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Final Paper - Low Birth Weight and Lifetime Exposure to Poverty

Early childhood health has long been the subject of a well-established epidemiologic literature that has studied health status at birth as an indicator of early and late-life health outcomes. Low birth weight (less than 2500 grams at birth) is often cited as a strong indicator of early childhood health and a powerful predictor of an infant's life outcomes during their first year of life (Luke et al. 1993). The inverse relationship between neonatal and post neonatal infant mortality and birth weight can be clearly seen in data stored in the National Vital Statistics System[1]. The infant mortality rate of babies born in 2018 was 1.99 per 1000 for those weighing over 2500 grams, 13.26 per 1000 for those weighing between 1500 and 2500 grams, and 207.07 per 1000 for those weighing under 1500 grams (Ely and Driscoll 2020).

In addition to studying first-year health outcomes, early epidemiologic research has linked poor development during prenatal and postnatal life stages with a variety of late life health complications. These have been found to range from cardiovascular disease and stroke to schizophrenia and obstructive lung disease (Barker 1990). More recently, a study of Danish conscripts between 1973 and 1975 found that, on average, low birth weight individuals scored

[1] It may be worth noting that findings from twin studies paint a slightly different picture, with findings that show little to no relationship between low birth weight and infant mortality (Black, Devereux, and Salvanes 2005). However, it may be difficult to generalize these results to larger populations given the sample size limitations inherent to twin studies.

significantly lower on a cognitive test at age twenty than did their normal birth weight counterparts (Sorensen et al. 1997). Despite criticisms levied towards the more correlational nature of these findings, researchers across several disciplines have mounted substantial efforts to study the relationship between health in the very early stages of life with outcomes that occur in the later stages of life (Almond and Currie 2011).

One such academic discipline can be found in the field of economics. A growing economic literature has been studying the lasting effect that unequal health at the "starting gate" of life can have on socioeconomic outcomes that manifest in the later stages of an individual's lifetime. A study of intergenerational sibling data found that low birth weight had a significant negative impact on an individual's likelihood of graduating high school by their 19th birthday (Conley and Bennett 2000). A study of Norwegian twins estimated that a 10 percent increase in birth weight was associated with a significant 1 percent increase in early adulthood earnings[2] (Black et al. 2005). Likewise, a study of Swedish twins estimated a similar link between birth weight, early adulthood earnings[3] and permanent income[4] (Bharadwaj et al. 2015). In both twin studies, the estimated relationships between birth weight and earnings were positive and statistically significant. These results, among others, seem to strongly suggest that health inequalities at birth can persist and have far-reaching effects upon an individual's socioeconomic status during the later stages of their life.

[2] Black et al. study individuals aged 23-33.
[3] Bharadwaj et al. define early adulthood as the age range 25-33.
[4] Bharadwaj et al. define permanent income as income earned within the age range 35-45.

A seemingly natural extension of this literature might include a discussion of the relationship between birth weight and lifetime exposure to poverty. Unfortunately, poverty implications appear to be an underexplored area of the surveyed economic literature. A number of papers have studied the effect of parental poverty upon the likelihood of a low weight birth event (Conley and Bennett, 2000; Costa, 1997). Few, if any, appear to have explicitly studied the relationship between an individual's birth weight and their relative risk of exposure to poverty. As such, the remainder of this paper will be dedicated to an exploratory study of the relative risk of later life exposure to poverty among low birth weight individuals.

The data used in this exploratory study is sourced from the National Longitudinal Surveys (NLS) website. The NLS is a data collection program sponsored by the U.S. Bureau of Labor Statistics which encompasses a number of long-running surveys that gather information on a nationally representative sample of individuals over multiple years. The data collected by the NLS covers a wide range of socioeconomic and health-related factors including, but not limited to, birth weight, income, and educational attainment. The NLS website provides a suite of tools which allow users to extract public use data through customizable data sets. This study focuses on a particular survey known as the NLSCYA which has biennially followed the biological children of the women surveyed in the original NLSY79 surveys.

The economic literature features a number of methods for treating this form of data, most of which involve different ways of addressing the endogeneity of birth weight. Some studies analyze identical twins as a way to control for potential differences in prenatal conditions and genetic endowments (Black et al. 2005, Bharadwaj et al. 2015). It is easy to see why twin studies might appear to be attractive, given their ability to achieve higher degrees of internal validity. However, this advantage often comes at the cost of poor external validity due to the fact that twin births only make up one to two percent of all births (Johnson and Schoeni 2011). An alternative approach involves comparing sibling pairs born to the same mother. Studies that implement sibling fixed effect models similarly attempt to control for genetic and environmental factors that can vary across different families, though perhaps not to the extent that twin fixed effect studies can (Conley and Bennett 2000; Johnson and Schoeni 2011).

This study forgoes both of these methodologies in favor of implementing a set of relatively simple, if somewhat crude, logistic regression models. Though the importance of pursuing internal validity is difficult to understate, there is also some value to be found in simple exploratory studies. Developing a base of insight and background information can lead to better informed study design and illuminate avenues for future research. This particular approach is likely to expose my results to a good deal of unobserved variable bias. These concerns can be addressed in follow-up studies upon the conclusion of this preliminary study.

Two logistic regression models were built upon data from the most recent 2018 NLSCYA questionnaire with the goal of studying the associations between variables within the data. After cleaning and processing the NLSCYA dataset, I began by defining a binary response variable representing a respondent's exposure to poverty. I accomplished this by applying federal poverty thresholds to their reported total income, as well as by using records of their participation in federal low-income assistance programs such as the Supplemental Nutrition Assistance Program (SNAP), Temporary Assistance for Needy Families (TANF) and Aid to

Families with Dependent Children (AFDC). I proceeded to generate a series of dummy variables to control for respondent birth weight, race, sex, and educational attainment. I then created a subset of the data to focus on respondents born in the year 1991 or earlier. This was done in the interest of exploring the effects of low birth weight on later life outcomes for individuals aged thirty or older.

The two logistic regression models used in this analysis differ based on the number of independent variables they utilize. The first model regresses the binary response variable associated with poverty exposure upon the low birth weight dummy variable. The second model includes a number of variables associated with race, sex, and educational attainment in order to control for potential confounders. The first model seeks to establish whether any significant connections can be drawn between an individual's lifetime exposure to poverty and their weight at birth. The second model is intended to examine whether any detected effects remain significant once other factors linked to lifetime outcomes are introduced. Specific details and documentation on each model can be found in Appendices A and B towards the end of the paper.

The results produced by the first model appear, initially, to be quite promising. The low birth weight dummy is statistically significant with a p-value of 0.028 and has a positive coefficient with a value of 0.294. This would suggest that weighing 5.5 pounds or less at birth is associated with a 0.294 increase in one's log odds of being exposed to poverty relative to normal birth weight individuals. Alternatively, being born of low birth weight is associated with a likelihood of exposure to poverty which is approximately $e^{0.294}$ or 1.342 times higher. The table below provides a brief summary of the first model.

Model 1 Summary:			
(All Variables)	Estimate	Std. Error	P-Value
Intercept	-0.334	0.040	< 2e-16
Low Birth Weight	0.294	0.133	0.028

Interestingly, the story changed once additional controls for race, sex, and levels of educational attainment are added to the equation. The inclusion of these additional variables within the second model rendered the low birth weight dummy statistically insignificant with a p-value of 0.862. While the relevant coefficient was still positive, it had a much smaller value of 0.026, which suggested that the direct effect of low birth weight upon lifetime exposure to poverty had all but vanished. The coefficient on the sex dummy was positive and statistically significant. Here, this implied that being born as a female was associated with a higher relative risk of lifetime exposure to poverty. The coefficients on the various race variables were somewhat of a mixed bag, but it was interesting to see that the coefficient on being nonblack/non-Hispanic was negative and statistically significant. The coefficients on the various levels of educational attainment were all negative and, for the most part, statistically significant. In particular, the coefficient on post-high school vocational training was relatively small in absolute terms at -0.723 and was statistically insignificant, whereas the coefficient on earning a bachelor’s degree was relatively large in absolute terms at -2.740 and was statistically significant. This result suggested that educational attainment tended to lower one's relative risk of lifetime exposure to poverty, with higher levels of educational attainment being associated with a greater reduction in said risk. The table below provides a brief summary of a few variables from the second model.

Model 2 Summary:			
(Selected Variables)	Estimate	Std. Error	P-Value
Intercept	0.866	0.490	0.077
Low Birth Weight	0.026	0.147	0.862
Hispanic	0.095	0.113	0.400
Nonblack/Non-Hispanic	-0.285	0.109	0.009
Female	0.848	0.087	< 2e-16
High School Graduate	-0.981	0.492	0.046
Vocational Training	-0.723	0.554	0.192
Bachelor's Degree	-2.740	0.499	3.87e-08
Master's Degree	-3.132	0.535	4.92e-09

Thus far, the results appear to show that low birth weight is a relatively poor predictor of lifetime exposure to poverty. Assuming that the models were reasonably well-defined and observational counts were adequate, there may be a number of reasons as to why this might be the case. It is possible that low birth weight is a poor predictor of exposure to poverty, but a strong predictor of total income. This would track, somewhat, with findings among the surveyed literature which indicate that low birth weight individuals tend to go on to earn lower adult incomes and realize worse labor market outcomes than their normal birth weight counterparts. Following this line of reasoning, it seems plausible that low birth weight could have a negative effect on total income, but perhaps not to the extent that the relevant population is significantly more likely to experience poverty over the course of their lives.

Additionally, it may be the case that low birth weight has an indirect effect on lifetime exposure to poverty through its influence on an individual's educational attainment. A sibling fixed effect study conducted by Conley and Bennett found low birth weight to have a significant negative effect on an individual's likelihood of graduating high school in a timely fashion (2000). Admittedly, it would be difficult to extrapolate from this rather specific result and infer the effects of low birth weight on an individual's likelihood of pursuing higher education. However, it seems to advocate for the plausible existence of the indirect effect mentioned earlier, insofar as the study seems to suggest that low birth weight is somewhat related to academic performance. These topics could potentially serve as interesting avenues for future research.

To conclude, this study aims to explore the relationship between low birth weight and lifetime exposure to poverty. Initial findings from the logistic regression models indicate that while low birth weight may be associated with a higher likelihood of poverty exposure, this effect is rendered insignificant once control variables pertaining to race, sex, and education are factored in. Going forward, it would be interesting to apply different analytical methodologies and preparation methods to the NLSCYA dataset. For instance, one might expect to see some slightly different results by implementing dynamic multi-period models to track individuals over time.

As previously discussed, a relatively dense literature has studied how low birth weight can affect a wide range of earlier life outcomes ranging from higher first year mortality rates to lower cognitive performance at age twenty (Luke et al. 1993, Sorensen et al. 1997). A few studies have even ventured to examine the effect of low birth weight on life outcomes during adulthood, finding negative effects on income and health (Black et al. 2005, Johnson and Schoeni 2011, Bharadwaj et al. 2015). Few, if any have directly addressed the issue of lifetime exposure to poverty, so the hope is that this paper may serve as a small step in this direction. While the results here may not have been the most groundbreaking or conclusive, I hope they can contribute somewhat towards a more comprehensive understanding of the long-run implications of early life circumstances when placed in context of the existing literature.

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Appendix A: Model 1 Summary Output (RStudio)

Call:

glm(formula = impov ~ birthweight_low,

family = "binomial", data = sub)

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.160	-1.039	-1.039	1.322	1.322

Coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	-0.33413	0.03951	-8.456	<2e-16 ***
birthweight_low	0.29364	0.13328	2.203	0.0276 *

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 3926.1 on 2880 degrees of freedom

Residual deviance: 3921.3 on 2879 degrees of freedom

AIC: 3925.3

Number of Fisher Scoring iterations: 4

Appendix B: Model 2 Summary Output (RStudio)

Call:

glm(formula = impov ~ birthweight_low + factor(highest_school) + factor(race) + female,
    family = "binomial", data = sub)

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.9135	-0.9809	-0.4674	1.0264	2.2918

Coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.86577	0.49039	1.765	0.077483 .
birthweight_low	0.02560	0.14725	0.174	0.861958
factor(highest_school)2	-0.17798	0.49936	-0.356	0.721535
factor(highest_school)3	-0.98052	0.49247	-1.991	0.046478 *
factor(highest_school)4	-0.72337	0.55432	-1.305	0.191901
factor(highest_school)5	-1.29780	0.51467	-2.522	0.011682 *
factor(highest_school)6	-1.44223	0.49282	-2.926	0.003428 **
factor(highest_school)7	-1.73830	0.49850	-3.487	0.000488 ***
factor(highest_school)8	-2.74030	0.49854	-5.497	3.87e-08 ***
factor(highest_school)9	-2.20748	0.66323	-3.328	0.000873 ***
factor(highest_school)10	-3.13242	0.53548	-5.850	4.92e-09 ***
factor(highest_school)11	-2.34197	0.76950	-3.043	0.002339 **
factor(highest_school)12	-3.93974	1.14495	-3.441	0.000580 ***
factor(highest_school)13	-2.05182	1.28849	-1.592	0.111290
factor(highest_school)14	-2.69090	0.74364	-3.619	0.000296 ***
factor(race)2	0.09503	0.11280	0.842	0.399550

factor(race)3	-0.28453	0.10882	-2.615	0.008930 **
female	0.84757	0.08694	9.749	< 2e-16 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 3926.1 on 2880 degrees of freedom

Residual deviance: 3392.7 on 2863 degrees of freedom

AIC: 3428.7

Number of Fisher Scoring iterations: 5