Disparities in Birth Weight by Maternal Educational Attainment and Race/Ethnicity: An Illustrative Example of a New Modeling Approach

Michael S. Pollard
RAND Corporation
1700 Main St.
Santa Monica, CA 90407-2138

And

Narayan Sastry
University of Michigan
Institute for Social Research
426 Thompson Street
Ann Arbor, MI 48106

March 2007

Paper prepared for the 2007 Population Association of America meetings, March 29-31, 2007, New York, New York. Address correspondence to mpollard@rand.org (1-310-393-0411, x7627)

1. Introduction

This paper takes an in-depth look at a new way of modeling the major underlying cause of infant mortality and childhood morbidity—low birth weight.

Low birth weight (less than 2,500 grams) is both a critical public health concern as well as a scientific problem of substantial interest. Its high priority as a public health problem stems from the facts that it is the major determinant of infant mortality in developed countries and that it contributes substantially to the overall burden of childhood handicap. Both low birth weight and its primary antecedent, preterm delivery (usually referring to birth prior to 37 completed weeks of gestation), are more common in the United States than in most other Western European nations, and these differences account for America's relatively poor infant mortality rate.

At the same time, dealing with low birth weight is not a simple process. Despite advances in the medical care of pregnancy and delivery, and the introduction of a variety of programs that have substantially increased the access to that care, the proportion of U.S. births that are low birth weight has increased steadily, from a low of 6.7% in 1984 to 8.1% in 2004, the highest level since 1970 (Hoyert et al. 2006). Although medical innovation has played a major role in lowering infant mortality, its impact on the incidence of low birth weight appears to have been minimal.

Subsequently, the present state of knowledge about the nature of low birth weight does not appear adequate to mitigate the problems involved, nor do established social and medical programs appear to provide sufficient solutions. Better understanding of the nature of low birth weight is essential to addressing the challenges it poses. It is possible that prior research on low birth weight has been limited by the analytical techniques used to identify potentially causal factors associated with low birth weight infant births; this paper presents a relatively new, and arguably more appropriate way of modeling low birth weight than is commonly employed: quantile regression. The study of birth weight differentials is most commonly based on statistical models of the mean using ordinary least squares, or categorical low birth weight status using logit or probit regression. These approaches are limited by several shortcoming, however. Linear regression is concerned with how covariates affect the *mean* of the birth weight distribution, and thus the relationships that are identified may not provide meaningful insights into the ways covariates affect birth weight at other, potentially more salient, points on the birth weight distribution. Categorical measures of birth weight, such as "birth weight below 2,500 grams" similarly suffer from methodological as well as conceptual problems.

This paper illustrates the quantile regression technique and its benefits by focusing on the association between maternal education and subsequent birth weight. Quantile regression can be used to fit a model to the median (50^{th} percentile) of the (birth weight) distribution, but can also be specified to fit other fixed percentiles (quantiles) of the distribution using a family of models. Using a family of models it is possible to assess the impact of covariates across the entire birth weight distribution, and to zero in on particular portions of the distribution of interest (such as the fifth percentile at the bottom of the distribution) without the substantial loss of information that results when continuous variables are collapsed into dichotomous ones. Graphic presentations of the quantile regression results provide additional valuable insights.

This paper is structured as follows. Section 2 provides a brief overview of the importance of birth weight. Section 3 includes a discussion of the shortcomings associated with standard approaches to modeling birth weight. Section 4 describes the data. In Section 5 we present our conceptual framework, identify specific covariates and outline our modeling approach. Results are presented in Section 6. Section 7 concludes and suggests further research directions.

2. Background

Birth weight is one of the leading indicators of infant and reproductive health and a key determinant of child health (Aber et al., 1997), mortality (Cramer 1987; Institute of Medicine 1985; MacDorman and Atkinson, 1999; Mathews, Macdorman and Menacker 2002), development (Hack et al., 1995), as well as chronic disease at old age (Elo and Preston 1992). Babies weighing less than 1,500g have a mortality risk at least 100 times higher than babies at the optimal (associated with lowest risk) weight (Basso Wilcox Weinberg 2006).

While there have been recent dramatic increases in survival rates, very low birth weight (VLBW; <1,500 grams) and extremely low birth weight (ELBW; <1,000 grams) children (Anderson and Doyle 2003; Hack et al. 2005; Lorenz et al. 1998; Saigal et al. 1991; Sommerfelt, Ellersen and Markestad 1993) and adolescents (Grunau, Whitfield and Fay 2004; Jefferis, Power and Hertzman 2002; Saigal et al 2000; Saigal et al. 2003) remain significantly disadvantaged on many measures of cognition, academic achievement, behavior, and social adaptation.

For example, ELBW individuals at age 16 reported more functional limitations in cognition, sensation, mobility, and self care than did normal birth weight individuals (Saigal et al. 2006a). Lower birth weight babies continue to have worse outcomes into young adulthood as well, with regards to educational attainment and earnings, and employment (Black, Devereux and Salvanes 2005; Conley and Bennett 2000; Currie and Hyson 1999; Richards et al. 2001), although this may be primarily due to disabilities associated with low birth weight, rather than low birth weight itself (Saigel et al. 2006b)

Additionally, birth weight is linked to the intergenerational transmission of health status through the association between a mother's birth weight and the likelihood of her having a preterm birth (Porter et al. 1997) or an infant with low birth weight (Sanderson, Emanuel and Holt 1996).

Finally, low birth weight is a marker of fetal undernutrition, which may permanently program metabolic changes in the body that are associated with the emergence of chronic illness in later life (Barker 1998; Law et al. 1993; Rich-Edwards et al. 1997).

3. Models of Birth Weight

There have been an enormous number of studies that have examined the covariates of birth weight or low birth weight. With only two exceptions that we are aware of (discussed below), *all* of these studies have either modeled birth weight as a continuous variable using least squares regression or have modeled a categorical low birth weight indicator (e.g., birth weight below 2,500 grams, corresponding to low birth weight) using logit or probit regression.

There are a number of shortcomings associated with studying birth weight as a continuous outcome using linear regression or low birth weight as a dichotomous outcome using logit or probit regression. First, these models do not provide a comprehensive and complete picture of how birth weight is related to the covariates being examined. Linear regression only tells us how covariates affect the *mean* of the birth weight distribution. The relationships that are uncovered may not provide meaningful insights into the ways that covariates affect birth weight at other points on the birth weight distribution. Partly to address this problem, and to focus attention on what is perceived to be an important dichotomy, researchers have examined whether birth weight falls above or below 2,500 grams. However, in doing so they disregard the rest of the birth weight distribution.

Second, the "low birth weight" measure suffers from a number of methodological problems. In particular, by converting a continuous variable (birth weight) into a dichotomous variable (low vs. normal birth weight), a tremendous amount of information is discarded. One result is a loss of statistical power to estimate covariate effects with precision, which it makes it more difficult to uncover true relationships that are present in the data.

Third, the idea of "low birth weight" has a number of conceptual problems. Wilcox (2001) argued that "the category of 'low birthweight' is uninformative and seldom justified." In addition to "low birth weight" (LBW, weighing <2,500g), additional cut-offs such as "very low birth weight" (VLBW, weighing <1,500g) and "extremely low birth weight" (ELBW, weighing <1,000g) are commonly identified. Complicating this collection of groups is a lack of consistency in the literature with regard to where each group's boundaries begin; for example, while ELBW is usually identified as <1,000g, Grunau, Whitfield and Fay (2004) consider <800g to be the ELBW threshold, and Shankaran et al. (2004) identify <750g to be the ELBW ceiling. The proliferation of dichotomous contrasts continues, with "moderately low birth weight" (1,500-2,499g) being recently introduced as a category that is routinely excluded from analyses (Stein, Siegel, Bauman 2006).

This highlights the point that although cut-offs such as 2,500 grams are meaningful in certain ways, in others they are arbitrary. As Rose (1992) notes, disease is nearly always a quantitative rather than a categorical phenomenon and hence has no natural definitions. The sharp distinction provided by the contrast of low birth weight with normal birth weight is in many ways a medical artifact. For example, a recent analysis of U.S. singleton neonatal death rates from 1995-2000, by birth weight measured as a continuous variable, indicates a concave curve, with the lowest mortality risks at roughly 3,875g, but with risks that increase steadily down to, and continuing below, 2,500g (Basso Wilcox Weinberg 2006). There is no noticeable disconnect when crossing below the 2,500g threshold, nor beyond 1,000g.

Finally, Black, Devereux, and Salvanes (2005) contrast the fit of models using a dichotomous indicator of low birth weight (<2,500g) and a continuous measure of birth weight as explanatory variables predicting a variety of adult outcomes – not surprisingly, the model incorporating more information (the continuous measure of birth weight) provides the better fit, and they suggest that using cutoffs such as <2,500 grams as independent variables may not be appropriate for analyses of that sort. It also stands to reason that as a dependent variable, too, continuous measures are likely more appropriate.

To date there have been only two analyses of birth weight using quantile regression. Abrevaya (2001) used quantile regression on large subsamples of singleton births from the 1992 and 1996 Natality Data Sets to study the effects of background demographic and social characteristics and maternal behaviors on birth weight. Koenker and Hallock (2001) extended Abrevaya's work as an illustrative analysis in an article providing an introduction to the technique of quantile regression.

Quantile regression can be informative about the impact of covariates at different points in the birth weight distribution. Quantile regression provides a method for estimating models of conditional quantile functions, where the median (the 50th percentile), or some other quantile, is expressed as a function of observed covariates. See Koenker and Hallock (2001) for an introduction to quantile regression. In contrast, linear regression based on ordinary least squares provides a method for estimating models of the conditional mean. The median provides a more robust measure of central tendency than the mean—in the sense that it is less influenced by outlier values—and quantile regression based on the median shares this attractive property.

In contrast to linear regression based on ordinary least squares, the focus in quantile regression moves away from the mean to other selected points on the conditional wage distribution and the estimation procedure is formulated in terms of absolute rather than squared errors. Median regression minimizes the sum of absolute residuals, and the estimator is known as the Least Absolute Deviations (LAD) estimator, whereas linear regression minimizes the sum of squared residuals around the mean. We can also extend the general method to other quantiles by minimizing a sum of asymmetrically weighted absolute residuals. The resulting minimization problem can be solved easily and efficiently by linear programming methods. Standard error estimates are often based on bootstrap resampling, which has the advantage of yielding a variance-covariance matrix that is heteroscadistic-consistent. The asymptotic formula for the computation of the variance-covariance matrix is known to understate the true variance-covariance matrix in the presence of heteroscedasticity. The conventional approach used to compute the variance-covariance matrix is the bootstrapping method, which we employ.

Quantile regression was introduced by Koenker and Bassett (1978). Following Buchinsky (1998), the model can be written as:

$$y_i = x_i'\beta_\tau + e_{\tau i}, \qquad \text{Quant}_\tau(y_i \mid x_i) = x_i'\beta_\tau,$$

for the τ^{th} quantile (e.g., $\tau = .5$ for median regression), where $\text{Quant}_\tau(y_i \mid x_i)$ is the conditional quantile of y_i given the vector of regressors x_i. The distribution of the error term, $e_{\tau i}$, is left unspecified; the only assumption concerning the error term is that $e_{\tau i}$ satisfies $\text{Quant}_\tau(e_{\tau i} \mid x_i) = 0$. An important feature of the model is that the covariate effects, β_τ, may vary across the quantiles. As the value of τ is increased gradually from 0 to 1, a series of models can trace out the entire conditional distribution of y given the regressors x. Although the various quantile regression estimates are correlated, it is straightforward to obtain the joint distribution of the estimates in order to conduct appropriate statistical tests by estimating the models simultaneously. The estimated joint variance-covariance matrix that includes between-quantile blocks can be estimated using bootstrap techniques (Efron and Tibshirani, 1993). Wald tests may then be used to examine the equality of the estimated coefficients of a given regressor across quantiles. Although this method has been found to perform better than other alternatives to estimating standard errors (Buchinsky, 1995), it is extremely computer-intensive and impractical with sample sizes as large as those we examine here (close to four million observations). The parameter estimates are interpreted as the marginal change in the τ^{th} conditional quantile due to a unit change in a covariate. Some caution is required in interpreting the results because the effects of a change in a covariate could be to change the quantile of the observation.

There are a number of useful features of quantile regression (see Buchinsky, 1998). The major advantage of quantile regression is that it provides a more detailed portrait of the relationship between the conditional birth weight distribution and the selected covariates. These results can be easily seen visually, using graphs that plot coefficients against the quantiles of the birth weight distribution, connecting the point estimates to trace out the profile of how the covariate affects birth weight. Distinct parameter effects at different quantiles may be interpreted as differences in the response of the dependent variable to changes in the regressors at various points in the conditional distribution of the dependent variable. Finally, the models are not sensitive to outlier values of the dependent variable and quantile regression may be more efficient than least squares when the error term is non-normal (see Koenker and Bassett (1978)). Quantile regression models also may have better properties than OLS in the presence of heteroscedasticity (See Deaton (1997)).

4. Data

Our analysis is based on the 2001 Natality Data Set (NDS), an annual data set assembled by the National Center for Health Statistics. The NDS contains information from birth certificates on *all* live births that occur in the U.S. during any given year. The NDS includes information from birth certificates on the parents' social and demographic background, maternal factors, pregnancy-related behaviors, and birth outcomes (e.g., birth weight and sex). We use the most recent year available for these data (2001), which contains nearly 4 million observations. We omit twins and multiple births from our analysis because their birth weight is related to their multiplicity.

5. Conceptual Framework, Covariates, and Modeling Approach

The conceptual framework that guides our analysis closely follows that used in previous studies (e.g., Cramer, 1995; Hummer 1993; Mosley and Chen 1984; Schulz et al. 2002). We do not present the conceptual framework because it is well known. Instead, we use it to organize the available covariates and to inform our modeling approach. The conceptual framework also helps us to recognize factors that are unmeasured or unmeasurable and to gauge their likely effects.

The covariates that we consider are listed in Table 1, along with their summary statistics. Our focus in this paper is on birth weight disparities by maternal educational attainment, and in the first panel of the table we show the distribution of the sample by the mother's education.

[Table 1 About Here]

The second panel in Table 1 includes mother's race/ethnicity, which has previously been shown to be strongly associated with birth weight; the size of our data set enables much more detailed race / ethnic contrasts than prior research.

The third panel contains background demographic and socioeconomic characteristics. Sex is our only infant-specific background factor. It is well documented that males have higher birth weights than females. Relevant measured background characteristics of the mother and family include the mother's age, education, nativity, and marital status. A key variable that is unavailable from vital statistics is household economic status; we also exclude father's education from the analysis because of high rates of missing data. Note that many aspects of the mother's inherent healthiness are not reflected on the birth certificate, including, for example, her genetic endowment that either predisposes or protects her—and her child—from adverse health outcomes.

Intermediate infant- or pregnancy-specific risk factors are shown in the bottom panel of Table 1 and include gestation length, parity, and medical risk factors. Birth weight is closely tied to gestation length and it is essential to control for this because there are systematic differences in gestation length according to factors such as race and ethnicity. First births have distinct risks for low birth weight and there is an established relationship between parity and birth weight reflecting, for example, benefits (such as experience) as well as costs (such as maternal depletion) associated with reaching higher parities. A variety of medical risk factors may directly affect birth weight. We separately examine each medical risk factor that affected at least 1% of births. These risk factors include anemia, lung disease, diabetes, hydramnios, hypertension, a previous large birth, and a previous pre-term birth. We also considered the effects of obstetric procedures that may directly affect gestation length (and, hence, birth weight); these include induced labor and tocolysis (a procedure to delay or inhibit premature labor).

Smoking and alcohol use are intermediate factors that represent longer-term health behavior choices of mothers. There is considerable evidence that both of these behaviors lead to lower birth weight and worsen other birth outcomes (Lundsberg, Bracken, and Saftlas 1997; Sprauve et al. 1999). Finally, use of health services represents mother-specific behavior. We consider the effects of prenatal care, which has been hypothesized to be a key intermediate factor affecting birth outcomes and, in particular, to be one that is amenable to policy intervention. However, evidence for the relationship between prenatal care and birth weight is inconsistent (Alexander and Korenbrot, 1995; Fiscella, 1995; Huntington and Connell, 1994). In particular, many studies have found greater prenatal care to be associated with lower birth weight and worse birth outcomes or for beneficial effects to be substantially underestimated (Frick and Lantz, 1996). These findings point to the ways in which unobservable pregnancy- or mother-specific characteristics can shape the nature of the relationship between certain intermediate characteristics and birth weight. It is unreasonable to conclude from this evidence that prenatal care is unassociated with or reduces birth weight. Rather, the observed association reflects the adverse selection among mothers who are experiencing a difficult pregnancy, or who are unhealthy, that leads them to obtain earlier and more intensive prenatal care.

The analysis will proceed in several steps. We will begin by documenting and describing differences in mean birth weight by mother's educational attainment. We will then estimate three sets of quantile regression models for birth weight. The first set of models will estimate basic quantile regression with no covariates except for mother's education. The results of these models will allow us to describe how maternal educational disparities in birth weight vary over the entire birth weight distribution. The second set of quantile regression models uses a reduced-form specification that includes only basic demographic and socioeconomic characteristics. This specification will include none of the intermediate variables. Background factors in this model will include infant sex and mother's age, race and ethnicity, nativity, and marital status in addition to educational attainment. The third set of models includes the full set of intermediate factors described above, in addition to the background factors included in the reduced form model. Intermediate factors will include gestation length, inter-pregnancy intervals, parity, medical risk factors, use of alcohol and tobacco, and prenatal care.

Comparing the results across the three sets of quantile regression models will tell us the extent to which background demographic and socioeconomic characteristics, and, separately, intermediate factors, account for the observed disparities in birth weight across mother's educational attainment. The family of quantile regression models we estimate comprises of ten separate equations fit to the following quantiles: 0.05, 0.16, 0.25, 0.35, 0.45, 0.55, 0.65, 0.75, 0.85, and 0.95. This set of ten equations provides a relatively parsimonious, yet thorough, characterization of the conditional birth weight distribution. Note that we use the 0.16 quantile rather than the 0.15 quantile, as the second model specification failed to derive t values for this quantile for some unidentified reason. For consistency across the models we used the 0.16 quantile in all three models. We estimate the individual equations separately, rather than jointly, because it is extremely computationally demanding to estimate bootstrapped joint models with a sample size of nearly four million observations. Comparisons of standard errors between models estimated jointly and models estimated separately as part of a preliminary analysis revealed that there were only very minor differences that are certainly not large enough to affect any of our results or conclusions.

6. Results

Our results are presented in two subsections. We begin by presenting our findings regarding birth weight disparities by maternal education. Next, we turn to our results for the other covariates in the model which include background demographic and socioeconomic characteristics and intermediate factors.

Disparities in Birth Weight by Mother's Education

Disparities in birth weight by mother's education are noticeable, but not initially striking. Table 2 presents mean birth weights by mother's education. Infants born to women with 16 years of education have the highest mean birth weight at 3,428 grams, followed closely by those with 17+ years of education. Infants born to women with less than 12 years of education have the lowest mean birth weight: 3,259 grams. Standard deviations across the educational attainment categories are relatively comparable, ranging from 580 grams for women with 13 years of education down to 535 grams for women with 17+ years education. The general trend is for higher educational attainment to be associated with higher mean birth weight and lower standard deviations, which when converted into categorical measures of birth weight, translates into lower rates of low birth weight (< 2,500 grams) and very low birth weight (< 1,500 grams) infants. The low birth weight rate of 7.5% for mothers with the lowest educational attainment (less than 12 years) is nearly twice that of mothers with the highest educational attainment, with a rate of 4.1%. The very low birth weight rate of the bottom three educational attainment categories (1.2%) is twice as large as the rate for the most educated group, although in absolute terms the magnitude of the difference across categories is less impressive (a difference of 0.6%). While we can observe birth weight differences across levels of maternal educational attainment, Table 2 suggests that the pattern is generally a moderate linear association

[Table 2 About Here]

Limiting our focus to disparities in the mean birth weight by maternal education, or to disparities in dichotomous specifications of birth weight (LBW, VLBW) as in Table 2 might lead us to conclude that the relationship between educational attainment and birth weight outcomes is straight forward – that disparities increase in a linear fashion over the range of educational attainment. This conclusion appears to be incorrect, however. Figure 1 presents the birth weight disparities associated with each level of educational attainment, compared to 12 years of education. Point estimates from each of the ten quantile regressions considering only educational attainment are presented in a three-dimensional chart that visually describes the disparity profile from the 0.05 quantile to the 0.95 quantile for each level of educational attainment in a more succinct fashion than the complete regression results, which are included in Table 3. The disparity profile suggested by the measures in Table 2 is that of a step function, where the impact of a particular level of education is similar across the entire birth weight distribution (quantiles 0.05 to 0.95) but with greater educational attainment increasing birth weight like a series of steps. The results in Figure 1 are generally consistent with the suggested profile only at the <12 years and 13 years education. There is a fairly constant disparity of 55 grams between infants born to mothers with less than 12 years of education compared to infants born to mothers with 12 years education. Similarly, there is generally a constant 30 gram disparity between infants born to mothers with 13 years of education compared to those born to mothers with 12 years education (with the births to less educated mothers suffering the lower birth weight). However, as educational attainment increases we see that the relationship between education and birth weight is more complex than we would have otherwise been led to suspect.

[Figure 1 About Here]

For many of the educational attainment levels, the birth weight disparities compared to 12 years of education are not constant across the birth weight distribution. Rather, disparities vary across the different quantiles in the birth weight distribution at the higher levels of education. Disparities are relatively small at the upper end of the birth weight distribution (0.85+), but there is a steadily widening disparity as we move down the birth weight distribution, such that at the lowest quantile in the birth weight distribution, the birth weight disparity between lower levels of maternal education and higher levels of education are substantially increased; nearly a 200 gram disparity between infants born to mothers with 12 years of education compared to those born to mothers with 17+ years of education at the bottom .05 percentile, contrasted with an 83 gram disparity at the upper two quantiles in the birth weight distribution. This can be more intuitively interpreted as indicating that birth weight disparities by mother's education are greatest at the most critical (lowest) part of the birth weight distribution.

[Table 3 About Here]

We turn next to an examination of birth weight disparities by maternal education after controlling for background demographic and other socioeconomic characteristics. The complete set of quantile regression results are presented in Table 4. Figure 2 presents the key results graphically, showing the educational disparities in birth weight after controlling for these background characteristics. It is immediately clear that controlling for the background characteristics attenuates the observed disparities across educational attainment levels, but that this is much more the case at the upper end of the birth weight distribution than the bottom end. Birth weight disparities by educational attainment are greatly homogenized for years of education from 13-15 compared to 12 years (to roughly a disparity of 40 grams at all but the lower ends of the birth weight distribution), but even after the array of background controls is added, substantial birth weight disparities by maternal education are observed at the lowest ends of the birth weight distribution. The disparity profile is made more apparent in Figure 2 with the addition of the background controls than it was in the uncontrolled estimates shown in Figure 1. Once again, disparities associated with educational attainment are greatest at the most critical location in the birth weight distribution; infants born to mothers with 12 years of education suffer a nearly 150 gram disparity compared to infants born to mothers with 16+ years of education.

[Table 4 and Figure 2 About Here]

The third model specification that we estimate adds intermediate variables to the prior model that included background demographic and socioeconomic factors. Complete results are presented in Table 5, but again we focus on the key results presented in Figure 3: the quantile regression estimate of disparities in birth weight by mother's educational attainment, adjusted for the complete set of controls. Again, the addition of more controls attenuates the disparity profile associated with maternal education, but the same pattern observed in the first two specifications persists; while birth weight disparities by maternal education are further equalized (such that education greater than 12 years is nearly uniformly associated with a birth weight disparity of 25 grams for births to women with 12 years of education), the greatest disparities are again found at the most vulnerable portions of the weight distribution. Infants born to women with 12 years of education are faced with a birth weight disparity of more the 75 grams compared with births to mothers with 16+ years of education. A closer look at the complete results in Table 5 indicates that educational attainment is among the most protective, non-ascribed factors (i.e., excluding factors such as race/ethnicity, gender, etc.) at the most vulnerable portions of the birth weight distribution, second only to not smoking during pregnancy. Maternal education contributes more to birth weight than factors such as (lack of) alcohol use, number of prenatal care visits, or the adequacy of prenatal care initiation. However, above the median (0.5 quantile) point in the birth weight distribution, maternal education contributes only minimally to birth weight outcomes, and has substantially less impact than those same factors.

[Table 5 and Figure 3 About Here]

Effects of Background Socioeconomic and Demographic Factors on Birth weight

The background socioeconomic and demographic factors in the models include infant sex and mother's marital status, age, nativity, and race / ethnicity. The estimated parameters for these variables can be found in Tables 4 and 5, corresponding to the effects of these variables before (Table 4) and after (Table 5) controlling for the intermediate factors. Results indicate that before controlling for the intermediate factors, there are sharply varying effects of the background factors across the birth weight distribution. The birth weight penalty for single mothers is particularly large at the 0.05 quantile (-134 grams), but is only about one-third as large at the 0.95 quantile (-47 grams). Foreign born mothers have births that are 60 grams heavier at the 0.05 quantile, but virtually no effect at the 0.95 quantile (2 grams, not significant). Mother's race / ethnicity is associated with some of the most sizeable birth weight disparities, particularly for non-Hispanic black, Asian Indian, and Filipino mothers. While there is substantial variation in the disparities associated with race / ethnicity across the weight distribution, in most cases non-Hispanic white mothers are advantaged.

After controlling for the intermediate factors in the model, the profile of effects for each of these background factors is substantially attenuated, although race / ethnicity remains a key factor associated with birth weight disparity.

7. Conclusions

This paper has presented a new approach to modeling birth weight – quantile regression – which both addresses many of the shortcomings associated with the statistical techniques currently employed. Quantile regression also elucidates aspects of the determinants of birth weight that other methods may miss; both mean-based and dichotomy-based analyses would have hidden the strong association between maternal educational attainment and birth weight disparities at the most vulnerable portions of the birth weight distribution.

Future analyses considering the impact of maternal education *within* race / ethnic groups in a quantile regression framework is likely to be particularly fruitful; race / ethnicity is a powerful factor associated with complex birth weight disparities across the birth weight distribution, and educational attainment is particularly salient at the most critical part of the birth weight distribution.

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* 18:463-483.

Abrevaya, Jason. 2001. "The Effects of Demographics and Maternal Behavior on the Distribution of Birth Outcomes," *Empirical Economics* 26: 247-257.

Alexander, G.R., and C.C. Korenbrot. 1995. "The Role of Prenatal Care in Preventing Low Birth Weight," *The Future Child* 4: 103-120.

Anderson, P. and L.W. Doyle. 2003. "Neurobehavioral Outcomes of School-Age Children Born Extremely Low Birth Weight or Very Preterm in the 1990s." *Journal of the American Medical Association* 289: 3264-3272.

Barker, D.J.P. 1998. *Mothers, Babies, and Disease in Later Life.* Second edition. London: BMJ Publishing Group.

Basso, O., A.J. Wilcox, and C.R. Weinberg. 2006. "Birth Weight and Mortality: Causality or Confounding?" *American Journal of Epidemiology* 164: 303-311.

Black, S.E., P.J. Devereux and K.G. Salvanes. 2005. "From the Cradle to the Labor Market? The Effect of Birth Weight on Adult Outcomes." Institute for the Study of Labor (IZA) Discussion Paper No. 1864, Bonn, Germany.

Buchinsky, M. 1995. "Estimating the Asymptotic Covariance Matrix for Quantile Regression Models: A Monte Carlo Study," *Journal of Econometrics* 68: 303-338.

Buchinsky, M. 1998. "Recent Advances in Quantile Regression Models: A Practical Guide for Empirical Research," *Journal of Human Resources* 33: 88-126.

Conley, Dalton, and Neil G. Bennett. 2000. "Is Biology Destiny? Birth Weight and Life Chances," *American Sociological Review* 65: 458-467.

Cramer, James C. 1987. "Social Factors and Infant Mortality: Identifying High-Risk Groups and Proximate Causes," *Demography* 24: 299-322.

Currie, J., and R. Hyson. 1999. "Is the Impact of Health Shocks Cushioned by Socioeconomic Status? The Case of Low Birthweight," *American Economic Review* 89: 245-250.

Deaton, A. (1997), *The Analysis of Household Surveys: A Microeconometric Approach to Development Policy*, John Hopkins University Press.

Efron, B., and R. Tibshirani. 1993. *An Introduction to the Bootstrap.* New York: Chapman and Hall.

Elo, Irma T. and Samuel H. Preston. 1992. "Effects of Early-Life Conditions on Adult Mortality: A Review," *Population Index* 58:186-212.

Fiscella, K. 1995. "Does Prenatal Care Improve Birth Outcomes? A Critical Review," *Obstetrics and Gynecology* 85: 236-244.

Frick, K.D. and P.M. Lantz. 1996. "Selection Bias in Prenatal Care Utilization: An Interdisciplinary Framework and Review of the Literature." *Medical Care Research and Review* 53: 371-396.

Grunau, R.E., M.F. Whitfield and T.B. Fay. 2004. "Psychosocial and Academic Characteristics of Extremely Low Birth Weight (< or = 800g) adolescents who are Free of Major Impairment Compared with Term-Born Control Subjects." *Pediatrics* 114: E725-E732.

Hack, M., N.K. Klein, and H.G. Taylor. 1995. "Long-Term Developmental Outcomes of Low Birth Weight Infants." *The Future of Children* 5:176-96.

Hack, M., H.G. Taylor, D. Drotar et al. 2005. "Chronic Conditions, Functional Limitations, and Special Health Care Needs of School-Aged Children Born with Extremely Low-Birth-Weight in the 1990s." *Journal of the American Medical Association* 294: 318-325.

Hoyert, D.L., T.J. Matthews, F. Menacker, F. Strobino and B. Guyer. 2006. "Annual Summary of Vital Statistics, 2004". *Pediatrics* 117: 168-183.

Hummer, R.A. 1993. "Racial Differentials in Infant Mortality in the U.S.: An Examination of Social and Health Determinants." *Social Forces* 72:529-54.

Huntington, J., and F.A. Connell. 1994. "For Every Dollar Spent: The Cost Savings Argument for Prenatal Care," *New England Journal of Medicine* 331: 1303-07.

Institute of Medicine. 1985. *Preventing Low Birth Weight*. Washington, D.C.: National Academy Press.

Jefferis, Barbara J. M. H., Chris Power, and Clyde Hertzman. 2002. "Birth weight, childhood socioeconomic environment, and cognitive development in the 1958 British birth cohort study," *British Medical Journal* 325:1-6.

Koenker, R., and G. Bassett. 1978. "Regression quantiles," *Econometrica* 46: 33-50.

Koenker, Roger, and Kevin F. Hallock. 2001. "Quantile regression," *Journal of Economic Perspectives* 15: 143-156.

Law, C.M., M. de Swiet, C. Osmond, et al. 1993. “Initiation of hypertension in utero and its amplification throughout life,” *British Medical Journal* 306: 24-27.

Lorenz, J.M., D.E. Wooliever, J.R. Jetton and N.Paneth. 1998. “A Quantitative Review of Mortality and Developmental Disability in Extremely Premature Newborns.” *Archives of Pediatric and Adolescent Medicine* 152: 425-435.

Lundsberg, Lisbet S., Michael B. Bracken, and Audrey F. Saftlas. 1997. “Low-to-moderate gestational alcohol use and intrauterine growth retardation, low birthweight, and preterm delivery,” *Annals of Epidemiology* 7:498-508.

MacDorman, M.F. and J.O. Atkinson. 1999. “Infant Mortality Statistics from the 1997 Period Linked Birth/Infant Death Data Set.” *National Vital Statistics Reports* 47(23). Hyattsville, MD: National Center for Health Statistics.

Mathews, T. J., Marian F. MacDorman, and Fay Menacker. 2002. “Infant mortality statistics from the 1999 period linked birth/infant death data set,” National Vital Statistics Reports, Vol. 50, No. 4. Hyattsville, MD: National Center for Health Statistics.

Mosley, W.H., and L.C. Chen. 1984. "An Analytical Framework for the Study of Child Survival in Developing Countries." Pp. 25-45 in *Child Survival: Strategies for Research*, edited by W.H. Mosley and L.C. Chen. A supplement to Vol. 10 of *Population and Development Review*

Porter, T.F., A.M. Fraser, C.Y. Hunter, R.H. Ward, and M.W. Varner. 1997. “The risk of preterm birth across generations,” *Obstetrics and Gynecology* 90: 63-67.

Richards, Marcus, Rebecca Hardy, Diana Kuh, and Michael E. J. Wadsworth. 2001. “Birth weight and cognitive function in the British 1946 birth cohort: Longitudinal population based study,” *British Medical Journal* 322: 199-203.

Rich-Edwards, J.W., M.J. Stampfer, J.E. Manson, et al. 1997. “Birth weight and the risk of cardiovascular disease in a cohort of women followed up since 1976,” *British Medical Journal* 315: 396-400.

Rose, G. 1992. *The strategy of preventive medicine.* New York: Oxford University Press.

Saigal, S., L.A. Hoult, D.L. Streiner, B.L. Stoskopf and P.L. Rosenbaum. 2000. “School Difficulties at Adolescence in a Regional Cohort of Children Who Were Extremely Low Birth Weight.” *Pediatrics* 105: 325-331.

Saigal, S., J. Pinelli, L. Hoult, M.M. Kim and M. Boyle. 2003. “Psychopathology and Social Competencies of Adolescents Who Were Extremely Low Birth Weight.” *Pediatrics* 111: 969-975.

Saigal, S., P. Szatmari, P. Rosenbaum, D. Campbell and S. King. 1991. "Cognitive Abilities and School Performance of Extremely Low Birth Weight Children and Matched Term Control Children at Age 8 Years: A Regional Study." *Journal of Pediatrics* 118: 751-760.

Saigal, S., B. Stoskopf, J.Pinelli, D. Streiner, L. Hoult, N. Paneth and J. Goddeeris. 2006a. "Self-Perceived Health-Related Quality of Life of Former Extremely Low Birth Weight Infants at Young Adulthood." *Pediatrics* 118: 1140-1148.

Saigal, S., B. Stoskopf, D. Steiner, M. Boyle, J.Pinelli, N. Paneth and J. Goddeeris. 2006b. "Transition of Extremely Low-Birth-Weight Infants From Adolescence to Young Adulthood." *Journal of the American Medical Association* 295: 667-675.

Sanderson, M., I. Emanuel, and V.L. Holt. 1995. "The Intergenerational Relationship Between Mother's Birthweight, Infant Birthweight, and Infant Mortality in Black and White Mothers," *Paediatric Perinat Epidemiol.* 9: 391-405.

Schulz, A.J., D.R. Williams, B.A. Israel, and L.B. Lempert. 2002. "Racial and Spatial Relations as Fundamental Determinants of Health in Detroit." *The Milbank Quarterly* 80:677-707.

Shankaran, S., Y. Johnson, J.C. Langer, B.R. Vohr, A.A. Fanaroff, L.L. Wright and W.K. Poole. 2004. "Outcome of Extremely-Low-Birth-Weight Infants at Highest Risk: Gestational Age <=24 Weeks, Birth Weight <=750g, and 1-Minute Apgar <=3." *American Journal of Obstetrics & Gynecology* 191: 1084-1091.

Sommerfelt, K., B. Ellertsen, and T. Markestad. 1993. "Personality and Behavior in Eight-Year-Old, Non-Handicapped Children with Birthweight Under 1500 g," *Acta Paediatrica* 82: 723-728.

Sprauve, Margaret E., Michael K. Lindsay, Carolyn D. Drews-Botsch, and William Graves. 1999. "Racial Patterns in the Effects of Tobacco Use on Fetal Growth," *American Journal of Obstetrics and Gynecology* 181: S22-S27.

Stein, R.E., M.J. Siegel, and L.J. Bauman. 2006. "Are Children of Moderately Low Birth Weight at Increased Risk for Poor Health? A New Look at an Old Question." *Pediatrics* 118: 217-223.

Wilcox, Allen J. 2001. "On the Importance—and the Unimportance—of Birthweight," *International Journal of Epidemiology* 30: 1233-1241.

Table 1. Sample summary statistics for background and intermediate covariates

Variable	Mean or percent in category	(Std. Dev.)
Mother's education (%)		
Less than 12	21.7	
12 years	31.3	
13 years	8.4	
14 years	10.6	
15 years	3.5	
16 years	15.0	
17+ years	9.5	
Missing (%)	1.2	
Mother's race/ethnicity (%)		
Non-Hispanic white	57.9	
Non-Hispanic black	14.7	
Asian Indian	0.7	
Chinese	0.8	
Filipino	0.8	
Korean	0.3	
Other Asian	2.1	
Hawaiian	0.1	
Native American	1.0	
Mexican Hispanic	15.5	
Latin American Hispanic	3.1	
Cuban Hispanic	0.4	
Puerto Rican Hispanic	1.4	
Other Hispanic	1.2	
Missing	0.6	
Infant sex (%)		
Female	48.9	
Male	51.1	
Mother's marital status(%)		
Single	33.8	
Married	66.2	
Missing	0.0	
Mother's age (years)	27.2	(6.2)
Mother's Nativity (%)		
Foreign-born	22.7	
U.S. born	77.3	
Missing	0.2	
Gestation length (weeks)	38.9	(2.4)
Missing	6.0	

(Continued…)

Table 1. *Continued*

Variable	Mean or percent in category	(Std. Dev.)
First birth (%)		
Yes	40.2	
No	59.8	
Birth order	2.1	(1.2)
Missing	0.3	
Adequacy of prenatal care initiation (%)		
Inadequate	3.6	
Intermediate	5.8	
Adequate	24.9	
Adequate plus	65.7	
Missing	3.8	
Number of prenatal care visits	11.5	(3.9)
Missing	3.0	
Mother smoked during pregnancy (%)		
Yes	10.4	
No	89.6	
Missing	13.7	
Average number of cigarettes per day	9.0	(7.4)
Mother used alcohol use during pregnancy (%)		
Yes	0.8	
No	99.2	
Missing	13.9	
Average number of drinks per week	1.9	(4.1)
Medical risk factors (%)		
Anemia	2.4	
Lung disease	1.2	
Diabetes	3	
Hydramnios	1.4	
Pregnancy hypertension	3.6	
Previous large birth	1	
Previous preterm birth	1.2	
Other	17.5	
Missing	0.9	
Obstetric procedures		
Induced labor	20.7	
Tocolysis	1.9	
Missing	0.4	
Total observations	3,868,739	

Table 2. Summary statistics for birthweight by mother's education

Variable	Birthweight (grams) Mean	Birthweight (grams) (Std. Dev.)	Low birthweight[a]	Very low birthweight[b]	Number of observations
Mother's education					
Less than 12 years	3,258.80	(571.8)	7.5%	1.2%	839,257
12 years	3,311.80	(577.0)	6.6%	1.2%	1,210,105
13 years	3,342.60	(580.3)	6.1%	1.2%	324,641
14 years	3,378.80	(566.7)	5.3%	1.0%	410,369
15 years	3,374.00	(565.9)	5.4%	1.0%	136,311
16 years	3,428.20	(540.0)	4.2%	0.7%	581,024
17+ years	3,424.50	(534.9)	4.1%	0.6%	367,032
Total	3,340.40	568.7	6.0%	1.0%	3,868,739

Note: [a] Low birthweight defined as < 2,500 grams.
[b] Very low birthweight defined as < 1,500 grams.

Table 3. Quantile regression estimates for models of birthweight with controls for mother's educational attainment

Variables	0.05 Quantile	0.16 Quantile	0.25 Quantile	0.35 Quantile	0.45 Quantile	0.55 Quantile	0.65 Quantile	0.75 Quantile	0.85 Quantile	0.95 Quantile
Mother's education (ref=12 years)										
Less than 12	-51.0 ***	-57.0 ***	-57.0 ***	-57.0 ***	-56.0 ***	-57.0 ***	-58.0 ***	-62.0 ***	-57.0 ***	-56.0 ***
	(0.6)	(1.0)	(1.2)	(1.3)	(1.4)	(1.4)	(1.3)	(1.2)	(1.0)	(0.6)
12 years (reference)	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
13 years	36.0 ***	28.0 ***	28.0 ***	28.0 ***	29.0 ***	28.0 ***	37.0 ***	38.0 ***	28.0 ***	29.0 ***
	(0.8)	(1.4)	(1.7)	(1.8)	(1.9)	(1.9)	(1.9)	(1.7)	(1.4)	(0.8)
14 years	108.0 ***	75.0 ***	65.0 ***	73.0 ***	57.0 ***	57.0 ***	77.0 ***	68.0 ***	56.0 ***	57.0 ***
	(0.8)	(1.3)	(1.5)	(1.7)	(1.8)	(1.8)	(1.7)	(1.5)	(1.2)	(0.8)
15 years	85.0 ***	57.0 ***	57.0 ***	63.0 ***	57.0 ***	57.0 ***	57.0 ***	48.0 ***	56.0 ***	57.0 ***
	(1.2)	(2.0)	(2.4)	(2.7)	(2.8)	(2.8)	(2.7)	(2.4)	(2.0)	(1.2)
16 years	199.0 ***	142 ***	115.0 ***	113.0 ***	102.0 ***	113.0 ***	111.0 ***	103.0 ***	85.0 ***	85.0 ***
	(0.7)	(1.1)	(1.4)	(1.5)	(1.6)	(1.5)	(1.5)	(1.4)	(1.1)	(0.7)
17+ years	199.0 ***	135 ***	114.0 ***	113.0 ***	86.0 ***	94.0 ***	111.0 ***	98.0 ***	84.0 ***	83.0 ***
	(0.8)	(1.4)	(1.6	(1.8)	(1.8)	(1.8)	(1.8)	(1.6)	(1.3)	(0.8)
Constant	2381.0 ***	2835.0 ***	3005.0 ***	3147.0 ***	3288.0 ***	3402.0 ***	3518.0 ***	3667.0 ***	3856.0 ***	4167.0 ***
	(0.4)	(0.6)	(0.8)	(0.8)	(0.9)	(0.9)	(0.9)	(0.8)	(0.6)	(0.4)

Note: Standard errors in parentheses.
**p*<. 05, ***p*<.01, ****p*<.001

Table 4. Quantile regression estimates for models of birthweight with controls for background demographic and socioeconomic characteristics

Variables	0.05 Quantile	0.16 Quantile	0.25 Quantile	0.35 Quantile	0.45 Quantile	0.55 Quantile	0.65 Quantile	0.75 Quantile	0.85 Quantile	0.95 Quantile
Mother's education (ref=12 years)										
Less than 12	-61.6 ***	-46.0 ***	-44.2 ***	-41.8 ***	-38.5 ***	-37.3 ***	-36.2 ***	-34.1 ***	-31.7 ***	-30.8 ***
	(2.6)	(1.5)	(1.1)	(1.0)	(1.0)	(0.7)	(0.8)	(1.0)	(1.1)	(1.2)
12 years (reference)	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
13 years	61.5 ***	45.3 ***	36.5 ***	32.8 ***	28.7 ***	27.2 ***	25.8 ***	25.5 ***	25.0 ***	24.8 ***
	(3.7)	(2.0)	(1.5)	(1.4)	(1.4)	(1.0)	(1.2)	(1.4)	(1.5)	(1.7)
14 years	74.2 ***	50.7 ***	43.7 ***	39.5 ***	36.4 ***	33.6 ***	30.1 ***	26.5 ***	22.8 ***	18.0 ***
	(3.2)	(1.8)	(1.3)	(1.2)	(1.2)	(0.8)	(1.0)	(1.2)	(1.3)	(1.5)
15 years	71.7 ***	51.3 ***	46.1 ***	40.6 ***	35.5 ***	33.7 ***	29.8 ***	26.7 ***	24.0 ***	18.4 ***
	(5.0)	(2.8)	(2.0)	(1.9)	(1.9)	(1.3)	(1.6)	(1.9)	(2.0)	(2.4)
16 years	132.9 ***	93.7 ***	75.3 ***	62.7 ***	54.8 ***	47.0 ***	38.4 ***	31.7 ***	22.1 ***	0.3
	(3.0)	(1.7)	(1.2)	(1.1)	(1.1)	(0.8)	(0.9)	(1.1)	(1.2)	(1.4)
17+ years	137.0 ***	82.0 ***	68.2 ***	55.6 ***	46.2 ***	39.4 ***	31.7 ***	22.8 ***	11.4 ***	-9.9 ***
	(3.5)	(1.9)	(1.4)	(1.3)	(1.3)	(0.9)	(1.1)	(1.3)	(1.4)	(1.6)
Mother's education missing	-196.6 ***	-82.3 ***	-67.1 ***	-58.1 ***	-51.8 ***	-46.0 ***	-43.0 ***	-40.7 ***	-39.3 ***	-39.9 ***
	(8.6)	(4.8)	(3.5)	(3.3)	(3.2)	(2.3)	(2.8)	(3.2)	(3.5)	(4.1)
Mother's race/ethnicity (ref=non-Hispanic white)										
Non-Hispanic black	-353.0 ***	-198.0 ***	-183.9 ***	-178.5 ***	-174.9 ***	-173.8 ***	-173.4 ***	-171.2 ***	-168.4 ***	-162.3 ***
	(2.8)	(1.5)	(1.1)	(1.1)	(1.0)	(0.8)	(0.9)	(1.0)	(1.1)	(1.3)
Asian Indian	-263.7 ***	-257.0 ***	-263.4 ***	-263.1 ***	-262.8 ***	-266.2 ***	-269.5 ***	-273.3 ***	-278.3 ***	-281.6 ***
	(11.2)	(6.2)	(4.5)	(4.3)	(4.1)	(2.9)	(3.5)	(4.1)	(4.5)	(5.3)
Chinese	-34.8 ***	-93.3 ***	-117.5 ***	-130.5 ***	-141.0 ***	-154.3 ***	-165.8 ***	-176.3 ***	-181.9 ***	-199.2 ***
	(10.3)	(5.8)	(4.2)	(4.0)	(3.8)	(2.7)	(3.3)	(3.8)	(4.2)	(4.9)
Filipino	-233.3 ***	-192.7 ***	-196.4 ***	-198.6 ***	-202.2 ***	-206.0 ***	-209.8 ***	-211.8 ***	-210.7 ***	-206.8 ***
	(10.3)	(5.7)	(4.1)	(3.9)	(3.8)	(2.7)	(3.3)	(3.8)	(4.2)	(4.8)
Korean	-35.4 *	-83.7 ***	-102.4 ***	-113.0 ***	-119.1 ***	-129.6 ***	-133.3 ***	-142.7 ***	-158.2 ***	-160.5 ***
	(17.6)	(9.9)	(7.1)	(6.8)	(6.6)	(4.7)	(5.6)	(6.6)	(7.2)	(8.3)
Other Asian	-178.0 ***	-175.3 ***	-181.5 ***	-184.4 ***	-186.6 ***	-191.5 ***	-194.6 ***	-193.8 ***	-194.2 ***	-190.7 ***
	(7.2)	(4.0)	(2.9)	(2.8)	(2.7)	(1.9)	(2.3)	(2.7)	(3.0)	(3.4)

(Continued…)

Table 4. *Continued*

Variables	0.05 Quantile	0.16 Quantile	0.25 Quantile	0.35 Quantile	0.45 Quantile	0.55 Quantile	0.65 Quantile	0.75 Quantile	0.85 Quantile	0.95 Quantile
Mother's race/ethnicity (ref=non-Hispanic white)										
Hawaiian	-61.2 *	-44.0 ***	-53.4 ***	-46.2 ***	-51.1 ***	-43.2 ***	-38.8 ***	-36.8 ***	-17.9	-7.7
	(24.2)	(13.5)	(9.8)	(9.3)	(9.0)	(6.4)	(7.7)	(9.0)	(9.9)	(11.4)
Native American	-32.9 ***	21.7 ***	27.1 ***	33.7 ***	37.8 ***	47.5 ***	56.1 ***	58.5 ***	67.9 ***	94.7 ***
	(9.1)	(5.1)	(3.7)	(3.5)	(3.4)	(2.4)	(2.9)	(3.4)	(3.7)	(4.3)
Mexican Hispanic	25.7 ***	18.0 ***	9.7 ***	3.4 **	-2.5 *	-6.7 ***	-10.8 ***	-13.8 ***	-15.2 ***	-14.2 ***
	(3.2)	(1.8)	(1.3)	(1.2)	(1.2)	(0.8)	(1.0)	(1.2)	(1.3)	(1.5)
Latin American Hispanic	-29.6 ***	-14.0 ***	-20.1 ***	-23.9 ***	-28.0 ***	-34.6 ***	-38.9 ***	-41.7 ***	-45.1 ***	-49.0 ***
	(5.8)	(3.2)	(2.3)	(2.2)	(2.1)	(1.5)	(1.8)	(2.1)	(2.3)	(2.7)
Cuban Hispanic	-35.0 *	-15.7	-19.4 ***	-14.6 *	-26.7 ***	-28.9 ***	-31.2 ***	-39.8 ***	-36.7 ***	-35.9 ***
	(15.0)	(8.4)	(6.0)	(5.8)	(5.6)	(3.9)	(4.8)	(5.6)	(6.1)	(7.1)
Puerto Rican Hispanic	-156.2 ***	-92.7 ***	-85.2 ***	-85.7 ***	-85.4 ***	-86.9 ***	-88.3 ***	-84.8 ***	-85.7 ***	-84.2 ***
	(7.5)	(4.2)	(3.0)	(2.9)	(2.8)	(2.0)	(2.4)	(2.8)	(3.1)	(3.6)
Other Hispanic	-76.8 ***	-62.7 ***	-66.3 ***	-68.1 *	-68.6 ***	-71.0 ***	-75.7 ***	-79.7 ***	-82.8 ***	-89.3 ***
	(8.2)	(4.6)	(3.3)	(3.1)	(3.0)	(2.1)	(2.6)	(3.0)	(3.3)	(3.8)
Mother's race/ethnicity missing	-18.7	-10.3	-13.6 **	-9.3 *	-11.8 **	-13.8 ***	-11.5 **	-11.5 **	-13.1 **	0.8
	(11.7)	(6.5)	(4.7)	(4.5)	(4.3)	(3.1)	(3.7)	(4.3)	(4.8)	(5.5)
Infant sex (ref=female)										
Male	48.4 ***	89.0 ***	101.2 ***	108.9 ***	114.1 ***	121.4 ***	126.8 ***	130.5 ***	135.6 ***	143.6 ***
	(1.8)	(1.0)	(0.7)	(0.7)	(.7)	(0.5)	(0.6)	.(0.7)	(.7)	(0.8)
Mother's marital status (ref=married)										
Single	-133.5 ***	-83.3 ***	-73.2 ***	-65.2 ***	-61.2 ***	-57.9 ***	-55.9 ***	-53.3 ***	-49.5 ***	-46.7 ***
	(2.3)	(1.3)	(.9)	(.9)	(0.8)	(.6)	(0.7)	(0.8)	(0.9)	(1.1)
Mother's marital status missing	-398.7 ***	-138.7 ***	-124.7 ***	-101.4 ***	-93.8 ***	-88.8 ***	-95.5 ***	-78.5 ***	-78.6 **	-64.5 *
	(57.9)	(32.7)	(23.6)	(22.5)	(21.8)	(15.4)	(18.6)	(21.7)	(23.9)	(27.4)
Mother's age (years)	-4.6 ***	0.3 ***	1.7 ***	3.0 ***	3.8 ***	4.7 ***	5.4 ***	6.3 ***	7.5 ***	9.6 ***
	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)	(0.0)	(0.1)	(0.1)	(0.1)	(0.1)
Mother's Nativity (ref=U.S. born)										
Foreign-born	60.5 ***	29.7 ***	22.4 ***	16.8 ***	12.6 ***	10.5 ***	8.6 ***	6.3 ***	5.0 ***	2.3
	(2.9)	(1.6)	(1.2)	(1.1)	(1.1)	(0.7)	(0.9)	(1.0)	(1.1)	(1.3)
Mother's nativity missing	-422.8 ***	-120.7 ***	-86.3 ***	-67.9 ***	-58.1 ***	-55.1 ***	-41.6 ***	-38.2 ***	-28.0 ***	-32.8 ***
	(17.9)	(10.1)	(7.3)	(7.0)	(6.7)	(4.8)	(5.8)	(6.7)	(7.4)	(8.6)
Constant	2480.8 ***	2869.3 ***	3032.5 ***	3170.5 ***	3292.2 ***	3407.4 ***	3529.1 ***	3665.8 ***	3839.3 ***	4147.9 ***
	(2.2)	(1.2)	(0.9)	(0.8)	(0.8)	(0.6)	(0.7)	(0.8)	(0.9)	(1.0)

Note: Standard errors in parentheses.
**p*<. 05, ***p* <.01, ****p* <.001

Table 5. Quantile regression estimates for models of birthweight with controls for background demographic and socioeconomic characteristics and intermediate variables

Variables	0.05 Quantile	0.16 Quantile	0.25 Quantile	0.35 Quantile	0.45 Quantile	0.55 Quantile	0.65 Quantile	0.75 Quantile	0.85 Quantile	0.95 Quantile
Mother's education (ref=12 years)										
Less than 12	-24.7 ***	-22.4 ***	-22.1 ***	-22.1 ***	-20.2 ***	-19.4 ***	-19.0 ***	-19.3 ***	-20.0 ***	-21.4 ***
	(1.5)	(1.0)	(0.9)	(0.8)	(0.8)	(0.9)	(0.9)	(1.0)	(1.1)	(1.6)
12 years (reference)	--	--	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--	--	--
13 years	30.2 ***	24.2 ***	21.0 ***	18.6 ***	17.2 ***	15.8 ***	15.8 ***	16.3 ***	15.1 ***	13.6 ***
	(2.0)	(1.3)	(1.2)	(1.2)	(1.1)	(1.2)	(1.2)	(1.3)	(1.6)	(2.2)
14 years	44.1 ***	33.1 ***	30.3 ***	27.5 ***	25.2 ***	22.8 ***	20.5 ***	17.6***	14.8 ***	11.6 ***
	(1.8)	(1.1)	(1.1)	(1.0)	(1.0)	(1.1)	(1.0)	(1.2)	(1.4)	(1.9)
15 years	44.9 ***	35.9 ***	33.2 ***	31.0 ***	27.6 ***	24.7 ***	23.5 ***	20.2 ***	17.6 ***	13.1 ***
	(2.7)	(1.8)	(1.6)	(1.6)	(1.5)	(1.6)	(1.6)	(1.8)	(2.1)	(3.0)
16 years	75.1 ***	55.3 ***	46.5 ***	39.7 ***	34.2 ***	29.6 ***	26.4 ***	21.2 ***	14.2 ***	1.2
	(1.7)	(1.1)	(1.0)	(1.0)	(0.9)	(1.0)	(1.0)	(1.1)	(1.3)	(1.9)
17+ years	78.6 ***	55.4 ***	45.7 ***	37.6 ***	32.3 ***	25.5 ***	21.5 ***	15.7 ***	8.3 ***	-4.6 *
	(1.9)	(1.3)	(1.2)	(1.1)	(1.1)	(1.2)	(1.1)	(1.3)	(1.5)	(2.2)
Mother's education missing	-40.6 ***	-29.8 ***	-24.0 ***	-23.8 ***	-24.1 ***	-21.0 ***	-17.2 ***	-21.5 ***	-18.7 ***	-24.2 ***
	(4.7)	(3.1)	(2.9)	(2.8)	(2.7)	(2.9)	(2.8)	(3.1)	(3.7)	(5.3)
Mother's race/ethnicity (ref=non-Hispanic white)										
Non-Hispanic black	-159.2 ***	-158.4 ***	-160.0 ***	-162.0 ***	-164.5 ***	-163.8 ***	-163.9 ***	-162.3 ***	-162.4 ***	-156.8 ***
	(1.6)	(1.0)	(0.9)	(0.9)	(0.9)	(0.9)	(0.9)	(1.1)	(1.2)	(1.7)
Asian Indian	-205.9 ***	-221.0 ***	-226.0 ***	-230.4 ***	-235.8 ***	-241.8 ***	-245.4 ***	-256.5 ***	-264.6 ***	-273.8 ***
	(6.0)	(4.0)	(3.7)	(3.5)	(3.4)	(3.7)	(3.6)	(4.0)	(4.7)	(6.8)
Chinese	-68.2 ***	-93.3 ***	-110.7 ***	-122.9 ***	-133.3 ***	145.1 ***	-154.3 ***	-162.6 ***	-172.1 ***	-186.2 ***
	(5.6)	(3.7)	(3.4)	(3.3)	(3.2)	(3.4)	(3.3)	(3.7)	(4.4)	(6.3)
Filipino	-134.7 ***	-146.9 ***	-151.2 ***	-154.5 ***	-159.8 ***	-167.1 ***	-169.2 ***	-178.4 ***	-186.2 ***	-180.5 ***
	(5.6)	(3.7)	(3.4)	(3.3)	(3.2)	(3.4)	(3.3)	(3.7)	(4.4)	(6.2)
Korean	-64.8 ***	-92.5 ***	-96.0 ***	-104.0 ***	-112.3 ***	-115.9 ***	-123.4 ***	-127.9 ***	-140.3 ***	-148.7 ***
	(9.6)	(6.3)	(5.8)	(5.6)	(5.5)	(5.8)	(5.7)	(6.4)	(7.5)	(10.7)
Other Asian	-145.0 ***	-155.6 ***	-162.2 ***	-165.4 ***	-167.2 ***	-170.8 ***	-175.9 ***	-177.2 ***	-179.8 ***	-180.6 ***
	(3.9)	(2.6)	(2.4)	(2.3)	(2.2)	(2.4)	(2.3)	(2.6)	(3.1)	(4.4)

(Continued…)

Table 5. *Continued*

Variables	0.05 Quantile	0.16 Quantile	0.25 Quantile	0.35 Quantile	0.45 Quantile	0.55 Quantile	0.65 Quantile	0.75 Quantile	0.85 Quantile	0.95 Quantile
Mother's race/ethnicity (ref=non-Hispanic white)										
Hawaiian	-24.8	-48.3 ***	-54.9 ***	-52.7 ***	-39.5 ***	-43.5 ***	-33.3 ***	-21.0 *	-7.7	-8.2
	(13.2)	(8.6)	(8.0)	(7.7)	(7.5)	(7.9)	(7.7)	(8.7)	(10.3)	(14.7)
Native American	5.4	12.4 ***	20.4 ***	26.4 ***	32.7 ***	42.8 ***	49.0 ***	.58.2 ***	63.6 ***	81.9 ***
	(5.0)	(3.3)	(3.0)	(2.9)	(2.8)	(3.0)	(2.9)	(3.3)	(3.9)	(5.5)
Mexican Hispanic	-27.3 ***	-29.7 ***	-31.6 ***	-33.8 ***	-34.9 ***	-36.0 ***	-36.7 ***	-37.3 ***	39.7 ***	-39.0 ***
	(1.9)	(1.2)	(1.1)	(1.1)	(1.0)	(1.1)	(1.0)	(1.2)	(1.4)	(2.0)
Latin American Hispanic	-40.1 ***	-39.5 ***	-39.9 ***	-41.9 ***	-44.5 ***	-45.6 ***	-47.2 ***	-48.4 ***	-52.9 ***	-56.7 ***
	(3.2)	(2.1)	(1.9)	(1.8)	(1.8)	(1.9)	(1.8)	(2.1)	(2.4)	(3.5)
Cuban Hispanic	-39.6 ***	-30.9 ***	-31.9 ***	-32.5 ***	-30.0 ***	-29.3 ***	-32.2 ***	-34.0 ***	-29.5 ***	-30.2 **
	(8.2)	(5.3)	(4.9)	(4.7)	(4.6)	(4.9)	(4.8)	(5.4)	(6.4)	(9.1)
Puerto Rican Hispanic	-86.6 ***	-86.9 ***	-88.1 ***	-88.8 ***	-89.0 ***	-91.3 ***	-90.6 ***	-89.3 ***	-89.8 ***	-84.4 ***
	(4.1)	(2.7)	(2.5)	(2.4)	(2.3)	(2.5)	(2.4)	(2.7)	(3.2)	(4.6)
Other Hispanic	-88.2 ***	-84.3 ***	-83.5 ***	-84.2 ***	-83.5 ***	-82.4 ***	-83.2 ***	-88.1 ***	-91.3 ***	-91.6 ***
	(4.4)	(2.9)	(2.7)	(2.6)	(2.5)	(2.7)	(2.6)	(2.9)	(3.5)	(4.9)
Mother's race/ethnicity missing	-19.5 **	-15.6 ***	-14.8 ***	-17.3 ***	-16.6 ***	-16.4 ***	-15.9 ***	-14.3 **	-12.0 ***	-9.1
	(6.3)	(4.2)	(3.8)	(3.7)	(3.6)	(3.8)	(3.7)	(4.2)	(5.0)	(7.1)
Infant sex (ref=female)										
Male	98.6 ***	113.5 ***	119.2 ***	123.8 ***	127.9 ***	131.6 ***	134.7 ***	137.4 ***	140.5 ***	145.2 ***
	(1.0)	(0.6)	(0.6)	(0.6)	(0.5)	(0.6)	(0.6)	(0.6)	(0.8)	(1.1)
Mother's marital status (ref=married)										
Single	-34.5 ***	-29.4 ***	-27.4 ***	-25.6 ***	-23.6 ***	-22.1 ***	-20.1 ***	-17.3 ***	-15.1 ***	-15.7 ***
	(1.3)	(0.8)	(0.8)	(0.7)	(0.7)	(0.7)	(0.8)	(0.8)	(1.0)	(1.4)
Mother's marital status missing	-104.5 **	-81.2 ***	-83.6 ***	-80.9 ***	-92.2 ***	-65.4 **	-67.5 ***	-41.2 *	-41.8	-35.2
	(31.5)	(20.9)	(19.2)	(18.5)	(18.1)	(19.2)	(18.7)	(21.1)	(25.0)	(35.1)
Mother's age (years)	-1.7 ***	0.0	0.7 ***	1.25 ***	1.7 ***	2.1 ***	2.5 ***	3.0 **	3.7 ***	4.9 ***
	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	.(0.1)	(0.1)
Mother's Nativity (ref=U.S. born)										
Foreign-born	0.9	-4.3 ***	-5.0 ***	-5.6 ***	-5.7 ***	-4.9 ***	-4.0 ***	-3.0 **	-1.9	0.5
	(1.6)	(1.0)	(1.0)	(0.9)	(0.9)	(0.9)	(0.9)	(1.0)	(1.2)	(1.7)
Mother's nativity missing	-47.2 ***	-34.2 ***	-34.5 ***	-38.0 ***	-35.3 ***	-25.6 ***	-29.2 ***	-18.3 ***	-13.4	-14.5
	(9.8)	(6.5)	(6.0)	(5.7)	(5.6)	(5.9)	(5.8)	(6.5)	(7.8)	(11.0)

(Continued…)

Table 5. *Continued*

Variables	0.05 Quantile	0.16 Quantile	0.25 Quantile	0.35 Quantile	0.45 Quantile	0.55 Quantile	0.65 Quantile	0.75 Quantile	0.85 Quantile	0.95 Quantile
Gestation length (spline)										
18–41 weeks	148.8 ***	149.0 ***	147.7 ***	144.0 ***	137.8 ***	129.4 ***	119.7 ***	108.4 ***	95.3 ***	80.2 ***
	(0.3)	(0.2)	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)	(0.2)	(0.2)	(0.3)
42–50 weeks	-88.5 ***	-78.5 ***	-74.3 ***	-68.7 ***	-62.1 ***	-54.9 ***	-46.5 ***	-36.7 ***	-27.2 ***	-13.9 ***
	(0.7)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.6)	(0.7)	(0.9)
Gestation length missing	-51.1 ***	-23.5 ***	-13.7 ***	-5.5 ***	0.1	4.8 ***	9.4 ***	12.2 ***	13.6 ***	16.1 ***
	(2.0)	(1.3)	(1.2)	(1.2)	(1.1)	(1.2)	(1.2)	(1.3)	(1.6)	(2.3)
First birth (ref=no)	-105.6 ***	-96.4 ***	-93.0 ***	-91.2 ***	-89.1 ***	-85.6 ***	-82.3 ***	-78.2 ***	-72.0 ***	-57.4 ***
Yes	(1.4)	(0.9)	(0.8)	(0.8)	(0.8)	(0.8)	(0.8)	(0.9)	(1.1)	(1.5)
Birth order	6.26 ***	9.4 ***	10.4 ***	11.5 ***	12.2 ***	13.0 ***	14.2 ***	15.2 ***	16.9 ***	21.1 ***
	(0.6)	(0.4)	(0.4)	(0.3)	(0.3)	(0.4)	(0.3)	(0.4)	(0.5)	(0.6)
Birth order missing	-83.8 ***	-79.8 ***	-69.0 ***	-65.9 ***	-60.8 ***	-60.9 ***	-57.3 ***	-53.1 ***	-46.6 ***	-28.1 **
	(8.7)	(5.7)	(5.3)	(5.1)	(5.0)	(5.3)	(5.1)	(5.8)	(6.9)	(9.7)
Adequacy of prenatal care initiation (ref=adequate plus)										
Inadequate	27.0 ***	27.4 ***	32.7 ***	35.6 ***	36.5 ***	38.4 ***	37.4 ***	38.4 ***	44.7 ***	43.6 ***
	(3.1)	(2.0)	(1.9)	(1.8)	(1.8)	(1.9)	(1.8)	(2.1)	2.4	(3.5)
Intermediate	16.4 ***	15.4 ***	18.5 ***	21.4 ***	22.9 ***	26.7 ***	28.1 ***	28.5 ***	31.5 ***	29.9 ***
	(2.3)	(1.5)	(1.4)	(1.3)	(1.3)	(1.4)	(1.3)	(1.5)	(1.8)	(2.5)
Adequate	-5.5 ***	-4.8 ***	-3.1 ***	-2.0 **	-0.3	1.6 *	3.1 ***	4.5 ***	6.2 ***	8.2 ***
	(1.2)	(0.8)	(0.7)	(0.7)	(0.7)	(0.7)	(0.7)	(0.8)	(0.9)	(1.3)
Prenatal care adequacy missing	6.8	10.2 **	6.6 *	5.8	6.3 *	8.0 *	12.6 ***	16.7 ***	19.1 ***	22.4 ***
	(5.3)	(3.4)	(3.2)	(3.0)	(3.0)	(3.2)	(3.1)	(3.5)	(4.1)	(5.8)
Number of prenatal care visits (spline)										
0–14 visits	14.1 ***	12.0 ***	11.7 ***	11.7 ***	11.5 ***	11.5 ***	11.4 ***	11.4 ***	11.6 ***	11.3 ***
	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.2)	(0.2)
15 or more visits	-8.3 ***	-6.0 ***	-5.0 ***	-4.4 ***	-3.7 ***	-3.2 ***	-2.7 ***	-2.0 ***	-1.3 ***	0.6 *
	(0.3)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.3)
Prenatal care visits missing	-77.0 ***	-66.1 **	-57.6 ***	-50.8 ***	-48.3 ***	-46.8 ***	-47.9 ***	-46.5 ***	-44.4 ***	.-38.1 ***
	(5.9)	(3.9)	(3.6)	(3.4)	(3.3)	(1.5)	(3.5)	(3.9)	(4.6)	(6.6)

(Continued…)

Table 5. *Continued*

Variables	0.05 Quantile	0.16 Quantile	0.25 Quantile	0.35 Quantile	0.45 Quantile	0.55 Quantile	0.65 Quantile	0.75 Quantile	0.85 Quantile	0.95 Quantile
Smoked during pregnancy (ref=no)										
Yes	-128.2 ***	-128.5 ***	-129.4 ***	-130.5 ***	-132.2 ***	-133.5 ***	-133.0 ***	-133.9 ***	-134.4 ***	-135.2 ***
	(2.5)	(1.6)	(1.5)	(1.4)	(1.4)	(1.5)	(1.5)	(1.7)	(2.0)	(2.8)
Smoked during pregnancy missing	-45.4 ***	-49.1 ***	-56.4 ***	-49.4 ***	-46.1 ***	-47.4 ***	-49.6 ***	-44.5 ***	-33.5 ***	-33.3 **
	(10.7)	(6.9)	(6.4)	(6.1)	(5.9)	(6.3)	(6.1)	(6.8)	(8.0)	(11.1)
Cigarettes per day	-5.0 ***	-5.0 ***	-5.1 ***	-5.1 ***	-5.2 ***	-5.2 ***	-5.4 ***	-5.5 ***	-5.6 ***	-5.8 ***
	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.2)	(0.2)
Alcohol use during pregnancy (ref=none)										
Some	-24.9 ***	-19.1 ***	-12.5 **	-14.5 ***	-14.9 ***	-14.3 ***	-13.6 ***	-14.8 ***	-17.1 ***	-21.8 **
	(6.0)	(4.0)	(3.7)	(3.5)	(3.5)	(3.7)	(3.6)	(4.1)	(4.9)	(7.2)
Alc. use during pregnancy missing	13.5	35.3 ***	47.6 ***	45.1 ***	44.5 ***	49.2 ***	54.5 ***	53.9 ***	49.3 ***	57.2 ***
	(10.7)	(6.9)	(6.4)	(6.1)	(5.9)	(6.2)	(6.1)	(6.8)	(8.0)	(11.0)
Alcoholic drinks per week	-5.8 ***	-7.6 ***	-7.0 ***	-6.1 ***	5.4 ***	-5.2 ***	-4.6 ***	-4.2 ***	-4.3 ***	-2.9
	(1.1)	(0.8)	(0.7)	(0.7)	(0.7)	(0.8)	(0.8)	(0.9)	(1.2)	(1.9)
Medical risk factors (ref=none)										
Anemia	41.8 ***	34.5 ***	30.7 ***	29.2 ***	27.5 ***	25.7 ***	24.5 ***	21.8 ***	23.2 ***	19.1 ***
	(3.1)	(2.1)	(1.9)	(1.8)	(1.8)	(1.9)	(1.8)	(2.1)	(2.5)	(3.5)
Lung disease	-2.8	-9.0 **	-8.9 **	-9.4 ***	-10.3 ***	-10.4 ***	-12.0 ***	-11.6 ***	-7.7 *	-4.5
	(4.4)	(2.9)	(2.7)	(2.6)	(2.5)	(2.7)	(2.6)	(2.9)	(3.5)	(5.0)
Diabetes	34.0 ***	54.1 ***	65.5 ***	75.0 ***	85.7 ***	98.8 ***	112.5 ***	134.2 ***	165.7 ***	234.8 ***
	(2.8)	(1.8)	(1.7)	(1.6)	(1.6)	(1.7)	(1.7)	(1.9)	(2.2)	(3.1)
Hydramnios	-284.4 ***	-230.1 ***	-210.6 ***	-196.6 ***	-182.8 ***	-166.6 ***	-147.8 ***	-127.8 ***	-91.4 ***	-41.4 ***
	(4.2)	(2.7)	(2.5)	(2.4)	(2.4)	(2.5)	(2.5)	(2.8)	(3.3)	(4.7)
Pregnancy hypertension	-257.2 ***	-195.6 ***	-157.2 ***	-128.1 ***	-108.0 ***	-93.1 ***	-81.3 ***	-68.3 ***	-53.0 ***	-29.5 ***
	(2.6)	(1.7)	(1.6)	(1.5)	(1.5)	(1.6)	(1.5)	(1.7)	(2.1)	(2.9)
Previous large birth	320.6 ***	344.4 ***	353.6 ***	363.2 ***	370.9 ***	381.3 ***	393.5 ***	399.4 ***	402.7 ***	415.8 ***
	(4.8)	(3.1)	(2.9)	(2.8)	(2.7)	(2.9)	(2.8)	(3.2)	(3.8)	(5.3)
Previous preterm birth	-210.0 ***	-190.3 ***	-187.7 ***	-189.5 ***	-190.7 ***	-197.4 ***	-200.5 ***	-201.5 ***	-202.5 ***	-196.3 ***
	(4.5)	(2.9)	(2.7)	(2.6)	(2.5)	(2.7)	(2.6)	(3.0)	(3.5)	(5.0)
Other	-51.1 ***	-34.1 ***	-29.7 ***	-26.6 ***	-23.7 ***	-21.6 ***	-19.3 ***	-16.3 ***	-11.7 ***	-1.0
	(1.3)	(0.8)	(0.8)	(0.8)	(0.7)	(0.8)	(0.8)	(0.9)	(1.0)	(1.4)

(Continued…)

Table 5. *Continued*

Variables	**0.05 Quantile**	**0.16 Quantile**	**0.25 Quantile**	**0.35 Quantile**	**0.45 Quantile**	**0.55 Quantile**	**0.65 Quantile**	**0.75 Quantile**	**0.85 Quantile**	**0.95 Quantile**
Medical risk factors (ref=none)										
Medical risk factors missing	-33.4 ***	-12.0 **	-12.8 **	-8.5 *	-11.4 **	-10.3 **	-6.7	0.1	5.8	14.8 *
	(6.7)	(4.3)	(4.0)	(3.8)	(3.7)	(3.9)	(3.8)	(4.3)	(5.1)	(7.3)
Obstetric procedures (ref=none)										
Induced labor	30.1 ***	28.1 ***	28.7 ***	30.1 ***	32.4 ***	35.0 ***	37.0 ***	38.8 ***	40.0 ***	34.7 ***
	(1.2)	(0.8)	(0.7)	(0.7)	(0.7)	(0.7)	(0.7)	(0.8)	(1.0)	(1.4)
Tocolysis	-70.1 ***	-73.2 ***	-76.8 ***	-78.6 ***	-79.5 ***	-75.9 ***	-72.5 ***	-72.8 ***	-69.9 ***	-69.6 ***
	(3.5)	(2.3)	(2.1)	(2.0)	(2.0)	(2.1)	(2.1)	(2.3)	(2.8)	(3.9)
Obstetric procedures missing	9.4	13.7 *	15.7 **	14.4 *	27.5 ***	25.7 ***	24.5 ***	21.8 ***	23.2 ***	19.1 ***
	(10.1)	(6.4)	(5.9)	(5.7)	(1.8)	(1.9)	(1.8)	(2.1)	(2.5)	(3.5)
Constant	-1275.3***	-1025.6***	-865.4 ***	-652.2 ***	-10.3 ***	-10.4 ***	-12.0 ***	-11.6 ***	-7.7 *	-4.5
	(8.1)	(5.1)	(4.5)	(4.1)	(2.5)	(2.7)	(2.6)	(2.9)	(3.5)	(5.0)

Note: Standard errors in parentheses.
*$p<.05$, **$p<.01$, ***$p<.001$

Figure 1. Quantile regression estimates of disparities in birthweight by mother's educational attainment: raw differences

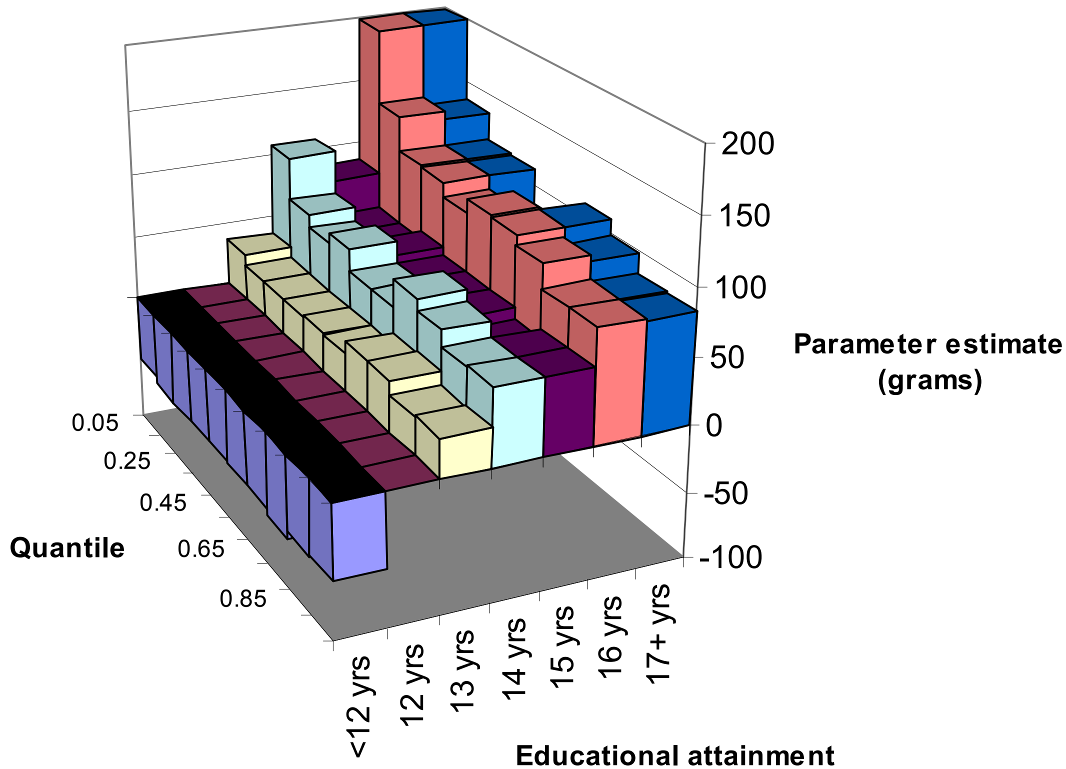

Figure 2. Quantile regression estimates of disparities in birthweight by mother's educational attainment: adjusted for background demographic and socioeconomic status characteristics

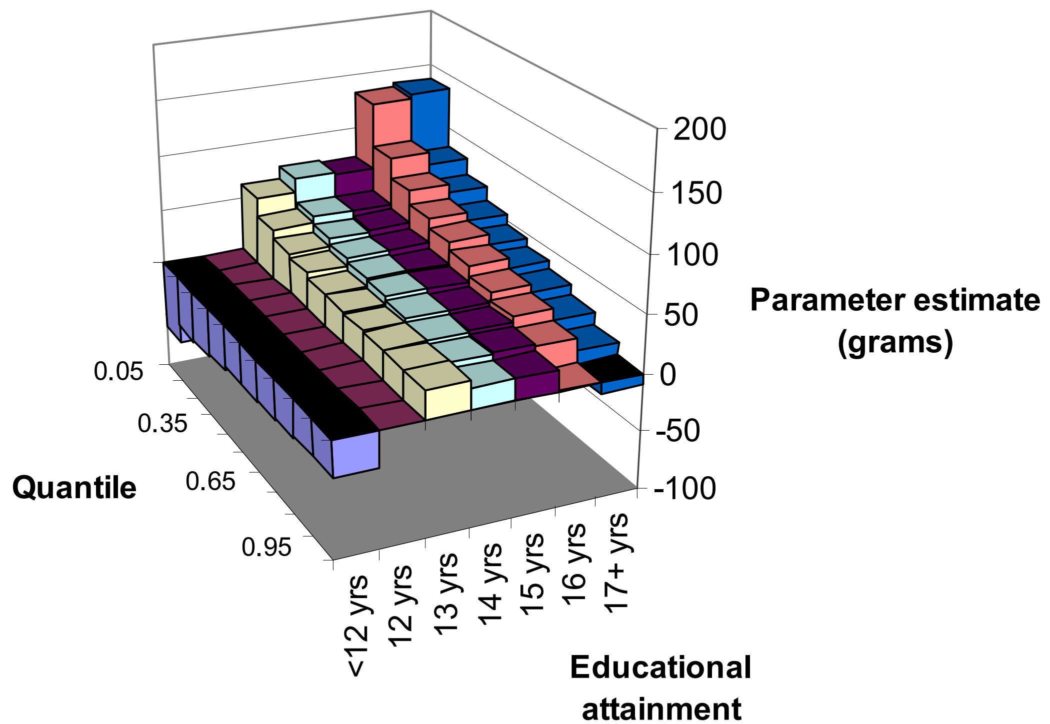

Figure 3. Quantile regression estimates of disparities in birthweight by mother's educational attainment: adjusted for background demographic, socioeconomic status characteristics, and intermediate variables