

ORIGINAL CONTRIBUTION

Birth Weight, Maternal Age, and Education: New Observations from Connecticut and Virginia

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It has been well established that increased maternal education, income, and social status contribute to increased birth weight, as well as reduced risk for low or very low birth weight offspring. However, there remains controversy about the mechanism(s) for this effect, as well as the interactions between these factors, maternal age, and race.

Presented here is the analysis of a large, recent sample of over 20,000 consecutive live births in 12 hospitals, about half in Connecticut and half in Virginia, including a maternal population that is educationally and racially diverse. Although information on potentially relevant details such as prenatal care, smoking, occupation, and neighborhood is lacking the data set, there is sufficient information to explore the previously noted strong effect of maternal education on birth weight, as well as the large racial difference in outcome at every educational level after adjustment for the effects of age, marital status, state of residence, and gender of the offspring. However, this relationship was not monotonic, and there were differences in the effect between the white and black families, with black women showing a linear and consistent benefit from education across the range, while whites show a sharp benefit from completion of primary education, less from subsequent schooling. A surprising result was the apparent negative impact of very advanced education (>16 years), with lowered birth weights and higher risk of low birth weight offspring in the women with post-college training.

The data also shed some addition light on the effect of age and birth weight. Whites show established improvement in birth outcome to about age 30, with slight decline thereafter, whereas in blacks there was progressive decline in birth weight with rising age starting in adolescence, as previously demonstrated by Geronimus. An additional unexpected observation was a sizable difference between births in Connecticut (larger, fewer low birth weight) than Virginia, correcting for all other covariates. It is hypothesized that this may reflect differences in services used, prenatal care in particular, given similarities in smoking rates and other predictors.

Because of the non-representiveness of and the limited information available in the present study, the conclusions should be taken as hypotheses for further research rather than definitive.

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^c Abbreviations: SES, socioeconomic states; LW, low weight; VLW, very low weight; OLS, ordinary least squares.

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INTRODUCTION

There is an extensive literature documenting the consistent relationship between maternal socioeconomic states (SES)^c and fetal health [1-5]. While infant mortality evidence clearly and unequivocally expresses the devastating consequence of very low SES, evidence, using birth weight outcome, demonstrates a more continuous relationship across the SES spectrum, rising SES being associated with increasing mean birth weights, as well as decreasing the probability of low (< 2500 gm) or very low (< 1500 gm) birth weight outcomes [1-3].

While these relationships appear secure, there are many uncertainties and controversies regarding the associations. First is the issue of pathway, some investigators feeling that most of the relationship can be explained by differences in reasonably well understood characteristics, such as smoking, maternal health, and access to prenatal care [4, 6, 8], while others infer large unexplained "SES" factors [2, 5, 9, 10]. Closely linked with this issue, especially in U.S. data, is the effect of race, whose role as an independent predictor of outcome has been variable in the published data sets [2, 5, 6, 8, 11, 12]. More recently, there has been a suggestion that not only race and SES but some "neighborhood" or community factor might substantially modulate birth weight outcome, though there is debate whether community heterogeneity, alternatively viewed as "income incongruity" (a beneficial factor) or "income disparity" (a negative predictor) is the dominant effect, or whether physical environment may contribute [5, 9, 10].

There also remains considerable controversy regarding the significance of the differences observed. Although the prenatal and child development literature clearly documents the relationship between low and very low birth weight and subsequent pediatric health/performance [13-16], there is less certainty about the effects of small differences in weight on health

above these categories. While there have been few studies that adequately demonstrate the relationship between birth weight and health while controlling for subsequent SES environmental effects, there is some empirical support for the view that the SES-health gradient demonstrable in adult populations may be a reflection of the long term effect of SES gradient differences at birth, with little postpartum environmental contribution [17, 18]. More recently, Geronimus [19] has speculated, based on an observed decline in birth weight with advancing maternal age after 15 in African-American women (unlike the positive effect of age in whites), that birth weight might be viewed as an expression of SES pre-clinical chronic health effects on young adults, a predictor of poor maternal health outcome. If confirmed and validated against other measures of adult health, birth weight might ultimately serve as a biomarker of health in two generations simultaneously.

In the present paper, we focus on the effects on birth weight of two maternal characteristics: age and education. In comparison to some previous surveys used to study birth weight, our data are non-representative and quite limited in terms of variables, but is recent and consists of over 20,000 births. The large sample permits a detailed analysis of the effects of education and age in both the white and the black populations.

The data presented below represent an effort to exploit a study of newborns that had been designed to investigate predictors of respiratory health and asthma in young children. To identify a broad and random population from which to select subjects based on exposure to indoor environmental pollutants of interest and carrying family risk factors of concern, over 20,000 consecutive live births were surveyed in Connecticut and Virginia from 1992 to 1994. We present here the outcomes of these births in relation to available maternal screening data in the hope of addressing some of the issues described

above, and with the possibility of identifying a population for subsequent sampling to address more challenging issues in the future. Because of the limitations of the present study in terms of representiveness and information on several confounders, inferences suggested by the relationships found in the paper should be taken as hypotheses for further studies.

METHODS

The data

The Yale Mother and Infant Health Study was started at six hospitals in Connecticut in 1992 to identify newborns for longitudinal evaluation of environmental and genetic risk for respiratory disease in childhood. Interviewers identified women admitted for delivery and attempted to briefly interview them after delivery while still in hospital or very shortly after return home. Mothers of almost all live births were approached at the hospitals (mothers of very adverse outcomes were not approached), and almost all women agreed to the survey interview, which captured data on maternal demographics (age, race, marital status, education) and questions related to household environment and respiratory disease by direct interview, either live or on the phone. Interviewers were trained in the Yale Prenatal Epidemiology Research Unit. The initial goal was to survey 10,000 mothers, but because the prevalence of certain environmental risk factors in Connecticut was too low, Virginia was selected for recruitment and an additional six hospitals enlisted; the screening procedure was the same. The Virginia hospitals were chosen to assure a higher representation of rural and African-American mothers. Approximately 11,000 additional subjects were interviewed in Virginia. Birth weight and birth gender, the outcome variables in this analysis, were obtained from the medical record.

The study resulted in information on 21,430 live births. Of these, 285 were multiple births. Of the singletons, 1,092 cases

(5.2 percent) had a missing value on one of the birth outcomes or on a mother's characteristics. The final working data set includes 20,058 single live births, of which there are 15,542 whites, 3,399 blacks, and 572 Hispanics.

The variables

The birth outcomes information includes the sex and the weight of the newborn. Weight is measured in kilograms. The mothers' characteristics included years of schooling, age, marital status, race/ethnicity, and state (Connecticut or Virginia).

The analysis strategy

We focus on three birth outcomes: weight (a continuous measure), low weight (< 2,500 gm) denoted by low weight (LW), and very low weight (VLW) (< 1,500 gm). We first present bivariate analysis relating the birth outcomes to mothers' characteristics in the entire population. Because of the known differences among racial and ethnic groups [11, 12], all the multivariate analysis was performed separately for whites, blacks, and Hispanics. In order to fully explore the effects of mothers' education and age, the multivariate analysis proceeded in three stages. First, we estimated the effects of the mothers' characteristics on birth outcomes in the entire sample using Ordinary Least Squares (OLS) regression for the weight, and Logit regressions for the binary outcomes of LW and VLW. In this first analysis, education was measured as a continuous variable (years of schooling), and a non-linear relationship was adopted to allow for a variable effect of both education and age. The estimates are corrected for heteroscedasticity. Second, we re-estimated the above relations using a recoded measure of education: 0 to 8, 9 to 11, 12, 13 to 15, 16, and 17+. This allows, first, for a possible non-parametric effect of education on the birth outcomes, and second, the estimation of the effect of the "type" (ability) of the mother rather than the effect of the individual years of schooling. In the third stage, in order to evaluate

Table 1. Description of the mothers (percent).

Years of schooling	White	Black	Hispanic
Mean (s.d.)	13.8 (2.5)	12.1 (1.8)	12.1 (2.5)
0 to 8	1.2	1.9	5.9
9 to 11	10.0	25.6	29.1
12	30.8	44.7	32.2
13 to 15	26.0	22.4	21.9
16	20.3	3.8	6.3
17+	11.7	1.6	4.7
Age			
Mean (s.d.)	28.8 (5.8)	25.0 (6.0)	25.5 (6.0)
13 to 18	3.8	13.5	12.4
19 to 22	13.1	26.0	81.7
23 to 25	70.7	54.8	
36+	12.4	5.7	5.9
State			
Connecticut	43.1	26.2	90.0
Marital status			
Married	81.5	27.1	48.6
n	15,542	3,403	572

the possibility of confounding effects of maternal age and education, we re-estimated the relationships restricted to mothers who had passed school age, first those aged 19+ and then those aged 23+.

RESULTS

Table 1 provides a description of the mothers' population. The mean age is 28, with 6 percent aged below 18 (the minimum age reported is 13, and the maximum is 55). The mean number of years of schooling completed is almost 13, with 15 percent not having completed high-school, and 10 percent having some graduate education. Over 70 percent are married, and 42 percent gave birth in a Connecticut facility. White mothers are more educated: 42 percent have completed only elementary or high-school by the time of the birth, while among black mothers that per-

centage is 72 percent, and among Hispanic mothers 67 percent. Over thirty percent of the white women completed college education by the time of giving birth, while only 5 percent did so among black mothers, and 11 percent among Hispanic mothers.

White mothers are also older at the time of birth. The mean age of these mothers is 29 years compared with a mean age of 25 and 26 years of black and Hispanic mothers, respectively. Four percent of the white mothers were below 18, compared with 14 percent and 13 percent among black and Hispanic mothers. On the other hand, 12 percent of white mothers were over 36, compared to only 6 percent of black and Hispanic mothers.

While 43 percent of the births to white mothers in the study took place in Connecticut, only 26 percent of the births to black mothers did so. Most of the

Table 2. Birth outcomes by mothers' characteristics.^a

	Weight (gm)	LW (percent) ^b	VLW (percent) ^c
Total	3370	6.6	0.8
Years of schooling			
0 to 8	3240	9.4	2.0
9 to 11	3219	10.4	1.0
12	3333	7.2	1.0
13 to 15	3411	5.8	0.8
16	3470	0.3	0.3
17+	3441	5.0	0.5
Age			
13 to 18	3204	10.3	1.1
19 to 30	3356	6.5	0.8
31 to 40	3420	6.1	0.8
41+	3413	5.6	0.3
Race/ethnicity			
White	3424	5.6	0.7
Black	3155	10.8	1.4
Hispanic	3315	7.2	0.9
Marital status			
Married	3431	5.3	0.7
Not married	3218	9.7	1.2
State			
Connecticut	3408	5.3	0.4
Virginia	3342	7.5	1.1

^a All differences in mean weight are significant at 5 percent (F-test).

All relations of LW and VLW are significant at $p = .05$ (chi-square test).

^b Low weight (< 2500 gm).

^c Very low weight (< 1500 gm).

Hispanic women in the study resided in Connecticut (90 percent). Finally, over 80 percent of the white mothers were married, compared with only 27 percent and 49 percent among blacks and Hispanic mothers.

Table 2 shows the unadjusted birth outcome data. The mean birth weight is 3,370 gm. 6.6 percent of the newborns have low weight, and 0.8 percent have a very low weight. The bivariate analysis confirms the main relationships reported in other studies. Higher education is associat-

ed with heavier babies and lower chances of low and very low weight. However, the relationship is not monotonic. Babies of women with 0 to 8 years of schooling are heavier (and their chances of having low weight are smaller) than those of women with 9 to 11 years of education. Very highly educated mothers, with 17+ years of schooling are more likely than women with a college degree to have low and very low weight babies and to have less heavy babies. A more detailed analysis revealed

Table 3. The determinants of birth weight.^a

	White	Black	Hispanic
Constant	2.386 (17.1)	2.910 (39.0)	2.916 (19.3)
Years of schooling	0.085 (4.7)	0.015 (2.2)	0.011 (0.9)
Years of schooling squared	-0.003 (4.2)	—	—
Age (/10)	0.154 (2.0)	-0.012 (0.5)	0.056 (1.3)
Age squared (/100)	-0.027 (2.1)	—	—
Connecticut	0.038 (4.0)	-0.009 (0.4)	0.082 (1.2)
Married	0.103 (7.3)	0.106 (4.2)	0.040 (0.7)
Male baby	0.120 (13.2)	0.123 (6.1)	0.067 (1.4)
N	15,542	3,399	572
Adjusted R ²	0.028	0.019	0.010

^aOLS, t-values in parenthesis.

that this pattern holds for individual years of schooling as well. Advanced age at birth is related to heavier babies, with a slight decline in the oldest age group. Babies born to white mothers are heavier, with lower chances of having low or very low birth weight than those born to black or Hispanic mothers. Hispanic babies are heavier than black babies. Babies born to married mothers are heavier than those born out of wedlock. Finally, Connecticut babies are heavier than babies born in Virginia.

Tables 3 to 5 report the multivariate results for the birth outcomes for white, black, and Hispanic mothers of all ages with education measured continuously. The entries in the tables are the parameters estimates. In Table 3, they are the marginal effects (in kilograms) on birth weight, while in Tables 4 to 5 they are the marginal effects on the log-odds. If we define the risk of LW or VLW as the odds-ratio ($p/[1-p]$), the coefficients of education and age in the respective LOGIT analysis measure their marginal effects on the rate of change in that risk.

Two general observations emerge: First, the birth weight and the chances of having low birth weight of Hispanic babies are not significantly determined by any measured maternal characteristic; the small number of cases prevented the analysis of very low birth weight among

Hispanics altogether. Second, there is a marked difference between the effects of the mothers' characteristics — education and age in particular — on birth weight in the white and the black populations.

Among whites, both education and education-squared have significant effects on birth weight (Table 3). At eight years of schooling, the marginal effect of a mother's school year on the newborn's weight is about 40 gm. At 12 years of schooling, the marginal effect is 13 gm, at 14 years of schooling the marginal effect of schooling on birth weight is nil, and at 16 years there is a negative effect, -11 gm. With graduate degree (22 years of schooling), the marginal effect of education on birth weight is -47 gm. Among black mothers, the marginal effect of education is constant at a level of 15 gm per year.

A similar pattern is found for the effect of the mother's age on birth weight. Among whites, at the age of 18, the marginal effect of a year of age is 6 gm. At age 22, this effect is 4 gm, and at age 29, which is the mean age at birth in our data, this effect is zero. When the mother is older than 29, each additional year reduces birth weight. At age 40, for example, the marginal effect of age on birth weight is -6 gm. No significant age effect is found among black women.

Other results indicate that white babies born in Connecticut are, on average,

Table 4. The determinants of low birth weight.^a

	White	Black	Hispanic
Constant	0.756 (0.9)	-1.707 (4.1)	-0.774 (0.7)
Years of schooling	-0.266 (2.6)	-0.064 (2.0)	-0.065 (0.8)
Years of schooling squared	0.007 (2.0)	—	—
Age (/10)	-0.805 (1.7)	0.214 (2.1)	-0.456 (1.3)
Age squared (/100)	0.162 (2.0)	—	—
Connecticut	-0.387 (5.0)	0.025 (0.2)	0.043 (0.1)
Married	-0.352 (3.8)	-0.276 (1.9)	0.257 (0.7)
Male baby	0.013 (0.2)	-0.237 (2.1)	-0.108 (0.3)
N	15,542	3,399	572
Goodness of fit ^b	0.017	0.006	0.020

^a Logit regression, t-values in parenthesis.

^b 1-Log-Likelihood (model)/log-likelihood (slopes = 0).

38 gm heavier than those born in Virginia. No significant state effect is found among black babies. Married mothers of both races give birth to heavier babies (103 gm among whites, 106 gm among blacks), and male newborns are 120 to 123 gm heavier than females in both races. Finally, while the estimated effects are very significant, the total explanation power of the characteristics considered is quite low (about 3 percent for whites and 2 percent for blacks).

Table 4 presents the effects of the mothers' characteristics on the log-odds of low birth weight. Among both white and black mothers, higher education is associated with lower chances of LW. However,

as was found for the analysis of weight, the nature of this effect varies between the race groups. The education effect amounts to a 6.4 percent decrease in the risk of LW (indicated by the odds-ratio) per year of schooling among blacks. Among whites, an additional year of schooling leads to a decrease of 15 percent in the risk of LW for women with elementary education; to a decrease of 10 percent for women with 12 years of schooling; and to a decrease of 4 percent for women with college education. For women with more than 19 years of education, the marginal effect of schooling on the risk of LW is positive.

While age has no effect on birth weight among blacks (Table 3), the effect

Table 5. The determinants of very low birth weight.^a

	White	Black
Constant	-3.170 (5.2)	-5.085 (4.5)
Years of schooling	-0.131 (2.8)	-0.013 (0.1)
Age (/10)	0.034 (0.2)	0.568 (2.2)
Connecticut	-1.114 (4.3)	0.337 (0.9)
Married	0.035 (0.1)	-0.753 (1.9)
Male baby	0.225 (1.1)	-0.501 (1.7)
N	15,542	3,399
Goodness of fit ^b	0.032	0.020

^a Logit regression, t-values in parenthesis.

^b 1-Log-Likelihood (model)/log-likelihood (slopes = 0).

of age on the risk of LW is positive and constant. On average, each year of the mother's age increases the risk of the newborn's low birth weight by about 2 percent. Among whites, the effect of age varies with age. At age 18, each year reduces the risk of LW by 2 percent. This rate of decrease is halved at age 22. At ages greater than 25, advanced age is related to higher risk of LW. At age 40, for example, an additional year leads, on average, to 5 percent increase in that risk.

Other results in Table 4 indicate that white babies born in Connecticut are 32 percent less likely (as measured by the relative odds-ratios) to have LW than those born in Virginia. No significant state effect is found among blacks. Married mothers are 30 percent and 24 percent less likely to have LW babies among whites and blacks, respectively. Interestingly, while both white and black male babies are heavier than female newborns, the baby's sex has no effect on the risk of LW among whites. Among blacks, however, male babies are 21 percent less likely to have LW.

Table 5 reports the results for VLW. Among white mothers, the risk of VLW decreases uniformly with more education at a constant rate of 13 percent per year. The only other significant predictor of VLW is state of delivery: white babies born in Connecticut are 77 percent less likely than those born in Virginia to be VLW. Among the blacks, years of schooling and state have no effect, and the newborn's sex has only a marginal effect on the probability of VLW. Married mothers are more than 50 percent less likely to have VLW babies than unmarried mothers.

When education is recoded as 0 to 8, 9 to 11, 12, 13 to 15, 16, and 17+ years of schooling, the main findings reported above are confirmed. However, several interesting observations emerge (the corresponding tables are not reported for brevity and are available upon request). In the analysis of birth weight, while (continuous) years of schooling had no effect on birth weight among Hispanics, on average, mothers with 13+ years of education gave

birth to babies 122 gm heavier than those of mothers with 0 to 12 years of education. Among black women, mothers with 13+ years of schooling have newborns which are 72 gm heavier than those born to mothers with 0 to 12 years of education. For both Hispanics and blacks, this was the only grouping of years of education that yielded significant differences. The differences among education levels are more pronounced among white mothers. The inverse U-shaped path of weight as a function of years of schooling found in Table 3 is repeated here, with the highest weight found among babies of mothers with college degree (16 years). Compared to mothers with complete high school education, those with elementary school education have newborns weighing 92 gm less. The newborns of those with incomplete high school education are, on average, 84 gm lighter. There is no significant difference between the weight of newborns to mothers with 0 to 8 or 9 to 11 years of schooling. Mothers with partial college (13 to 15 years) have 38 gm heavier newborns than those with complete high school. Mothers with complete college have 62 gm heavier babies than those with high school diploma. Mothers with some post graduate education have 43 gm heavier babies than those with 12 years of schooling, but a significant 20 gm less than those with 16 years of education.

While the recoding of years of schooling has not produced any further insight into the determination of LW among Hispanics, it revealed, among the black mothers, and confirmed, among the whites, the existence of a non-linear effect of education on the risk of LW. Black babies born to mothers with partial college education are 25 percent less likely to have LW than newborns to mothers with up to high school education. Babies born to mothers with college diploma are no different than those born to mothers with an elementary or high-school diploma. This group, however, is quite small (5 percent), and this result is not reliable. Among whites, the results confirm the effect of

education on the probability of LW found earlier (Table 4). Compared to newborns to mothers who have completed 12 to 15 years of schooling, newborns to mothers with 0 to 8 years of education are 78 percent more likely to have LW; newborns to mothers with 9 to 11 years are 47 percent more likely, and newborns born to mothers with a college degree are 28 percent less likely, to have LW. As was found for the black population, newborns born to mothers with very high education (17+ years of schooling) are more likely to have LW than those born to mothers with high education (16 years).

Recoding years of schooling did not, in general, cause an essential change in the estimated effects of the other variables. However, the effect of age on the risk of LW has changed among Hispanics and whites, because of the change in the correlation between age and education (see below). Among Hispanics, the age effect is now significantly negative, with each year of age reducing, on average, the risk of LW by 6 percent. Among whites, the age effect is constant positive, though only marginally significant. The only further insight with respect to the effect of education on the probability of VLW is that for whites, the negative effect of education found in Table 5 concentrates on the differences between women with 0 to 8 and those with 16+ years of schooling.

We then proceeded to replicate the original analyses (including all women, ages 13 and above, Tables 3 to 5) for two separate age groups: women 19 and above (19+) and women 23 and above (23+). Here again, for brevity, only the main results will be discussed (the complete tables are available upon request). Among white mothers aged 19+, the effects of education and age on birth weight are similar to those among women aged 13+. Among those aged 23+, the (variable) marginal effect of years of schooling is higher — for any level of education — than among the other two age groups. For

example, the marginal effect of education at 8 years is 51 gm among women aged 23+ vs. 37 gm among women aged 13+ and 19+; at 12 years -27 gm vs. 13 gm; at 16 years of schooling 0 vs. -11, and at 22 years of schooling the marginal effect of education is -33 gm vs. -47 gm among women aged 13+ and 19+. In other words, the marginal benefit of education in terms of one's newborn's weight is higher among older women, who have more likely completed their education. The effect of age on birth weight is constant at a level of -26 gm per year among white mothers aged 23+.

Among black mothers, the marginal effect of education is approximately the same across the three age groups. It is 15 gm among those aged 13+; 13 gm (only marginally significant) among those aged 19+; and reaches 18 gm in the 23+ age group. The marginal effect of age remains insignificant in all three age groups

Among whites, the pattern of the education effects on the likelihood of low weight is similar to the one found in the analysis of birth weight, namely, the older the sample the greater the effects for any level of schooling. Among black women, the effect of education on the probability of LW has become nil, and the age effect has increased from 2 percent to more than 3 percent with raising the age of the sample from 13+ to 19+ and to 23+.

Among white women aged 23 and above, the only change in the risk for VLW is in the effect of education, and in the same direction found for weight and the risk of LW. The rate of decrease in the risk of VLW per year of schooling increased from 13 percent among those aged 13+ to 15 percent among mothers aged 19+ and to 18 percent among those aged 23+. Among blacks, education continues to be unimportant, but the rate of increase in the risk of VLW per year of age has almost doubled from about 6 percent in the younger samples to more than 11 percent among women aged 23+.

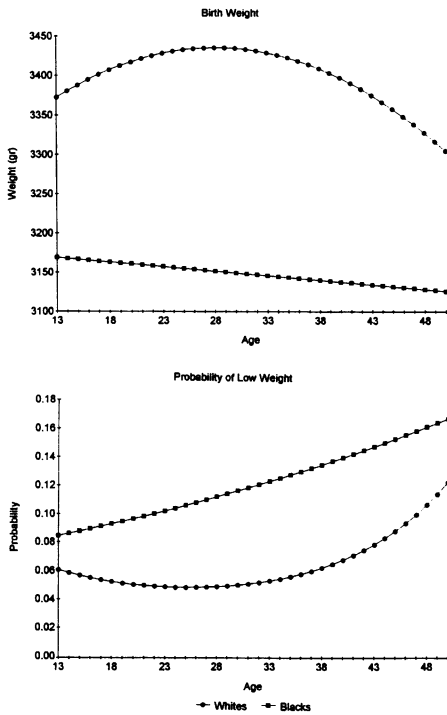


Figure 1. Birth outcomes and maternal age.

DISCUSSION

Figures 1 to 4 summarize the effects of maternal age and schooling on birth weight and LW graphically. In all figures, the predicted birth outcomes are derived from the relevant estimated equations, with all other covariates taken at their mean values. Figures 1 and 2 portray the effects of age and schooling, respectively, when education is measured by years of schooling (note that a similar pattern of effect was found using a categorical measure of education). Figures 3 to 4 show the effect of schooling among the three age groups (13+, 19+, and 23+).

Figure 1 would appear to support Geronimus' hypothesis regarding the paradoxical (at least relative to whites) decline in birth weight with age among black

women [19]. With advanced maternal age, both birth weight decreases and the chances of having a low or very low weight newborn increase. As Geronimus suggests, this may be the reason for the generally lower maternal age in blacks, as in our data. For white women, the maximal weight occurs at maternal age around 30. The minimum low weight risk age is about five years earlier. Giving birth after age of 40 — when about 10 percent of the women in our study gave birth — is subjected to a risk of low weight, which is 50 percent higher.

Figure 2 depicts the "return" for education in terms of birth outcomes. Here again, the relationships are linear for blacks and non-linear for whites. For black women, the probability of having low weight babies decreases by 50 percent

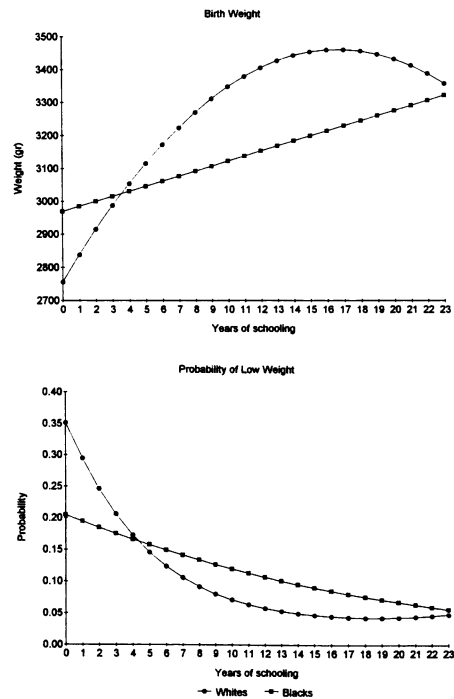


Figure 2. Birth outcomes and maternal education.

between graduating high-school and college. Mean birth weight increases by 6 percent. For white women, the optimal level of schooling (with respect to birth weight) is about 16 years, namely college education. Further education “costs” in terms of lower expected birth weight and higher risk of LW. Note that the estimated dramatic worsening of birth outcomes with very low education among white mothers, though, is based on small number of cases and is less reliable.

Although repeatedly found as positive, the explanation for the education effect on health has been controversial. Fuchs [20], for example, argues that educated people are “investors,” who are investing in their (and their offsprings’) health as well, both in terms of healthy

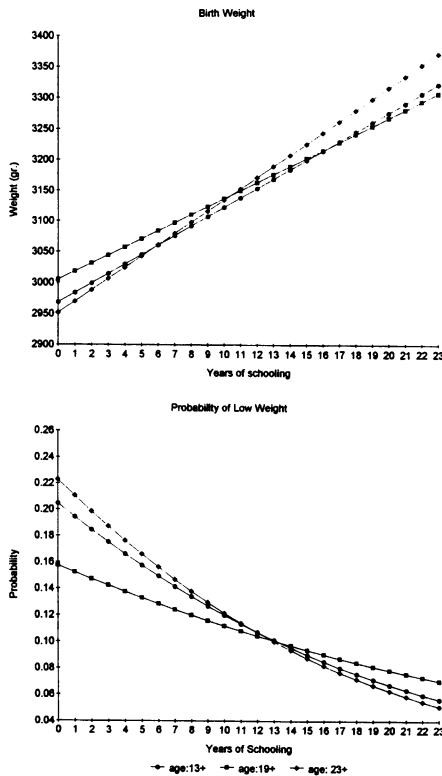


Figure 3. Birth outcomes and maternal education by age groups: black women.

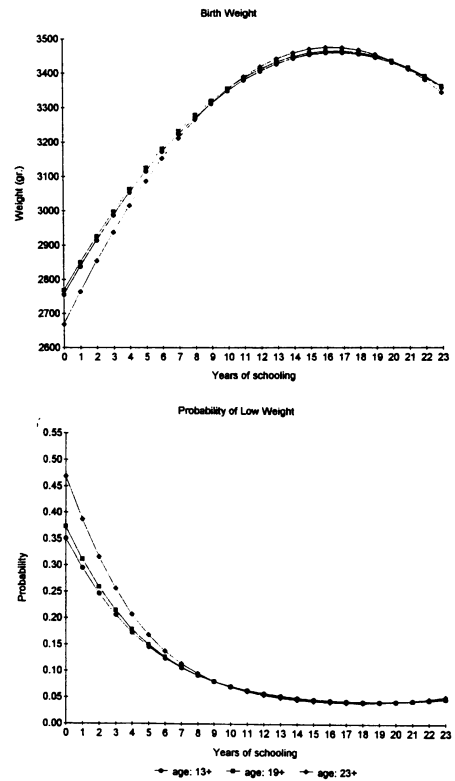


Figure 4. Birth outcomes and maternal education by age groups: white women.

behavior and use of (preventive and prenatal) health services. Several researchers have indeed treated the mothers’ inputs to the newborn health (smoking and prenatal care) as choice variables. In some cases the direct education effect on weight has vanished when these covariates are known and adjusted for [21] but in others, and more recently, education itself remains significant [22]. If, however, higher education exercises its effect on birth weight only through an increased demand for inputs, this effect should have been monotonic. The present findings indicate that this is true for blacks. Among white women, very high education has an adverse effect on birth outcomes. So it is either that very highly educated mothers invest “too much” (to the point where the marginal product of the inputs is nega-

tive), or that their health endowment is lower. Although possibly living more healthy lifestyles in some respects, women with postgraduate education may hold jobs associated with more stress resulting in worse birth outcomes [1]. As Rosenzweig and Schultz [23] have observed, this pattern of advanced education effect may be expected to become more pronounced in the future. Unfortunately, our data do not include information on smoking, stress, and the use of prenatal care to explore further these issues.

Naturally, there is a technical correlation between age and years of schooling originating from the fact that some women gave birth — planned or not — while studying, and some women discontinued their studying because of the birth. Such a correlation might confound the estimated effects of age and education. However, women who gave birth while studying are usually relatively young, in high school or in college. For all ages, the correlation between age and years of schooling at giving birth is 0.490 for whites and 0.421 for blacks. Among those aged 19+, these correlations decrease to 0.404 and 0.222, respectively. Among those aged 23+, these correlations are 0.278 and 0.128, respectively. Comparing age at birth with the computed age at leaving school (six plus the number of years of schooling), we get that 7.5 percent are in the range of +1 to -1 years difference, 70 percent of whom have completed high school. It seems that about 5 percent of the mothers in the study gave birth upon completing high school, and less than 3 percent did so while studying in high school or in college.

Due to lack of information in the data, we are unable to rigorously study the issue of the endogeneity of the level of education and age at giving birth, namely, to account for them being, in many cases, choice variables [24]. However, the small fraction of women giving birth while studying indicates that probably the decision to give birth is conditional, in most cases, on educational decisions. In Figures

3 and 4, we see that the issue is not so important among white mothers, but has several implications among the black mothers. Figure 3 demonstrates that, among white mothers aged 23+, those with very low level of education (0 to 8) have babies with lower weight (and higher chances of LW) than younger mothers with similar educational achievement. This means that the negative effect of age (over 30) on birth outcomes (Figure 1) is most pronounced for women with low education. These women seem to undergo relatively more rapid and sharp age-related deterioration. Among black mothers (Figure 4), excluding mothers whose college education might have been prevented (postponed?) by the birth by restricting maternal age to 19+, leads to better predicted outcomes for 9 to 12 years of schooling. Excluding mothers whose graduate education might have been prevented (postponed?) by the birth by restricting maternal age to 23+ leads to better predicted outcomes for 13 to 16 years of schooling. This means that the mothers whose education was potentially interrupted by the birth are not of a “higher education type” (higher ability, for example, which might be positively correlated to birth outcomes) but, on the contrary, there is some unobservable characteristic associated with giving birth during school that is negatively correlated with birth outcomes. Put differently, the “true” effect of education is related to better outcomes (described by the predicted outcomes among mothers aged 19+ for 9 to 12 years of schooling and among those aged 23+ for 13 to 16 years) than the outcomes predicted when “interruptions” are included. For black women, as was found for white women, the negative effect of age is more pronounced for women with low education level

Note, however, that we do not have data on birth number or parity. It is probable that for women whose education was interrupted and for younger women the birth is the first one.

Two further maternal characteristics show significant effects on the birth outcomes in our data: state of delivery and marital status. Connecticut white babies are heavier than Virginia white babies. Loprest and Gates [25] provide some comparative statistics that may explain the interstate differences. In 1988, while 4.18 percent of birth giving mothers received either no or only late prenatal care in Virginia, while the Connecticut rate was only 3.44 percent. In 1990, the Connecticut median income was 20 percent higher than that in Virginia. While the percentage on Medicaid was about the same, the rate of the uninsured in Virginia was 1.5 higher than that in Connecticut. It seems that the interstate difference in birth outcomes is related to differences in income, insurance coverage, and use of prenatal services. The rates of female smokers aged 20+ in the two states are quite similar: 20.7 percent in Connecticut and 22 percent in Virginia [26].

As has been found in several other studies, newborns to married mothers — both white and black — are more than 100 gm heavier than those born to unmarried mothers. Married mothers are, in general, wealthier, have greater insurance coverage, use prenatal services more often, and their pregnancies are more likely to be “wanted” [11, 12].

We acknowledge that while the present data base is large and recent, it suffers from limited information on many factors known to have a direct causal impact on birth weight such as prematurity, intrauterine growth retardation, maternal height and weight, smoking, parity, and previous birth outcomes. Each of these factors has been proven to affect birth weight and the probability of low and very low birth weight outcomes [1]. It is plausible, even likely, that these factors are distributed unevenly, with more adverse risk among the less educated, probably poorer women. As such, each is a potential candidate for explaining part or all of the SES relationship demonstrated in our analysis. Less likely, each could potentially confound

some of our observations, such as the interactions among age, education, and race. In either event, inferences suggested by the results of this paper should be made cautiously, as hypotheses for further study rather than definitive.

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