child has a low birth weight parent, then he or she benefits substantially from increases in income. For each unit increase in a family's income-to-needs ratio, a child's birth weight rises by more than half a pound (8.6 ounces). (We could not isolate the effect for only those children with low birth weight mothers due to small sample sizes.) In contrast, however, income bears no relation to an infant's birth weight if neither of that child's parents was born of low birth weight.⁴ In sum, these models show an important way in which heredity and social environment interact across generations.

The second portion of the intergenerational analysis explores the ultimate impact of birth weight status on life chances as measured by educational attainment. To address this issue, we examine the chances of completing high school by the end of the 19th year of life, first in a logistic regression framework and then in a fixed effects framework.

We display in the first column of Table 3 the coefficients associated with a model including an array of control variables in addition to the two main variables of interest—low birth weight and the family's average income-to-needs ratio during the first six years of the child's life. Among the control variables, being female and a first born are associated with significantly higher birth weights. The coefficients associated with both of our variables of interest are significantly different from zero. Specifically, if an infant is born of low birth weight, then she or he appears to be 32 percent less likely to graduate from high school by the 19th birthday. A unit increase in a family's income-to-needs ratio is associated with a child being 6 percent more likely to graduate from high school in a timely manner.⁵

The second column of Table 3 examines the problem under a "stricter" model: sibling comparisons. In this framework, the effect of being born of low birth weight is dramatic, but income no longer relates significantly to this long-term outcome. However, once again, it is important to keep in mind that the income variable in the fixed-effects framework to some extent measures transient income rather than permanent income. Our income variable essentially accounts for variations in income within the family (i.e., from one sibling's early childhood to that of the next sibling) and not for variations in income among families. The lack of an observed effect by no means precludes the possibility that early childhood income plays an important role in the educational attainment process.

The third column of Table 3 shows the coefficients of the same model displayed in column 1 but with the addition of an interaction term between low birth weight and income. The low birth weight coefficient becomes considerably more pronounced, while the income-to-needs coefficient is rendered insignificant. At the same time, the interaction term is positive and of borderline significance ($p < .10$). This result implies that higher income can offset the deleterious effects of low birth weight. A child whose first six years are spent at the poverty line (i.e., with an income-to-needs ratio of 1.0) and who is born of low birth weight is considerably less likely to graduate from high school "on time" than his or her counterpart who was not born of low birth weight. In contrast, a low birth weight baby whose family has an income of, let's say, five times the poverty threshold is

TABLE 3. Timely High School Graduation as Predicted by Low Birth Weight and Maternal Socio-Economic Circumstances: Logistic Regression Models (with standard errors robust to clustering by mother’s ID) versus Mother Fixed-Effects Conditional Logistic Regression Models [t-statistics in brackets]

	Logistic Regression	Mother Fixed Effects	Logistic Regression	Mother Fixed Effects
<i>Perinatal Conditions</i>				
Low Birth Weight	-.555* [-2.386]	-2.195** [-2.833]	-1.446** [-2.696]	-1.331 [-1.038]
Income-to-Needs Ratio, Ages 0–5	.095* [2.387]	.101 [.774]	.080 [.417]	.112 [.846]
Young Maternal Age (< 18 years)	-.411 [-1.250]	-1.134 [-1.684]	-.419 [-1.266]	-1.187 [-1.756]
Married at time of Birth	.101 [.493]	-.347 [-.729]	.086 [.417]	-.381 [-.790]
<i>Controls</i>				
Female Child	.397*** [3.653]	.338+ [1.825]	.391*** [3.568]	.337+ [1.822]
First Born Child	.232* [2.091]	.011 [.058]	.233* [2.100]	.008 [.044]
African American Race	-.005 [-0.036]	—	-.003 [-.019]	—
Maternal Education in Years (by 1984)	.022 [.768]	—	.025 [.842]	—
Individual Low Birth Weight * Income-to-Needs	—	—	.304+ [1.833]	-.518 [-.745]
Constant	-1.094** [-2.777]	—	-1.064** [-2.668]	—
L ²	40.68	20.56	43.19	21.20
df	8	6	9	7
N (clusters)	1388 (766)	581 (219)	1388 (766)	581 (219)

*p < .05, **p < .01, ***p < .001

essentially no less likely to graduate high school than a baby born at greater than five and one-half pounds. That is, the higher income has served successfully as a buffer against the potentially negative effects of low birth weight. Last, we apply the fixed-effects equivalent of this model in column four of Table 3. In this model, the coefficients associated with our variables of interest are now insignificantly different from zero. Because of the problems discussed above with respect to the measurement of income, permanent versus transitory, it is difficult to judge the true effect of income and low birth weight on educational attainment.

DISCUSSION

In this study we have sought to understand better how income and birth weight interact across generations. In particular, we explore whether the effect of a mother’s income during her pregnancy on her baby’s birth weight varies depending on the family’s birth weight history (specifically, the mother’s or father’s birth

weight status). We also examine whether the effect of an infant’s low birth weight on his or her adult life chances, as represented by the timely graduation from high school, depends on that child’s family income during his or her early childhood years. Our analyses provide mixed evidence of the benefits of higher income on child outcomes. First, the evidence from both ordinary least squares models and family-fixed effects models is clear that additional dollars during the gestational period do, in fact, have a significant impact in reducing the likelihood of low birth weight births among those individuals who are at high risk due to a family medical history of low birth weight. These results show the importance of considering the interaction of socio-economic conditions and biological or medical history (i.e., genes and environment).

On the other hand, the findings regarding the impact of income on the likelihood of completing high school in a timely fashion, that is, by one’s 19th birthday, are less straightforward. In our ordinary least squares formulation, the negative impact of low birth weight on high school graduation is substantial. Further,

income appears to have some positive effect on high school graduation among those born of low birth weight. Higher income, then, appears to offset the damaging effects of low birth weight, to the point where its substantial negative effects are completely eradicated as family income approaches a level five times the poverty threshold. When we shift to a fixed effects approach, however, the results are less clear and we must be more equivocal in expressing their implications. The magnitude of the impact of low birth weight status remains virtually unchanged from that seen in the ordinary least squares model, however the standard error of the coefficient increases such that the coefficient is rendered insignificant. Further, the interaction term of low birth weight and income-to-needs is no longer significantly different from zero. Consequently, a more definitive answer regarding the joint influence of an infant's birth weight and family during the child's early years on her or his later life chances, as indicated by the timely graduation from high school, must await the analysis of additional data.

Future researchers may want to extend this research by determining the exact causal mechanisms by which maternal poverty leads to poor birth outcomes. For example, the dynamics may be tied to maternal pregnancy behavior. It could be the case that an income drop (due to unemployment, for instance) leads to substance abuse by a pregnant mother as a stress reliever which in turn affects that birth outcome (in contrast to others of the woman). Alternatively, causation may work in the opposite direction: It may be possible that women who used drugs, alcohol, or cigarettes during one pregnancy also tended to have lower incomes during that time period by virtue of that substance abuse. In this case, it would not be the effect of income per se that we were detecting, but rather the behavioral dynamics that a drop in income between one pregnancy and the next is reflecting.

Some of these possibilities will be very difficult to investigate using survey research methods and lend themselves more to ethnographic study; other issues are readily addressed within the same methodological approach used in this study. For instance, does maternal poverty result in low birth weight by virtue of pre-term delivery (which has been shown to be more detrimental to the health and developmental statuses of infants [Cramer

1995]) or through intra-uterine growth retardation? Also, does the salience of these various socio-economic factors vary by race? In terms of low birth weight as a predictor, other researchers may want to investigate how low birth weight children end up disadvantaged educationally when compared to their siblings or cousins—that is, through health problems, slowed cognitive development, or social stigma within the family unit (i.e., being treated as the “fragile” or “weak” one)?

NOTES

1. In fact, much of the literature on the effects of poverty (on a range of outcomes) is plagued by this problem of unobserved heterogeneity. Mayer (1997) has been the most persuasive in arguing that traditional ordinary least squares approaches overestimate the effects of income. She uses a variety of innovative approaches—such as comparing the impact of income from different sources—to estimate that the impact of income on outcomes such as educational attrition, teenage fertility, and adult wages has been overstated. Few studies of the effects of poverty control for unobserved variable bias; most rely on traditional control variables (see, e.g., Duncan and Brooks-Gunn 1997). Those that do attempt to tackle this issue of unobserved variable bias arrive at mixed results. For example, Korenman and Miller (1997) find powerful effects of poverty status on the physical health of children (as measured by stunting, for instance) when modeled using traditional ordinary least squares approaches, but when they compare first cousins and control for maternal height and weight, the effects of poverty disappear (also see Currie and Thomas 1995). On the other hand, Duncan, Yeung, Brooks-Gunn, and Smith (1998) find strong, negative effects of poverty status on children's educational success even when they compare sibling pairs (and thereby control in large part for unobserved heterogeneity). The current research should add to this spirited debate on the impact of poverty.
2. This method is *not* the equivalent of what other researchers, such as Geronimus and Korenman (1993a and 1993b), Geronimus, Korenman, and Hillemeier (1994) and

- Hoffman, Foster, and Furstenberg (1993) call "sister comparisons." In their method, the sisters under comparison are the mothers of the children under investigation in this study, making these children cousins.
3. 1967 was the first year for which income information was available. Therefore, for those respondents born between 1965 and 1967, we use an average of however many years that individual was in the sample between ages 0 and 5; for instance, if someone were born in 1966, they would have a four-year income measure, 1967–1970, ages 1–4.
 4. We cannot account for the counterintuitive positive coefficient for "female child" that results in the fixed effects sample of children with a low birth weight parent. That said, a child's sex should be independent of income, which, after all, is our variable of interest. Thus, regardless of the sign of the child's sex coefficient, we would expect to obtain essentially the same coefficient of income.
 5. To interpret the effect of a change in our independent variable of interest on the probability of transition, we evaluate the estimated models at the means of all independent variables, while varying the value of the independent variables of interest, that is, low birth weight or income. In the latter case, we evaluate the equation for a one unit change in income-to-needs about its mean.
- REFERENCES
- Aber J. Lawrence, N.G. Bennett, D. Conley, and J. Li. 1996. "The Effects of Poverty on Child Health and Cognitive Development." *Annual Review of Public Health* 18:463–83.
- Bakketeig L.S., Jacobsen G., Hoffman H.J., Lindmark G., Bergsjø P., Molne K., and J. Rodsten. 1993. "Pre-Pregnancy Risk Factors of Small-for-Gestational Age Births among Parous Women in Scandinavia." *Acta Obstetrica and Gynecologica Scandinavica* 72:273–79.
- Blau, Peter and Otis Dudley Duncan. 1967. *The American Occupational Structure*. New York: Wiley.
- Bradley, R.H., L. Whiteside L, D.J. Mundfrom, P.H. Casey, K.J. Kehheher, and S.K. Pope. 1994. "Early Indications of Resilience and Their Relation to Experiences in the Home Environments of Low Birth Weight, Premature Children Living in Poverty." *Child Development* 65:346–60.
- Breslau, N., J.E. DelDotto, G.G. Brown, S. Kumar, S. Ezhuthachan, K.G. Hufnagle, and E.L. Peterson. 1994. "A Gradient Relationship between Low Birth Weight and IQ at Age 6 Years." *Archives of Pediatric and Adolescent Medicine* 148:377–83.
- Brooks-Gunn, Jeanne, Patricia Klebanov, and Greg J. Duncan. 1996. "Ethnic Differences in Children's Intelligence Test Scores: Role of Economic Deprivation, Home Environment, and Maternal Characteristics." *Child Development* 67:396–408.
- Cameron, Stephen V. and J.J. Heckman. 1993. "The Nonequivalence of High School Equivalents." *Journal of Labor Economics* 11:1–47.
- Collins, J.W. Jr. and D.K. Shay. 1994. "Prevalence of Low Birthweight among Hispanic Infants with United States-Born and Foreign-Born Mothers: the Effect of Urban Poverty." *American Journal of Epidemiology* 139:184–92.
- Conley, Dalton and Neil G. Bennett. 2000. "Is Biology Destiny? Birth Weight and Life Chances." *American Sociological Review* 65:458–67.
- Cornelius, M.D., P.M. Taylor, D. Geva, and N.L. Day. 1995. "Prenatal Tobacco and Marijuana Use among Adolescents: Effects on Offspring Gestational Age, Growth, and Morphology." *Pediatrics* 95:738–43.
- Cramer James C. 1995. "Racial and Ethnic Differences in Birth Weight: the Role of Income and Financial Assistance." *Demography* 32:231–47.
- Currie, Janet and Duncan Thomas. 1995. "Does Head Start Make a Difference?" *American Economic Review* 85:341–64.
- Davis, R.A. 1988. "Adolescent Pregnancy and Infant Mortality: Isolating the Effects of Race." *Adolescence* 23:899–907.
- Duncan, Greg J. and Jeanne Brooks-Gunn, eds. 1997. *Consequences of Growing Up Poor*. New York: Russell Sage Foundation.
- Duncan, Greg J. and Deborah Laren. 1990. "Neighborhood and Family Correlates of Low Birthweight: Preliminary Results on Births to Black Women from the PSID Geocode File." Ann Arbor, MI: Mimeo, Survey Research Center.
- Duncan, Greg J., W. Jean Yeung, Jeanne Brooks-Gunn, and Judith R. Smith. 1998. "How Much Does Childhood Poverty Affect the Life Chances of Children." *American Sociological Review* 63:406–23.
- Firebaugh, Glenn and F.D. Beck. 1994. "Does Economic Growth Benefit the Masses? Growth, Dependence, and Welfare in the Third World." *American Sociological Review* 59:631–53.
- Frisbie, W. Parker. 1994. "Birth Weight and Infant Mortality in the Mexican Origin and Anglo Populations." *Social Science Quarterly* 75:881–95.

- Frisbie, W. Parker, Monique Biegler, and Peter de Turk. 1997. "Racial and Ethnic Differences in Determinants of Intrauterine Growth Retardation and Other Compromised Birth Outcomes." *American Journal of Public Health* 87:1977-83.
- Frisbie, W. Parker, Douglas Forbes, and Robert A. Hummer. 1998. "Hispanic Pregnancy Outcomes: Additional Evidence." *Social Science Quarterly* 79:149-69.
- Geronimus, Arline T. 1996. "Black/White Differences in the Relationship of Maternal Age to Birth Weight: A Population Based Test of the Weathering Hypothesis." *Social Science and Medicine* 42:589-97.
- Geronimus, Arline T. and S. Korenman. 1993a. "Maternal Youth or Family Background? On the Health Disadvantages of Infants with Teenage Mothers." *American Journal of Epidemiology* 137:213-25.
- . 1993b. "The Socioeconomic Costs of Teenage Childbearing: Evidence and Interpretation." *Demography* 30:281-90.
- Geronimus, Arline T., Sanders Korenman, and Marianne M. Hillemeier. 1994. "Does Young Maternal Age Adversely Affect Child Development? Evidence from Cousin Comparisons in the United States." *Population and Development Review* 20:585-609.
- Getz, L., V. Dobson, and B. Luna. 1994. "Development of Grating Acuity, Letter Acuity, and Visual Fields in Small-for-Gestational-Age Preterm Infants." *Early Human Development* 40:59-71.
- Gortmaker, Stephen L. 1979. "Poverty and Infant Mortality in the United States." *American Sociological Review* 44:280-97.
- Grossman, M. and S. Jacobowitz. 1981. "Variations in Infant Mortality Rates among Counties of the United States: the Roles of Public Policies and Programs." *Demography* 18:695-713.
- Guendelman, S. and P.B. English. 1995. "Effect of United States Residence on Birth Outcomes among Mexican Immigrants: An Exploratory Study." *American Journal of Epidemiology* 142:s30-8.
- Helsel D., D.B. Petitti, and P. Kunstadter. 1992. "Pregnancy among the Hmong: Birthweight, Age, and Parity." *American Journal of Public Health* 82:1361-4.
- Hill, Martha. 1992. "The Panel Study of Income Dynamics: A User's Guide." Newbury Park, CA: Sage Publications.
- Hoffman, Saul D., E.M. Foster, and F.F. Furstenberg, Jr. 1993. "Reevaluating the Costs of Teenage Childbearing: Response to Geronimus and Korenman." *Demography* 30:291-6.
- Horn, Laura J. and C.D. Carroll. 1996. *Nontraditional Undergraduates: Trends in Enrollment from 1986 to 1992 and Persistence and Attainment among 1989-90 Beginning Postsecondary Students*. Statistical Analysis Report # 97578. Washington, DC: National Center for Education Statistics.
- Hummer, Robert A. 1993. "Racial Differentials in Infant Mortality in the U.S.: An Examination of Social and Health Determinants." *Social Forces* 72:529-54.
- Johnson, N.E. and K.P. Zaki. 1988. "Racial and Residential Differences in U.S. Infant Death Rates: A Temporal Analysis." *Rural Sociology* 53:207-19.
- Klebanoff, Mark A. 1988. "Short Interpregnancy Interval and the Risk of Low Birthweight." *American Journal of Public Health* 78:667-70.
- Klebanov P.K., Brooks-Gunn J., and McCormick M.C. 1994. "Classroom Behavior of Very Low Birth Weight Elementary School Children." *Pediatrics* 94:700-8.
- Korenman, Sanders and Jane E. Miller. 1997. "Effects of Long-Term Poverty on Physical Health of Children in the National Longitudinal Survey of Youth." Pp. 70-99 in *Consequences of Growing Up Poor*, edited by Greg Duncan and Jeanne Brooks-Gunn, Greg Duncan and Jeanne Brooks-Gunn, eds. New York: Russell Sage Foundation.
- Kramarow, E., H. Lentzner, R. Rooks, J. Weeks, and S. Saydah. 1999. *Health and Aging Chartbook. Health, United States, 1999*. Hyattsville, MD: National Center for Health Statistics.
- Luke, B., C. Williams, J. Minogue, and L. Keith. 1993. "The Changing Pattern of Infant Mortality in the U.S.: The Role of Prenatal Factors and Their Obstetrical Implications." *International Journal of Gynaecology and Obstetrics* 40:199-212.
- Mayer, Susan. 1997. *What Money Can't Buy: Family Income and Children's Life Chances*. Cambridge, MA: Harvard University Press.
- McLanahan, Sara and Gary Sandefur. 1994. *Growing Up with a Single Parent*. Cambridge, MA: Harvard University Press.
- Michaelis R., C. Asenbauer, M. Buchwald-Senal, G. Haas, and I. Krageboh-Mann. 1993. "Transitory Neurological Findings in a Population of At Risk Infants." *Early Human Development* 34:143-153.
- Miller, Jane. 1994. "Birth Order, Interpregnancy Interval and Birth Outcomes among Filipino Infants." *Journal of Biosocial Science* 26:243-59.
- National Center for Health Statistics. 2001. Table from the linked birth/infant death file (<http://www.cdc.gov/nchs/about/major/dvs/linked/tab4.txt>). Retrieved October 15, 2001.
- Overspect, M.D. and A.J. Moss. 1991. "Children's Exposure to Environmental Cigarette Smoke before and after Birth." *Advanced Data* No. 202. Vital and Health Statistics of the National Center for Health Statistics, U.S. Department of Health and Human Services.

- Pena, I.C., A.J. Teberg, and K.M. Finello. 1988. "The Premature Small-for-Gestational-Age Infant During the First Year of Life: Comparison by Birth Weight and Gestational Age." *Journal of Pediatrics* 113:1066-73.
- Peoples-Sheps, Mary D., E. Siegel, and C.M. Suchindran. 1991. "Characteristics of Maternal Employment During Pregnancy: Effects on Low Birthweight." *American Journal of Public Health* 81:1007-12.
- Rich-Edwards, J.W., M.J. Stampfer, J.E. Manson, B. Rosner, S.E. Hankinson, G.A. Colditz, W.C. Willett, and C.H. Hennekens. 1997. "Birth Weight and Risk of Cardiovascular Disease in a Cohort of Women Followed up Since 1976." *British Medical Journal* 35:496-500.
- Robertson, C.M., G.J. Hrynychshyn, P.C. Etches, and K.S. Pain. 1992. "Population-Based Study of the Incidence, Complexity, and Severity of Neurologic Disability among Survivors Weighing 500 through 1250 grams at Birth: A Comparison of Two Birth Cohorts." *Pediatrics* 90:750-5.
- Rosenzweig, Mark R. and Kenneth I. Wolpin. 1994. "Are There Increasing Returns to the Intergenerational Production of Human Capital? Maternal Schooling and Child Intellectual Achievement." *The Journal of Human Resources* 29:670-93.
- Rosenzweig, Mark R. and Kenneth I. Wolpin. 1995. "Sisters, Siblings, and Mothers: the Effect of Teen-Age Childbearing on Birth Outcomes in a Dynamic Family Context." *Econometrica* 63:303-26.
- Ruggles, Patricia. 1990. *Drawing the Line: Alternative Poverty Measures and Their Implications for Public Policy*. Washington, DC: The Urban Institute Press.
- Seidman, D.S., A. Laor, R. Gale, D.K. Stevenson, S. Mashiach, and Y.L. Danon. 1992. "Catch-up Head Growth and Motor Performance in Very-Low-Birthweight Infants." *Obstetrics and Gynecology* 79:543-6.
- Sorensen, H.T., S. Sabroe, J. Olsen, K.J. Rothman, M.W. Gillman, and P. Fischer. 1997. "Birth Weight and Cognitive Function in Young Adult Life: Historical Cohort Study." *British Medical Journal* 315:401-3.
- Starfield, Barbara, S. Shapiro, J. Weiss, K. Liang, K. Ra, D. Paige, and X. Wang. 1991. "Race, Family Income, and Low Birth Weight." *American Journal of Epidemiology* 134:1167-74.
- Stockwell E.G., Goza F.W., and Roach J.L. 1995. "The Relationship between Socioeconomic Status and Infant Mortality in a Metropolitan Aggregate, 1989-1991." *Sociological Forum* 10:297-308.
- Tresserras R., Canela J., Alvarez J., Sentis J., and Salleras L. 1992. "Infant Mortality, Per Capita Income, and Adult Illiteracy: An Ecological Approach." *American Journal of Public Health* 82:435-8.
- U.S. Department of Education, National Center for Education Statistics. 1997. *The Condition of Education 1997, NCES 97-388*, by Thomas M. Smith, Beth Aronstamm Young, Yupin Bae, Susan P. Choy, and Nabeel Alsalam. Washington, DC: U.S. Government Printing Office.
- Wilcox, A. and I. Russell. 1990. "Why Small Black Infants Have a Lower Mortality Rate than Small White Infants: The Case for Population-Specific Standards for Birth Weight." *Journal of Pediatrics* 116:7-10.
- Wang, X., B. Zuckerman, G. A. Coffman, and M.J. Corwin. 1995. "Familial Aggregation of Low Birth Weight among Whites and Blacks in the United States." *New England Journal of Medicine* 333:1744-49.

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