Racial and Ethnic Disparities in Birthweight in the United States: New Models and New Results

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1. Introduction

Birthweight is one of the leading indicators of infant and reproductive health and a key determinant of child health (Aber et al., 1997), mortality (MacDorman and Atkinson, 1999), and development (Hack et al., 1995) as well as chronic disease in old age (Elo and Preston, 1992). There is an enormous literature examining the determinants of birthweight (e.g.,). The study of birthweight differentials—and the factors accounting for these differentials—is most commonly based on statistical models of the mean, using ordinary least squares, or low birthweight status (i.e., birthweight below 2,500 grams), using logit or probit regression. However, these approaches have some potentially serious shortcomings. For instance, linear regression only tells us how covariates affect the *mean* of the birthweight distribution. Consequently, the relationships that are uncovered do not necessarily provide meaningful insights into the ways that covariates affect birthweight at other points on the birthweight distribution. On the other hand, the "low birthweight" measure has a number of serious conceptual and methodological problems.

In this paper, we present a new approach to modeling birthweight, namely quantile regression. This technique allows us to fit a model to the median of the distribution (i.e., the 50th percentile), as well as other fixed percentiles (i.e., quantiles) of the distribution using a family of models. These models provide information on how the effects of covariates vary across the entire birthweight distribution and allow us to focus on the determinants of low birthweight (for example, by fitting quantile regression models to the fifth percentile of the birthweight distribution) but without the large loss of information that comes with transforming a continuous variable to a dichotomous one. Graphical presentation of the quantile regression results provides additional valuable insights.

We use these new models to investigate the covariates of birthweight, focusing on differentials by race and ethnicity and the factors that account for these differentials. We also highlight new substantive findings that emerge for other covariates and on their implications for public policies to improve birthweight. Data for this study come from the 2001 Natality Data Set (NDS), compiled from birth certificates by the National Center for Health Statistics. The NDS covers the population of births in the U.S. in a given year, providing us with an enormous number of observations that will facilitate our analysis of finely graded differences in birthweight across the entire distribution.

In the next section we provide a brief overview of the importance of birthweight. In Section 3 we discuss shortcomings associated with standard approaches to modeling birthweight using linear or logistic regression and describe quantile regression. In Section 4 we describe the data and in Section 5 we present our conceptual framework, identify specific covariates and outline our modeling approach. We present our results in Section 6 and end the paper with some discussion and our conclusions.

2. Background

Birthweight is a leading indicator of mothers' reproductive health and the health of infants at birth. It is one of the strongest predictors of infant mortality risk (Cramer, 1987; Institute of Medicine, 1985; Mathews, MacDorman, and Menacker, 2002). For birthweights below 2,500 grams, the risk of infant death is almost 25 times greater than for birthweights above 2,500 grams, while for birthweights below 1,500 grams the risk of infant death is 100 times greater (Mathews, MacDorman, and Menacker, 2002). Furthermore, there are extremely large health care costs associated with caring for low birthweight babies (Lewit et al., 1995; Joyce, 1999).

Birthweight has effects on health and development in childhood and beyond. Low birthweight is a marker of fetal undernutrition, which may permanently program metabolic changes to the body. These programmed changes are associated with the emergence of chronic disease in later life (Barker, 1998), such as diabetes (Barker et al., 1993), hypertension (Law et al., 1993), and cardiovascular disease (Rich-Edwards et al., 1997). Birthweight may affect developmental outcomes such as behavioral problems (Sommerfelt, Ellertsen, and Markestad, 1993), school-age reading and math scores (Jefferis, Power, and Hertzman, 2002), cognitive function during young adulthood (Richards et al., 2001), adult educational attainment (Conley and Bennett, 2000), and labor market outcomes (Currie and Hyson, 1999). Finally, birthweight may shape the intergenerational transmission of health status because a mother's birthweight affects the likelihood of her giving having a preterm birth (Porter et al., 1997) or an infant with low birthweight (Sanderson, Emanuel, and Holt, 1995; Wang et al., 1995). Note that the apparent effects of birthweight may instead reflect the influence of omitted family background or genetic factors or possibly the effects of investments during infancy and childhood. Nevertheless, the implications of previous research is that higher birthweights are likely to represent enhanced infant and maternal health, lead to better health and development during childhood, and result in less chronic disease during adulthood.

There are major birthweight disparities by race and ethnicity… Reducing these disparities may contribute to a reduction of inequalities across these groups in a wide array of health and developmental outcomes.

3. Models of Birthweight

There have been an enormous number of studies that have examined the covariates of birthweight or low birthweight. With only two exceptions that we are aware of (discussed below), *all* of these studies have either modeled birthweight as a continuous variable using least squares regression or have modeled a low birthweight indicator (e.g., birthweight below 2,500 grams, corresponding to low birthweight, or birthweight below 1,500 grams, corresponding to very low birthweight) using logit or probit regression.[1]

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

Second, the "low birthweight" measure has a number of methodological problems. In

[1] Examples of recent studies analyzing birthweight as a dichotomous outcome include Roberts (1997), O'Campo et al. (1997), and Zhu et al. (1999). Among studies examining birthweight as a continuous outcome are David and Collins (1997), Pearl, Braveman, and Abrams (2001), and Shiono et al. (1997).

particular, by converting a continuous variable (birthweight) into a dichotomous variable (low vs. normal birthweight), 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 birthweight" has a number of conceptual problems. Wilcox (2001) argued that "the category of 'low birthweight' is uninformative and seldom justified." Although the cut-off of 2,500 grams is meaningful in certain ways, in others it is 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 birthweight with normal birthweight is in many ways a medical artifact. In particular, any increase in birthweight generally leads to better health and development outcomes. This is certainly the case for infant survival: throughout virtually the entire birthweight distribution, higher birthweight is clearly associated with lower infant mortality risks. However, the benefits are relatively large below 2,500 grams while the rise in infant mortality risks at the high end of the birthweight distribution suggests that increases in birthweight may not be always be beneficial.[2] Note, however, that there are no discontinuities at 1,500 or 2,500 grams. Furthermore, there is no evidence of discontinuities at these points for any other health or development outcome.

To date there have been only two analyses of birthweight 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 birthweight. 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 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.[3] 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. This is seen most clearly by noting that median regression minimizes the sum of absolute residuals, in contrast to linear regression which minimizes the sum of squared residuals. However, the general approach of minimizing the absolute deviations can be extended 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.

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[2] The rise in mortality risks for birthweights above 4,500 grams (9lbs., 15oz.) is the result of birth trauma (Spellacy et al., 1985) and congenital anomalies and congenital syndromes such as hypoglycemia that are often associated with gestational diabetes (Jones, 2001). In the U.S. in 1999, 1.5 percent of babies had birthweights above 4,500 grams.

[3] Quantiles provide a general way to divide a population into any number of groups. The median divides the population into two equal groups, with half lying above the median value and half below. Quartiles divide the population into four groups with equal proportions in each segment; quintiles refer to five groups, deciles ten groups, and percentiles 100 groups.

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

$$y_i = x_i' b_t + e_{ti}, \qquad \text{Quant}_t(y_i \mid x_i) = x_i' b_t,$$

for the t th quantile (e.g., $t = .5$ for median regression), where $\text{Quant}_t(y_i \mid x_i)$ is the conditional quantile of y_i given the vector of regressors x_i. The distribution of the error term, e_{ti}, is left unspecified; the only assumption concerning the error term is that e_{ti} satisfies $\text{Quant}_t(e_{ti} \mid x_i) = 0$. An important feature of the model is that the covariate effects, b_t, may vary across the quantiles. As the value of t 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). 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 one million observations). The parameter estimates are interpreted as the marginal change in the t 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 information on how covariates are related to birthweight over the entire conditional distribution of the dependent variable. These results can be easily seen visually, using graphs that plot coefficients against the quantiles of the birthweight distribution, connecting the point estimates to trace out the profile of how the covariate affects birthweight. 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.

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., birthweight and sex). We use the most recent year available for these data (2001) that contains about 4 million observations. We omit twins and multiple births from our analysis because their birthweight is related to their multiplicity. In addition, we work with a randomly selected 25% subsample that provides us with almost one million observations yet makes it easier to estimate the models.

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 birthweight disparities by race and ethnicity, and in the first panel of the table we show the distribution of the sample by the mother's race/ethnicity.

The second panel in Table 1 includes background demographic and socioeconomic characteristics. Sex is our only infant-specific background factor. It is well documented that males have higher birthweights 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. Birthweight 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 birthweight and there is an established relationship between parity and birthweight 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 birthweight. 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, birthweight); 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 birthweight 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 birthweight 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 birthweight 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 birthweight. It is unreasonable to conclude from this evidence that prenatal care is unassociated with or reduces birthweight. 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 race and ethnic differences in mean birthweight. We will then estimate three sets of quantile regression models for birthweight. The first set of models will estimate basic quantile regression with no covariates except for mother's race/ethnicity. The results of these models will allow us to describe how racial and ethnic disparities in birthweight vary over the entire birthweight 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, education, nativity, and marital status. 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 racial and ethnic disparities in birthweight. The family of quantile regression models we estimate comprises of ten separate equations fit to the following quantiles: 0.05, 0.15, 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 birthweight distribution. We estimate the individual equations separately, rather than jointly, because it is extremely computationally demanding to estimate joint models with a sample size of nearly one 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 race and ethnic disparities in birthweight. Next, we turn to our results for the other covariates in the model which include background demographic and socioeconomic characteristics and intermediate factors.

Race and Ethnic Disparities in Birthweight

There are major disparities in birthweight by mother's race/ethnicity. In Table 2 we present mean birthweights by mother's ethnicity. Infants born to non-Hispanic white mothers have the highest mean birthweight at 3,399 grams, while those born to non-Hispanic black mothers have the lowest. There are substantial differences in the standard deviation of birthweight by mother's ethnicity. For example, the standard deviation of birthweight for infants born to non-Hispanic black mothers is 622, which is substantially larger than the standard deviation for births to non-Hispanic white mothers of 554, or for births to mothers of any other ethnicity. The combined effect of non-Hispanic blacks having the lowest mean and the highest standard deviation of birthweight is that they have by far the highest rates of low birthweight (i.e., birthweight < 2,500 grams) and very low birthweight (< 1,500 grams). The low birthweight rate of 11.0% for non-Hispanic blacks is over twice as large as the rate for non-Hispanic whites and the very low birthweight rate of 2.4% is three times as large. Low birthweight and very low birthweight rates are also both above average for Asian Indians, Filipinos, Hawaiians, Native Americans, and Puerto Ricans.

We have suggested that ethnic disparities in mean birthweight may obscure potentially significant variation in ethnic disparities over the birthweight distribution. The results summarized in Figure 1 support this notion. The graphs in Figure 1 show, for each ethnic group, the birthweight disparity compared to non-Hispanic whites. Point estimates from each of the ten quantile regressions are connected linearly to trace out a profile of disparity from the 0.05 quantile to the 0.95 quantile. Also displayed on the graph using shading are 95% confidence intervals. The confidence intervals are very narrow due to the extremely large number of observations used to estimate these models.

For most of the ethnic groups, the birthweight disparities compared to non-Hispanic whites are not constant across the birthweight distribution. Instead, disparities vary across the different quantiles of the birthweight distribution. We can arrange the observed patterns into three distinct groups. The first pattern has disparities roughly constant over the birthweight distribution except at the bottom—specifically, the 0.05 quantile—where the disparity widens substantially. This pattern is most dramatic for non-Hispanic blacks: the observed disparity in birthweight at the 0.05 quantile between non-Hispanic whites and blacks is almost 450 grams. The disparity is about 225 grams smaller—and roughly constant—throughout the rest of the birthweight distribution. Patterns that are qualitatively similar, though quantitatively less pronounced, are observed for Puerto Ricans and Native Americans. It is notably that these three ethnic groups are the most socioeconomically disadvantaged.

The second observed pattern is one with relatively small disparities at the lower end of the birthweight distribution (either positive or negative) but with steadily widening negative disparities as we move up the birthweight distribution. This pattern is observed for all of the Asian groups (South Asians, Chinese, Koreans, and other Asians) except Filipinos. For each of these groups, at the upper end of the distribution birthweights are roughly 200 grams lower than for non-Hispanic whites.

The final observed pattern consists of the various Hispanic groups (except Puerto Ricans), for whom the observed disparity compared to non-Hispanic whites is approximately constant over the entire birthweight distribution. There is some evidence that the disparities are wider at the upper range of the birthweight distribution. It is certainly the case, however, that birthweight disparities are small at the lower end of the distribution for major Hispanic groups, including those from Mexico, Latin America, and Cuba.

We next examine ethnic disparities in birthweight after controlling for background demographic and socioeconomic characteristics. The complete set of quantile regression results is presented in Table 3. Figure 2 presents the results visually, showing ethnic disparities in birthweight before and after controlling for these background characteristics. The first interesting finding is that incorporating these controls narrows the observed disparities for ethnic groups that are socioeconomically disadvantaged, including non-Hispanic blacks, Native Americans, Mexican-origin Hispanics, Puerto Rican Hispanics, and other Hispanics. For the more advantaged ethnic groups, disparities after controlling for background characteristics are larger than observed disparities. The more advantaged groups comprise exclusively of Asians, and include each of the separate Asian groups.

For virtually all ethnic groups, the estimated profile of birthweight disparities after controlling for background demographic and socioeconomic characteristics is flatter than for the observed disparities. This is the case for Asian Indians, Chinese, Koreans, other Asians, Latin American Hispanics, Cuban Hispanics, and other Hispanics. This finding suggests that the more disadvantaged members of each of these seven ethnic groups are more likely to have infants that fall on the lower range of the birthweight distribution. In all but one of the remaining cases there is no shift in the slope of the profile, but instead it simply moves the profile up or down uniformly; this occurs for non-Hispanic blacks, Native Americans, Mexican Hispanics, and Puerto Rican Hispanics. The one exception is Filipinos, whose disparity profile appears to be steeper after controlling for background characteristics than before.

The third model specification that we estimate adds intermediate variables to the previous model that included background demographic and socioeconomic factors alone. The complete results from this set of models are shown in Table 4 and the results for ethnic disparities are summarized in Figure 3. The graphs in Figure 3 show the profiles for birthweight disparities for the full model and for the model that includes only background characteristics. It is more difficult to discern systematic patterns across the twelve graphs in Figure 3. Nevertheless, several interesting findings emerge.

First, the dramatically widening of disparities towards the bottom of the birthweight distribution that is observed both before and after controlling for background demographic and socioeconomic characteristics, particularly for non-Hispanic blacks, but also for Puerto Rican Hispanics, Native Americans, and Filipinos, is largely accounted for by the intermediate variables in the model. In other words, after controlling for all measured covariates, disparities in birthweight between non-Hispanic blacks and whites is constant, at approximately 160 grams, across the entire birthweight distribution. A remarkable finding is that intermediate factors in the model account for a major proportion of the observed birthweight disparity between non-Hispanic blacks and whites, but *only* at the bottom of the birthweight distribution. At the 0.05 quantile, there is an observed disparity in birthweight between these two groups of 450 grams. After controlling for background factors alone, the disparity is reduced by 90 grams. However, adding intermediate factors to the model accounts for 200 grams of the remaining disparity. In contrast, above the first quartile of the birthweight distribution, demographic and socioeconomic factors account for 50 grams of the observed disparity of approximately 225 grams while intermediate factors only account for 10 grams.

Second, birthweight disparities between Hispanics of various national origins and non-Hispanic whites are larger after controlling for all covariates. In addition, the magnitude of the disparities is generally constant across the birthweight distribution. It is largest for Puerto Ricans and other Hispanics, for whom the disparity compared to non-Hispanic whites is approximately 90 to 100 grams. The disparity is next largest for Hispanics of Latin American origin (at 50-60 grams) and of Mexican origin (40 grams). Finally, the gap is smallest for Hispanics of Cuban origin, who have birthweights about 30 grams lower than non-Hispanic whites across the entire birthweight distribution.

Third, for Asians, the birthweight disparities are smaller after controlling for the intermediate factors, but the profile of these disparities continues to be downward sloping. In other words, Asians are generally disadvantaged according to the intermediate variables in the models and their birthweights compared to non-Hispanic whites are higher after we control for these variables. However, the intermediate factors do not explain why birthweight disparities between non-Hispanic whites and each of the Asian groups is smaller at the lower end of the birthweight distribution and larger at the higher end. This result may be partly explained by the lower likelihood of Asians having infants with birthweights in the upper quantiles of the birthweight distribution. Results from the final model specification indicate that after controlling for all background and intermediate characteristics, the largest ethnic disparities in birthweight are between non-Hispanic whites and certain Asian groups such as Asian Indians (birthweights between 208 and 280 grams lower than non-Hispanic whites), Filipinos (145-187 grams lower), and other Asians (146-216 grams lower).

Finally, Native Americans have the best birthweight profile after controlling for all the variables in the models. Differences in birthweight compared to non-Hispanic whites are either statistically insignificant (in the bottom quartile of the birthweight distribution) or positive.

Effects of Background Socioeconomic and Demographic Factors on Birthweight

The background socioeconomic and demographic factors in the models include infant sex and mother's marital status, age, nativity, and years of education. The estimated parameters for these variables appear in Tables 3 and 4, corresponding to the effects of these variables before (Table 3) and after (Table 4) controlling for the intermediate factors. Figure 4 shows the results graphically.

Our results indicate that before controlling for the intermediate factors, there are sharply varying effects of the background factors across the birthweight distribution. The birthweight penalty for single mothers is especially large at the 0.05 quantile (-140 grams), but only one-third as large at the 0.95 quantile (47 grams). Foreign-born mothers have births that are 63 grams heavier at the 0.05 quantile, but there are no statistically-significant differences above 0.75 quantile. An additional year of schooling for mothers is associated with a 31 gram increase in birthweight at the 0.05 quantile but have an effect only one-tenth as large (3 grams) at the 0.95 quantile. Finally, mother's age has a statistically significant negative on birthweight at the 0.05 quantile, but a positive effect throughout the rest of the birthweight distribution with upward sloping profile.

After controlling for the intermediate factors in the model, the profile of effects for each of these background factors is substantially flatter.

7. Conclusions

In this paper, we have highlighted a new approach to modeling birthweight using quantile regression that overcomes a number of important limitations of statistical techniques in current use. The results enhance our understanding of the determinants of birthweight and the factors that account for disparities in birthweight by race/ethnicity. They also provide some valuable insights into effects on birthweight of background and intermediate factors across the birthweight distribution.

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Table 1. Sample summary statistics for background and intermediate covariates

Variable	Mean or percent in category	(Std. Dev.)
Mother's race/ethnicity (%)		
Non–Hispanic white	58.0%	
Non–Hispanic black	14.6	
Asian Indian	0.7	
Chinese	0.8	
Filipino	0.8	
Korean	0.3	
Other Asian/PI	2.0	
Hawaiian	0.1	
Native American	1.0	
Mexican Hispanic	15.4	
Latin American Hispanic	3.1	
Cuban Hispanic	0.4	
Puerto Rican Hispanic	1.4	
Infant sex (%)		
Female	48.8%	
Male	51.1	
Mother's marital status (%)		
Single	33.8%	
Married	66.2	
Mother's age (years)	27.2	(6.2)
Mother's nativity (%)		
Foreign born	22.7	
U.S. born	77.3	
Mother's education (years)	12.8	(2.8)
Gestation length (weeks)	38.9	(2.4)
First birth (%)		
Yes	40.2%	
No	59.8	
Birth order	2.1	(1.2)
Adequacy of prenatal care initiation (%)		
Inadequate	3.6%	
Intermediate	5.8	
Adequate	24.9	
Adequate plus	65.7	
Mother smoked during pregnancy (%)		
Yes	10.4%	
No	89.6	
Average number of cigarettes per day	9.0	(7.4)
Mother used alcohol during pregnancy (%)		
Yes	0.8%	
No	99.2	
Average number of drinks per week	1.9	(4.1)
Medical Risk Factors (%)		
Anemia	2.4%	
Lung Disease	1.2	
Diabetes	3.0	
Hydramnios	1.4	
Pregnancy Hypertension	3.6	
Previous large birth	1.0	
Previous pre-term birth	1.2	
Other	17.5	
Obstetric procedures (%)		
Induced labor	20.7%	
Tocolysis	1.9	
Total observations	973,026	

Table 2. Summary statistics for birthweight by mother's race/ethnicity

Variable	Birthweight (grams) Mean	(Std. Dev.)	Low birthweight[a]	Very low birthweight[b]	Number of observations
Mother's ethnicity					
Non–Hispanic white	3,399.4	(554.3)	4.9%	0.8%	564,435
Non–Hispanic black	3,140.1	(622.0)	11.0	2.4	142,399
Asian Indian	3,171.3	(516.5)	7.2	1.0	6,493
Chinese	3,316.2	(483.8)	4.1	0.6	7,448
Filipino	3,227.1	(538.9)	7.2	1.0	7,728
Korean	3,338.9	(480.0)	3.5	0.4	2,456
Other Asian/PI	3,221.9	(511.0)	6.4	0.7	19,712
Hawaiian	3,303.4	(581.5)	6.9	1.3	1,282
Native American	3,373.3	(592.0)	6.3	1.1	9,547
Mexican Hispanic	3,348.0	(541.2)	5.0	0.8	150,250
Latin American Hispanic	3,341.0	(538.5)	5.2	0.9	29,652
Cuban Hispanic	3,377.4	(539.2)	5.0	0.7	3,389
Puerto Rican Hispanic	3,248.3	(580.3)	8.0	1.4	13,940
Total	3,340.0	(568.7)	6.0%	1.0%	973,026

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 background demographic and socioeconomic characteristics

Variables	**0.05 Quantile**	**0.15 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)										
Non–Hispanic black	–356.1***	–203.9***	–186.0***	–179.5***	–174.2***	–173.5***	–174.4***	–172.0***	–168.3***	–162.1***
	(5.75)	(3.0)	(2.1)	(2.1)	(1.8)	(1.8)	(1.6)	(2.1)	(2.4)	(3.3)
Asian Indian	–276.6***	–277.2***	–280.0***	–282.7***	–278.9***	–276.9***	–276.0***	–275.7***	–277.0***	–280.4***
	(23.1)	(12.0)	(8.3)	(8.3)	(7.2)	(7.1)	(6.4)	(8.3)	(9.8)	(13.6)
Chinese	–44.8	–92.1***	–112.0***	–123.0***	–141.6***	–154.8***	–170.2***	–181.3***	–193.8***	–207.7***
	(21.6)	(11.2)	(7.8)	(7.8)	(6.8)	(6.6)	(6.0)	(7.8)	(9.2)	(12.6)
Filipino	–241.6***	–200.2***	–191.5***	–194.0***	–198.2***	–200.8***	–206.3***	–210.0***	–212.0***	–207.2***
	(21.1)	(11.0)	(7.6)	(7.6)	(6.6)	(6.5)	(5.8)	(7.6)	(9.0)	(12.4)
Korean	–1.6	–84.7***	–112.0***	–123.6***	–124.8***	–140.1***	–143.3***	–144.3***	–166.8***	–168.5***
	(36.6)	(19.1)	(13.3)	(13.3)	(11.5)	(11.3)	(10.2)	(13.3)	(15.6)	(21.5)
Other Asian	–165.3***	–179.4***	–198.0***	–200.3***	–205.4***	–211.6***	–218.3***	–222.0***	–222.6***	–225.7***
	(13.9)	(7.2)	(5.0)	(5.0)	(4.3)	(4.3)	(3.8)	(5.0)	(5.9)	(8.2)
Hawaiian	–116.3*	–36.7	–59.5***	–47.8***	–58.0***	–42.5**	–36.0**	–50.0**	–30.7***	–9.8
	(50.2)	(26.1)	(18.1)	(18.1)	(15.7)	(15.5)	(13.9)	(18.1)	(21.4)	(29.5)
Native American	–41.6*	13.9	21.5***	30.4***	31.2***	40.0***	48.0***	50.3***	52.5***	86.5***
	(18.6)	(9.7)	(6.7)	(6.7)	(5.8)	(5.7)	(5.2)	(6.7)	(7.9)	(10.9)
Mexican Hispanic	17.3**	5.9	–2.5	–9.6***	–15.0***	–19.6***	–22.3***	–25.0***	–27.4***	–23.9***
	(6.7)	(3.4)	(2.4)	(2.4)	(2.0)	(2.0)	(1.8)	(2.3)	(2.7)	(3.8)
Latin American Hispanic	–25.8*	–23.8***	–26.0***	–33.6***	–37.2***	–45.5***	–49.8***	–50.3***	–55.3***	–57.0***
	(11.9)	(6.2)	(4.3)	(4.3)	(3.7)	(3.7)	(3.3)	(4.3)	(5.0)	(6.9)
Cuban Hispanic	–27.4	–11.7	–19.5	–12.5	–21.8*	–24.4*	–28.0**	–32.67**	–35.9**	–39.4*
	(31.0)	(16.2)	(11.2)	(11.2)	(9.7)	(9.6)	(8.6)	(11.2)	(13.2)	(18.2)
Puerto Rican Hispanic	–169.9***	–102.1***	–91.0***	–89.8	–92.8***	–91.9***	–91.2***	–90.7***	–87.6***	–82.5***
	(15.6)	(8.1)	(5.6)	(5.6)	(4.9)	(4.8)	(4.3)	(5.6)	(6.6)	(9.2)
Other Hispanic	–78.8***	–73.2***	–77.0***	–72.9***	–76.9***	–79.9***	–89.0***	–97.3***	–95.6***	–115.2***
	(16.8)	(8.7)	(6.1)	(6.1)	(5.3)	(5.2)	(4.7)	(6.1)	(7.2)	(9.8)
Infant sex (ref=female)										
Male	50.4***	87.7***	101.5***	108.5***	113.5***	120.3***	126.3***	131.0***	135.8***	142.7***
	(3.7)	(1.9)	(1.3)	(1.3)	(1.1)	(1.1)	(1.0)	(1.3)	(1.6)	(2.1)
Mother's marital status (ref=married)										
Single	–139.9***	–86.3***	–75.0***	–67.6***	–63.6***	–59.2***	–57.0***	–53.7***	–49.9***	–47.4***
	(4.7)	(2.4)	(1.7)	(1.7)	(1.4)	(1.4)	(1.3)	(1.7)	(2.0)	(2.7)
Mother's age (years)	–4.1***	0.5**	2.0***	3.2***	4.1***	4.9***	5.7***	6.7***	7.9***	9.8***
	(0.4)	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0 1)	(0 1)	(0.2)

(Continued…)

Table 3. *Continued*

Variables	**0.05 Quantile**	**0.15 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 Nativity (ref=U.S. born)										
Foreign-born	63.8***	38.2***	27.5***	20.8***	15.5***	12.8***	10.6***	5.0*	4.6	–1.4
	(6.0)	(3.1)	(0.2)	(2.2)	(1.9)	(1.8)	(1.6)	(2.1)	(2.5)	(3.4)
Mother's education (yrs.)	31.4***	22.5***	18.5***	16.1***	14.0***	12.6***	10.9***	9.0***	7.0***	2.9***
	(1.1)	(0.6)	(0.4)	(0.4)	(0.3)	(0.3)	(0.3)	(0.4)	(0.5)	(0.6)
Constant	2445.4***	2822.4***	3010.5***	3151.5***	3275.3***	3391.8***	3514.7***	3653.3***	3829.6***	4141.8***
	(4.6)	(2.4)	(1.7)	(1.6)	(1.4)	(1.4)	(1.3)	(1.6)	(1.9)	(2.6)

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 and intermediate variables

Variable	0.05 Quantile	0.15 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)										
Non–Hispanic black	–162.0***	–157.6***	–160.1***	–162.5***	–164.9***	–163.9***	–162.7***	–162.7***	–162.3***	–159.5***
	(3.2)	(2.1)	(1.9)	(1.8)	(1.7)	(1.8)	(1.9)	(2.0)	(2.3)	(3.5)
Asian Indian	–208.4***	–228.5***	–236.4***	–241.1***	–243.5***	–251.2***	–249.1***	–257.8***	–259.3***	–280.1***
	(12.6)	(8.4)	(7.4)	(7.2)	(6.9)	(7.0)	(7.3)	(8.0)	(9.1)	(13.8)
Chinese	–77.3***	–91.7***	–106.1***	–119.1***	–129.7***	–142.3***	–155.4***	–167.9***	–181.5***	–189.2***
	(11.8)	(7.9)	(6.9)	(6.8)	(6.4)	(6.6)	(6.8)	(7.5)	(8.5)	(12.9)
Filipino	–145.2***	–146.4***	–147.7***	–159.0***	–154.9***	–161.5***	–162.9***	–174.8***	–189.3***	–186.8***
	(11.5)	(7.7)	(6.8)	(6.6)	(6.3)	(6.4)	(6.7)	(7.3)	(8.3)	(12.7)
Korean	–67.6**	–95.2***	–98.6***	–98.3***	–108.4***	–120.2***	–133.9***	–134.8***	–142.7***	–141.9***
	(19.9)	(13.3)	(11.7)	(11.5)	(11.0)	(11.2)	(11.6)	(12.7)	(14.4)	(22.0)
Other Asian	–145.5***	–166.3***	–174.8***	–181.6***	–183.4***	–187.0***	–192.1***	–199.7***	–205.5***	–215.6***
	(7.6)	(5.0)	(4.4)	(4.3)	(4.1)	(0.2)	(4.4)	(4.8)	(5.5)	(8.3)
Hawaiian	–34.2	–66.3***	–45.1**	–50.3***	–39.5**	–42.5**	–25.8	–17.8	–7.5	–30.0
	(27.3)	(18.2)	(16.0)	(15.7)	(15.0)	(15.3)	(15.9)	(17.3)	(19.7)	(30.1)
Native American	–11.3	7.4	17.6**	20.6***	29.6***	37.4***	43.0***	51.9***	55.8	82.3***
	(10.2)	(6.8)	(6.0)	(5.9)	(5.6)	(5.2)	(5.9)	(6.4)	(7.3)	(11.2)
Mexican Hispanic	–35.9***	–39.1***	–40.7***	–44.4***	–44.1***	–46.7***	–46.6***	–45.5***	–49.9	–46.2***
	(3.8)	(2.5)	(2.2)	(2.2)	(2.0)	(2.1)	(2.2)	(2.3)	(2.6)	(4.0)
Latin American Hispanic	–57.7***	–55.0***	–53.9***	–53.9***	–53.5***	–56.6***	–56.6***	–54.1***	–62.1	–65.0***
	(6.5)	(4.3)	(3.8)	(3.7)	(3.6)	(3.6)	(3.8)	(4.1)	(4.7)	(7.1)
Cuban Hispanic	–53.9***	–31.0	–32.1***	–27.4**	–26.4**	–29.2**	–33.2***	–26.7*	–29.1*	–37.7*
	(16.9)	(11.3)	(9.9)	(9.7)	(9.3)	(9.4)	(9.8)	(10.7)	(12.2)	(18.6)
Puerto Rican Hispanic	–92.9***	–99.0***	–101.8***	–99.9***	–96.6***	–96.5***	–92.3***	–88.4***	–93.3***	–92.2***
	(8.5)	(5.7)	(5.0)	(4.9)	(4.7)	(4.8)	(4.9)	(5.4)	(6.1)	(9.4)
Other Hispanic	–100.6***	–93.3***	–91.4***	–92.6***	–92.8***	–95.0***	–98.4***	–101.7***	–102.0***	–109.2***
	(9.1)	(6.1)	(5.4)	(5.3)	(5.0)	(5.1)	(5.3)	(5.8)	(6.6)	(10.1)
Infant sex (ref=female)										
Male	98.0***	112.1***	120.2***	124.6***	128.2***	132.4***	134.7***	136.5***	139.4***	144.6***
	(2.0)	(1.3)	(1.2)	(1.1)	(1.1)	(1.1)	(1.2)	1.3	(1.4)	(2.2)
Mother's marital status (ref=married)										
Single	–35.3***	–31.7***	–27.3***	–26.1***	–24.2***	–21.8***	–19.9***	–16.4***	–13.4***	–13.3***
	(2.6)	(1.7)	(1.5)	(1.5)	(1.4)	(1.4)	(1.5)	(1.6)	(1.8)	(2.8)
Mother's age (years)	–1.6***	0.1	1.0***	1.4***	2.0***	2.4***	2.7***	3.2***	4.0***	5.1***
	(0.2)	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.2)	(0.2)

(Continued…)

Table 4. *Continued*

Variable	0.05 Quantile	0.15 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 Nativity (ref=U.S. born)										
Foreign–born	6.2	2.2	0.8	–1.8	–3.5*	–1.8	–2.2	–1.9	.04	.03
	(3.3)	(2.2)	(2.0)	(2.0)	(2.0)	(2.0)	(2.0)	(2.0)	(2.0)	(3.5)
Mother's education (years)	17.0***	13.0***	11.2***	9.9***	8.4 ***	7.6***	6.8***	6.0***	4.7***	1.9**
	(0.6)	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(0.7)
Gestation length (spline)										
18–41 weeks	148.6***	149.2***	147.6***	144.0***	137.7 ***	129.4***	119.8***	108.9***	95.6***	80.0***
	(0.6)	(0.4)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.4)	(0.5)
42–50 weeks	–89.0***	–79.4***	–74.0***	–68.8***	–62.6 ***	–55.4***	–47.5***	–38.6***	–30.7***	–17.7***
	(1.5)	(1.1)	(1.0)	(1.0)	(0.9)	(1.0)	(1.0)	(1.1)	(1.3)	(1.9)
First birth (ref=no)										
Yes	–109.5***	–99.1***	–94.9***	–92.8***	–90.6***	–86.9***	–84.2***	–81.9***	–76.0***	–59.6***
	(2.9)	(1.9)	(1.7)	(1.7)	(1.6)	(1.6)	(1.7)	(1.8)	(2.1)	(3.2)
Birth order	4.8***	8.6***	9.8***	10.7***	11.0***	11.8***	13.1***	13.9***	15.1***	21.4***
	(1.2)	(0.8)	(0.7)	(0.7)	(0.7)	(0.7)	(0.7)	(0.8)	(0.9)	(1.3)
Adequacy of prenatal care initiation (ref=adequate plus)										
Inadequate	27.6***	20.9***	26.8***	32.2***	32.7***	37.6***	36.4***	43.6***	53.2***	50.5***
	(6.4)	(4.3)	(3.8)	(3.7)	(3.5)	(3.6)	(3.7)	(4.0)	(4.6)	(7.1)
Intermediate	23.8***	17.7***	21.9***	25.9***	24.5***	26.1***	27.0***	29.3***	34.6***	25.3***
	(4.7)	(3.1)	(2.7)	(2.7)	(2.6)	(2.6)	(2.8)	(3.0)	(3.4)	(5.2)
Adequate	–7.1**	–6.2***	–4.3**	–1.4	–0.03	1.9	2.5	5.2***	5.6**	7.1**
	(2.5)	(1.7)	(1.5)	(1.4)	(1.4)	(1.4)	(1.4)	(1.6)	(1.8)	(2.7)
Number of prenatal care visits (spline)										
0–14 visits	14.3***	11.7***	11.6***	11.9***	11.7***	11.7***	11.4***	11.8***	12.1***	11.3***
	(0.5)	(0.3)	(0.3)	(0.3)	(0.2)	(0.3)	(0.3)	(0.3)	(0.3)	(0.5)
15 or more visits	–8.6***	–6.0***	–5.12***	–4.4***	–4.1***	–3.5***	–3.0***	–1.9***	–0.9*	.0005
	(0.6)	(0.4)	(0.4)	(0.3)	(0.3)	(0.3)	(0.4)	(0.4)	(0.4)	(0.6)
Smoked during pregnancy (ref=no)										
Yes	–132.0***	–130.1***	–130.5***	–135.1***	–136.1***	–136.2***	–137.1***	–139.9***	–139.9***	–137.0***
	(5.1)	(3.4)	(3.0)	(3.0)	(3.0)	(3.0)	(3.0)	(3.0)	(4.0)	(5.9)
Cigarettes per day	–5.1***	–5.2***	–5.1***	–4.8***	–5.0***	–5.1***	–5.4***	–5.4***	–5.6***	–6.2***
	(0.4)	(0.3)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.3)	(0.3)	(0.5)
Alcohol use during pregnancy (ref=none)										
Some	–18.9	–8.1	1.2	.09	–3.5	–5.8	–1.3	–6.6	–19.2*	–29.0*
	(12.1)	(8.2)	(7.2)	(7.2)	(6.9)	(7.0)	(7.4)	(8.0)	(9.1)	(14.1)

(Continued…)

Table 4. *Continued*

Variable	0.05 Quantile	0.15 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
Alcoholic drinks per week	–5.8**	–10.0***	–8.2***	–7.6***	–4.6***	–5.1***	–5.3***	–3.9*	–4.5*	–0.5
	(2.0)	(1.5)	(1.4)	(1.4)	(1.4)	(1.5)	(1.6)	(1.7)	(2.0)	(3.2)
Medical risk factors (ref=none)										
Anemia	39.3***	39.0***	33.9***	29.3***	22.9***	21.3***	20.0***	20.4***	23.7***	20.1**
	(6.5)	(4.3)	(3.8)	(3.7)	(3.5)	(3.6)	(3.8)	(4.1)	(4.7)	(7.1)
Lung disease	–0.3	–7.9	–3.4	–6.3	–11.2*	–12.7*	–21.7***	–24.2***	–19.9**	–0.4
	(9.1)	(6.1)	(5.3)	(5.3)	(5.0)	(5.1)	(5.3)	(5.8)	(6.6)	(10.0)
Diabetes	43.4***	55.2***	67.3***	77.0***	89.8***	102.8***	115.1***	136.1***	163.9***	232.2***
	(5.8)	(3.9)	(3.4)	(3.4)	(3.2)	(3.3)	(3.4)	(3.7)	(4.2)	(6.4)
Hydramnios	–309.2***	–243.4***	–216.3***	–204.8***	–188.5***	–170.0***	–154.2***	–131.1***	–91.4***	–43.4***
	(8.7)	(5.8)	(5.1)	(5.0)	(4.7)	(4.8)	(5.0)	(5.5)	(6.2)	(9.6)
Pregnancy hypertension	–255.0***	–199.8***	–155.4***	–125.0***	–106.7***	–89.0***	–76.8***	–65.7***	–45.4***	–17.4**
	(5.4)	(3.6)	(3.2)	(3.1)	(3.0)	(3.0)	(3.2)	(3.5)	(3.9)	(6.0)
Previous large birth	322.2***	345.4***	362.6***	376.2***	383.5***	394.9***	401.2***	406.7***	405.2***	418.4***
	(9.9)	(6.6)	(5.8)	(5.7)	(5.4)	(5.5)	(5.8)	(6.3)	(7.1)	(10.9)
Previous preterm birth	–221.7***	–197.4***	–195.3***	–197.6***	–197.5***	–201.5***	–209.2***	–204.1***	–205.8***	–188.5***
	(9.3)	(6.2)	(5.4)	(5.3)	(5.1)	(5.2)	(5.4)	(6.0)	(6.7)	(10.2)
Other	–53.9***	–35.9***	–30.7***	–27.7***	–24.8***	–21.0***	–18.7***	–16.5***	–11.8***	–4.3
	(2.7)	(1.8)	(1.6)	(1.5)	(1.5)	(1.5)	(1.6)	(1.7)	(1.9)	(3.0)
Obstetric procedures (ref=none)										
Induced labor	30.1***	28.9***	28.8***	29.4***	31.4***	33.7***	37.0***	40.7***	41.4***	36.8***
	(2.5)	(1.7)	(1.5)	(1.5)	(1.4)	(1.4)	(1.5)	(1.6)	(1.8)	(2.8)
Tocolysis	–63.5***	–62.9***	–70.0***	–72.5***	–76.0***	–77.5***	–73.4***	–74.2***	–74.8***	–78.8***
	(7.2)	(4.8)	(4.2)	(4.2)	(4.0)	(4.0)	(4.2)	(4.6)	(5.2)	(8.0)
Constant	2735.8***	2972.1***	3113.1***	3227.9***	3333.5***	3432.5***	3538.4***	3659.4***	3818.2***	4092.6***
	(4.5)	(3.0)	(2.6)	(2.6)	(2.5)	(2.5)	(2.6)	(2.8)	(3.2)	(4.9)

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

Figure 1. Quantile regression estimates of disparities in birthweight between non-Hispanic whites (omitted) and other race/ethnic groups: raw differences

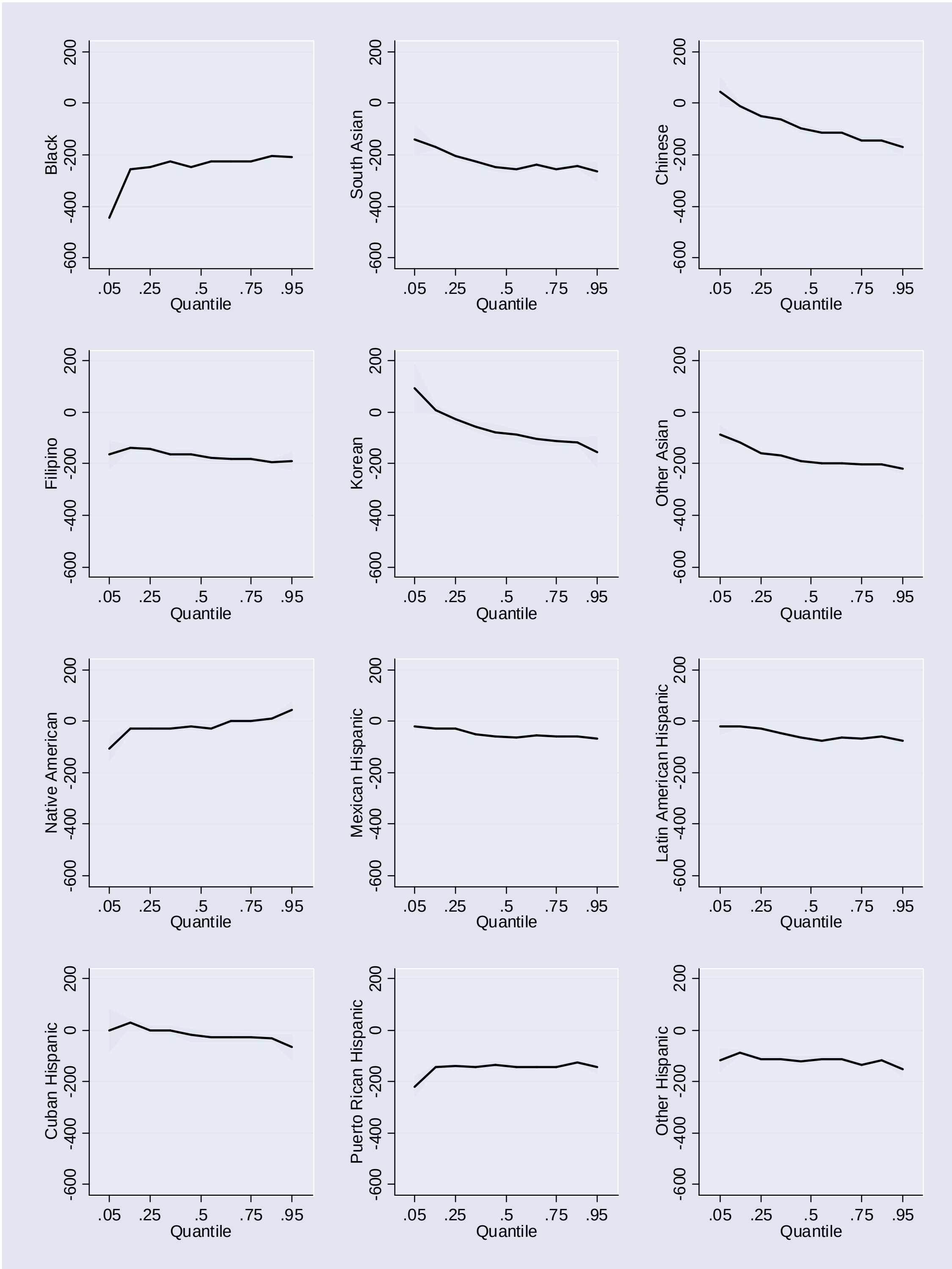

Figure 2. Quantile regression estimates of disparities in birthweight between non-Hispanic whites (omitted) and other race/ethnic groups: Raw differences (solid lines) and differences adjusted for background demographic and socioeconomic status characteristics (dashed lines)

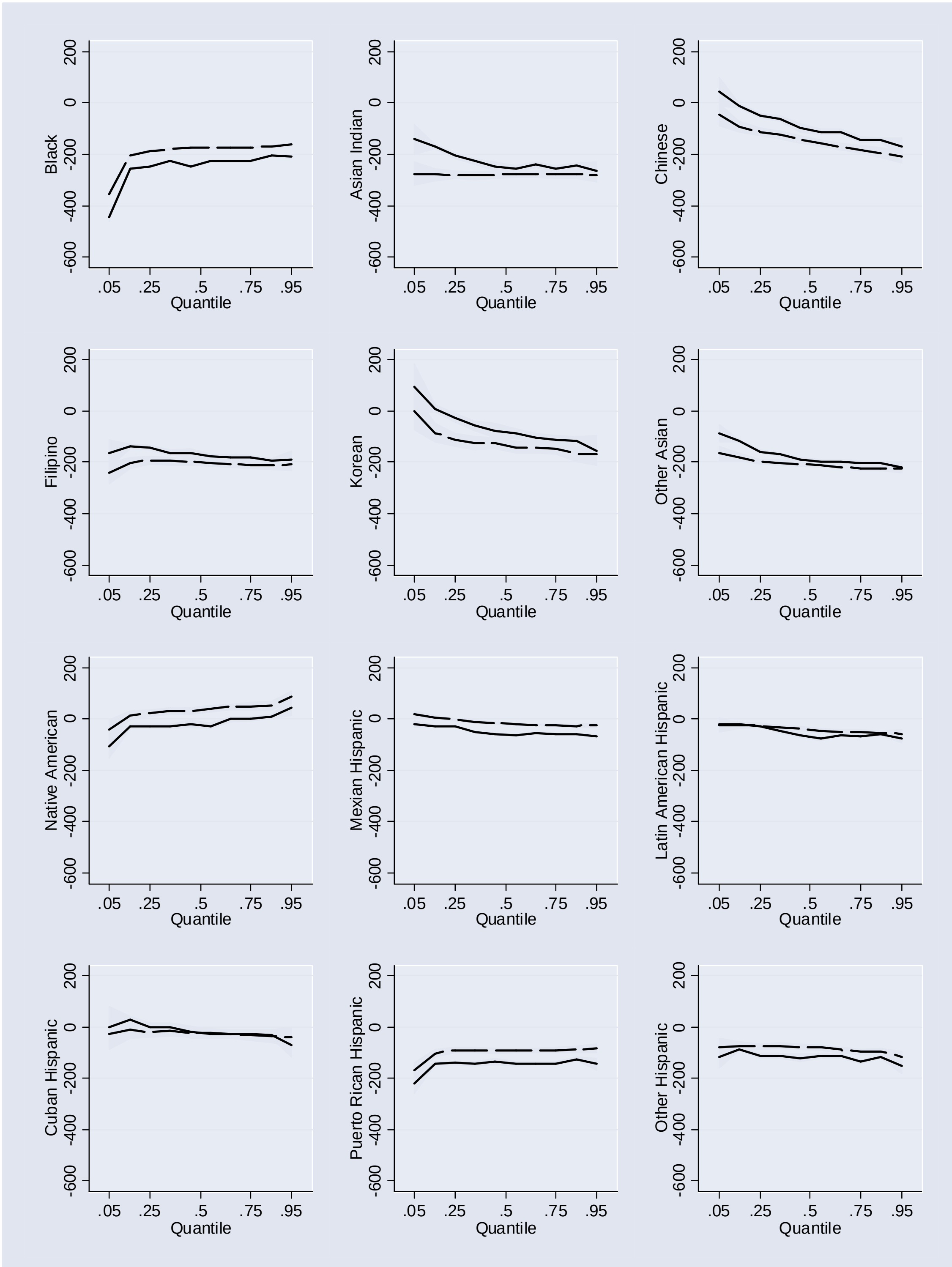

Figure 3. Quantile regression estimates of disparities in birthweight between non-Hispanic whites (omitted) and other race/ethnic groups: Differences adjusted for background demographic and socioeconomic status characteristics (solid lines) plus additional controls for intermediate variables (dashed lines)

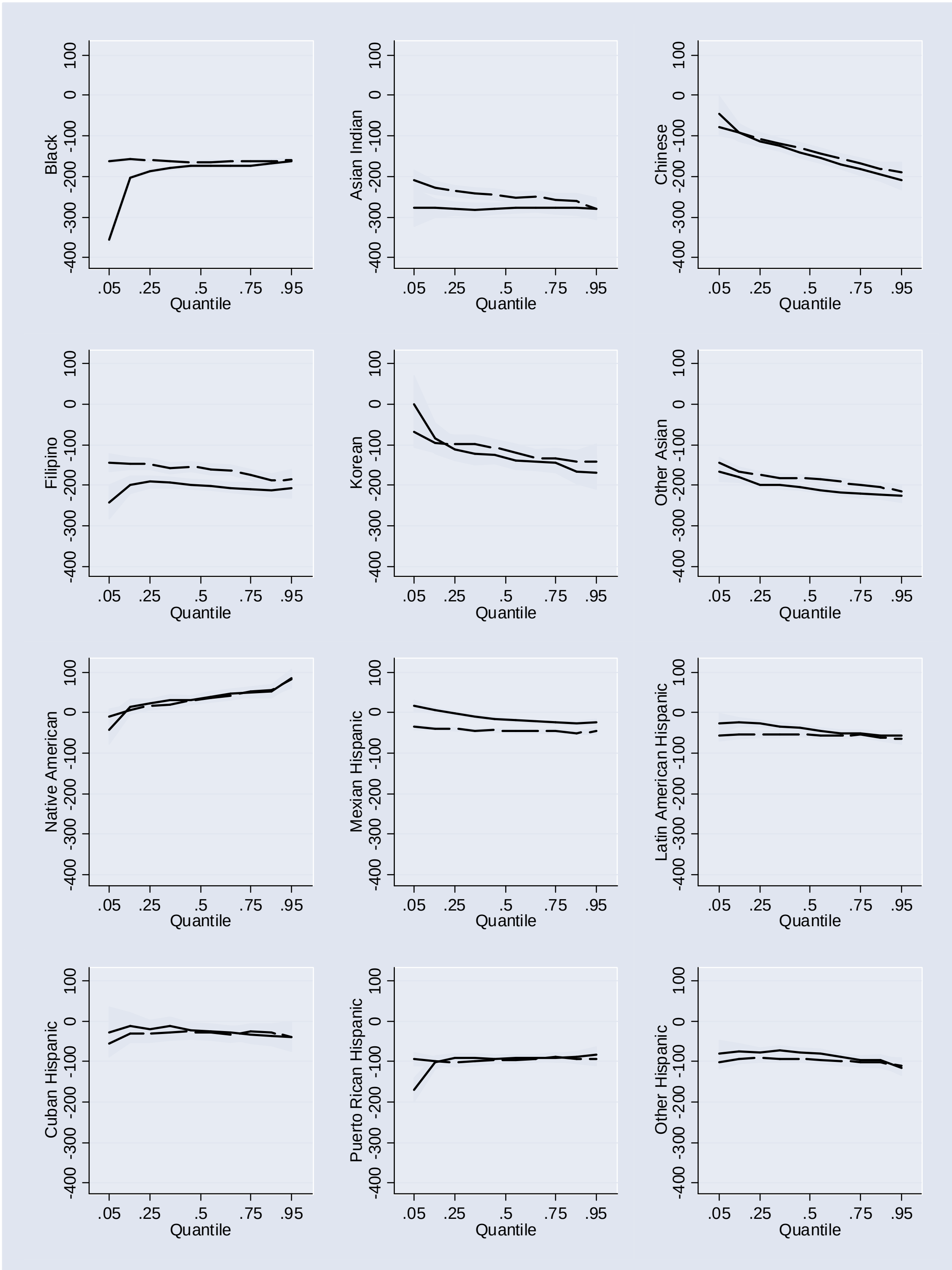

Figure 4. Quantile regression estimates of the effects of mother's characteristics on birthweight: Effects adjusted for other background demographic and socioeconomic characteristics (solid lines) plus additional controls for intermediate variables (dashed lines)