**PRENATAL CARE AND BIRTH ORDER EFFECTS**

Shawna Kolka

This paper examines a possible channel for the negative effect of birth order on long-term economic outcomes. It evaluates whether mothers’ behavior during pregnancy varies with birth order, and whether this variation in behavior produces birth order effects on birth outcomes (in particular birth weight and the likelihood of pre-term delivery). OLS regressions with fixed effects for child birth year suggest that mothers are significantly less likely to engage in various healthy behaviors during higher order pregnancies. Birth order is positively associated with birth weight; once controls for mothers’ behavior during pregnancy are added this positive association becomes larger in magnitude. This suggests that variation in mother behavior during pregnancy reduces the positive effect of birth order on birth outcomes.

I. INTRODUCTION

Researchers have long noticed a negative correlation between family size and economic outcomes. For years it was thought that this correlation was a function of a “quality-quantity trade-off” governing childrearing. For instance, Becker & Lewis (1973) proposed that parents had a limited amount of resources available to produce a quality child, and that as the number of children in a family rose, the amount of quality-producing resources allocated to each child fell. A large body of work has developed in support of this thesis, with research finding that an increased number of children per family is negatively correlated with a multitude of outcomes ranging from birth weight to educational attainment (Hanushek, 1992; Rozenweig & Wolphin 1980; Rozenweig & Schultz 1987; Schultz 2005).

More recent research, however, suggests that something other than a quantity-quality tradeoff may be responsible for the negative relationship between family size and economic outcomes. Angrist, Levy & Schlosser (2010) revisited the quantity-quality tradeoff model using more rigorous instruments to control for endogeneity than previous studies. Using twins and sibling sex composition as instruments for exogenous increases in family size, they found that, contrary to the predictions of the quantity-quality tradeoff model, there were no significant effects of an increase in family size on the economic outcomes of older siblings. These findings make sense in light of recent research that suggests that family size effects can in large part be explained by the effect of birth order on economic outcomes. Several studies have found that children born first in a family exhibit significantly better outcomes than the siblings born after them. Generally, first born children have approximately the same average outcomes regardless of family size. The same holds true for second-born children, and so on. However, outcomes are significantly lower for 3rd-born children than for 2nd-born children, and lower for 4th-born children than for 3rd born children, and so on. The effects of being born later rather than earlier become increasingly larger with each increase in birth order. When birth order effects are controlled for, the effects of family size become negligible. It appears that the negative relationship between family size and average outcomes can be explained by the lower outcomes of higher order children in large families – their lower outcomes drag down averages in large families (Black, Salvanes & Devereaux 2005; Gary-Bobo, Prieto & Picard 2006).

This paper explores one possible cause for the existence of birth order effects: variation in prenatal care. It examines whether women’s behavior during pregnancy varies with birth order, and, if it does, whether or not this variation in behavior could play a role in producing birth order effects. Little has been done to explain birth order effects so far, but one study by Price (2008) suggests that, cumulatively, parents spend significantly less time with each successive child. The extra time that older children spend with their parents, especially during their developmentally crucial younger years, could be partially responsible for a birth order effect. Given Price’s findings, it seems reasonable to suspect that higher birth order children get less time and attention even before birth: mothers might invest less time and energy into health precautions during pregnancy with higher order births. There are several plausible explanations for mothers might behave this way. Women might not be able to take care of themselves as well during higher order pregnancies because of constrained resources or exhaustion. Similarly, having been through the pregnancy process before, they might not feel the need to be as careful with their health. If, as expected, the quality of a mother’s prenatal care becomes lower with each successive birth, this could be evidence for a possible channel for birth order effects. A negative relationship between prenatal care and birth order could merely corroborate Price’s findings that high birth order children receive cumulatively less of their parents’ attention, and this lack of attention manifests itself through lower economic outcomes. More insidiously, variations in mothers’ behavior during pregnancy by birth order could have directly observable effects on prenatal development. Variations in a mother’s behavior could cause higher birth order babies to be born with poorer birth outcomes than their older siblings, which could play a role in producing long-term birth order effects.

First, in order to test whether prenatal care varies with birth order, this paper estimates how the likelihood of a woman engaging in various “healthy” pregnancy behaviors changes with birth order. Combining data from the National Longitudinal Survey of Youth (NLSY) 1979 Survey and the NLSY Child and Young Adult survey, OLS regressions were used to estimate the likelihood of a mother engaging in several different activities during pregnancy: drinking, smoking, *reducing* drinking, *reducing* smoking, reducing salt intake, taking vitamins, and initiating medical prenatal care in the first trimester. In regressions that included the entire sample but controlled for family size there was strong evidence that with each additional pregnancy mothers were more likely to smoke and drink and less likely to reduce smoking, reduce drinking, take vitamins, initiate prenatal care in the first trimester and reduce salt intake. When the sample was separated by family size and separate regressions were run for each family size, the evidence for variation in behavior became weaker, but the magnitude and direction of the coefficients in most of the regressions still suggested the presence of a birth order effect on mothers’ behavior during pregnancy.

Second, two more tests were conducted in order to gauge whether or not variations in pregnancy behavior might have directly observable effects on birth outcomes. Pre-term delivery and birth weight were used as measures of birth outcomes (where a higher birth weight signals a positive outcome and a pre-term delivery signals a negative outcome). While OLS estimates of birth order on pre-term delivery were inconclusive, an OLS regression of birth weight on birth order found that birth weight in fact increases with birth order. When the seven tested behaviors are added into the regression as controls, the coefficients on birth order increase in magnitude. This suggests that variations in mothers’ pregnancy behavior may result in higher order babies weighing less than they would have naturally. In other words, higher birth order babies seem to naturally weigh more at birth than low order babies. Mothers’ behavior during pregnancy seems to reduce how much more high birth order babies weigh at birth than low birth order babies.

This suggests that lower quality prenatal care may not produce birth order differences in birth outcomes, but may serve to reduce a natural advantage of high birth order babies. This reduced advantage could put higher order children at a disadvantage down the road. For instance, if, after birth, higher-order children receive less attention and resources than their older siblings, this could produce the negative effects of birth order on future outcomes. Perhaps higher-order children would be even worse off if they had not been born heavier (in that heavier babies are assumed to be healthier) than their older siblings. Thus, by reducing the amount by which higher-order children weigh more than their older siblings at birth, variation in prenatal care could contribute to birth order effects.

II. BACKGROUND

Lower quality prenatal care is generally associated with poor birth outcomes. It is difficult to accurately measure “health at birth” for an infant, but several easily measurable items have been found to be good predictors of health at birth. For this study birth weight and pre-term delivery were chosen as the birth outcomes of interest. Infants with very low birth weights (usually defined as 2500g or less) face a much higher risk of mortality than other infants. Furthermore, low birth weight has also been linked to a variety of poor health outcomes such as high blood pressure, cerebral palsy, deafness, and blindness, as well as with asthma and lung disease among children. Research has also found a correlation between low birth weight and poor cognitive development (Almond et. al 2005). Black, Devereaux & Salvanes (2007) used within-twin fixed effects to find that birth weight is significantly and positively correlated with long-term outcomes like height, IQ, education and income. Behrman and Rosenzweig (2004) conducted a similar study on twins and found similar results – higher birth weight twins had greater height, intelligence, educational attainment and income. Similarly, pre-term birth (defined as birth before 37 weeks of gestation) is another easily observable birth outcome. Pre-term delivery is considered to be a negative birth outcome, as it is associated with much higher mortality rates for infants that term birth (Goldenberg 1998).

Whether a mother initiated medical prenatal care within the first trimester of pregnancy was included as a tested behavior because of the importance of medical prenatal care to positive birth outcomes. For instance, Heaman & Co. (2008) studied the association between “inadequate” or no prenatal care as defined by two indices of prenatal care. They found associations between low birth weight and pre-term birth for no prenatal care on both indices. There was a significant increase in low birth weight and pre-term birth for inadequate care for one of the indices, though this was not significant in the other. On both indices no prenatal care or inadequate prenatal care was significantly predictive of a baby being small for gestational age.

The importance of prenatal care seems to stem partially from the fact that many women first receive advice about which behaviors are healthy for their baby during prenatal care visits. Prenatal care can have positive effects for the health of a baby, both through the advice women are given about healthy behavior and through the medical screenings conducted on the fetuses at these appointments – though perhaps especially through the advice about behavior alteration received at appointments. Kogan et. al. (1994) found that women who received sufficient advice on behavior alteration were significantly less at risk for having low birth weight infants compared to those who did not receive adequate advice. Evans & Liens (2004) studied low-income, high-risk pregnancy women affected by a brief bussing strike in Pennsylvania. They found suggestive (but not necessarily statistically significant) evidence that a couple of missed prenatal visits can have negative effects on birth outcomes. This evidence was strongest for missed prenatal visits early in a pregnancy and for the effect of prenatal visits reducing a mother’s smoking. This suggests that prenatal visits are most important to birth outcomes in the early stages of pregnancy, affect birth outcomes through the ways in which these visits encourage healthy behavior for pregnant mothers. Similarly, Subramanian & Co. (2011) studied intervention to reduce “behavioral and psychosocial risks” to pregnant African American mothers in Washington D.C. Initiation of early prenatal care (first trimester) significantly lowered the odds of giving birth to a baby that was small for gestational age.

As noted above, it seems that part of the way that prenatal care operates to produce healthy birth outcomes is by encouraging certain behaviors in pregnant women. Thus this study looked at many of the behaviors a woman engaged in during pregnancy. Both medical advice and common knowledge about healthy behavior during pregnancy has changed over the years. Some of these behaviors have been strongly linked to birth outcomes, whereas the link between others and birth outcomes is more dubious. For instance, until recently women were often advised to restrict their salt intake during pregnancy because it was thought to reduce the chance of pre-eclampsia. Actual research, though, has found little evidence of any benefits (or detriments) to salt intake during pregnancy, and this is rarely advised any more (Henderson-Smart 1999). Nevertheless, salt reduction was included as a behavior of interest in this study because many of the mothers would have been instructed by their doctors (or friends and family) to reduce salt intake. Consequently, whether or not a woman reduced her salt intake during pregnancy is a good measure of how much effort a woman was willing to expend on her pregnancy.

Another behavior tested in this study was whether women took vitamins during pregnancy. Pregnant women are also often advised to take prenatal vitamins, although data on the efficacy of such vitamins is mixed. Scholl & Co. (1997) studied the effects of taking prenatal vitamins during the first and second trimesters of pregnancy on low-income, urban women. They found that the risk of a pre-term baby was reduced two-fold by taking vitamins, and the risks for low birth-weight and very low birth-weight babies was also reduced. As Black (2001) points out in his review of the literature on micronutrients and prenatal outcomes, though, the research on vitamins and birth outcomes has not definitively linked specific vitamin supplements to positive birth outcomes, and much of the evidence seems to show that some vitamins (such as zinc and folic acid) need to be supplemented before conception in order to improve birth outcomes.

This study also looks at several measures of alcohol consumption during pregnancy. Women are generally encouraged to avoid alcohol completely during pregnancy, though the research on its effects on fetal growth is mixed. Most studies find that heavy drinking and binge drinking, even in early trimesters, is damaging to the fetus. Some studies show that moderate drinking is damaging to fetal development; Nearly all studies, though, are unable to find conclusive evidence that small amounts of alcohol exposure are detrimental to fetal development (Henderson, Gray, & Brocklehurst 2007; O’Leary et. al 2009; Jaddoe et. al 2007).

Other behaviors that women are advised against have been more definitely linked to poor birth outcomes, especially smoking. Brooke et. al (1989) demonstrated that there was a significant negative correlation between smoking and birth weight. Similarly, Hebel & Sexton (1984) demonstrated that a reduction in smoking in women who were already smoking in pregnancy significantly increased birth weight. Recent studies have not only confirmed the negative effects of smoking on fetal development but found a significant negative effect of second-hand smoke exposure on birth weight (Ward, Lewis & Coleman 2011).

A mother’s failure to alter any of these behaviors during pregnancy could have adverse effects on fetal development; if a mother’s compliance with these behaviors varies with birth order, it could be evidence that higher birth order children are developmentally at a disadvantage from the womb.

III. DATA & LIMITATIONS

The data used for this analysis come from the National Longitudinal Survey of Youth (NLSY), Child & Young Adult Survey. There are several advantages to using this data set. For one, data from the Child & Young Adult Survey can be matched with data from the NLSY 1979 to provide a rich supply of control variables for the mothers of the children in question. The NLSY asked mothers detailed and consistent questions about behavior during pregnancy over many years, with the latest survey being taken in 2008. Because the survey began with young adults in 1979, most of the women in the NLSY have completed their fertility, so information on birth order and family size should be fairly reliable.

The downside of the NLSY is its small sample size. The entire sample consists of over 11,000 child observations, but when separate regressions are run for each family size the sample becomes much smaller. Additionally, there were missing observations for several of the questions about pregnancy behavior, so the sample size for many of the regressions became very small.

There are also concerns about the attrition rate of the NLSY and the non-responses for several of the questions. There is no way to know if there was something systematically different about mothers who responded to some questions but not others. Attrition is a more serious concern – as of the last survey only 62 percent of the young women originally interviewed in 1979 filled out a questionnaire. This obviously raises questions about whether or not there was something systematically different about women who dropped from the survey. It also raises questions about the validity of the assumption that the current sample gives a picture of complete fertility – if a mother answered questions about her first two children and then dropped out of the survey before having six more children, her family will be categorized in this study as a “two-child” family. The point of separating families by family-size is to control for the effects of endogenously chosen family size – if too many families are incorrectly coded for family size this could undermine the validity of running separate regressions by family size.

Table 1 shows the number of children per family size. Families of two, three and four children are the most common in this sample. Because the sample size of families becomes so small after six children, all families with six children or more are combined into the “Six-Plus” category. Table 1 also summarizes relevant statistics about the children and their mothers. Two children were born in 2008, but over 99% of the children in the sample were born before 2001, indicating that this data set is a complete picture of lifetime fertility for most mothers in the sample.

Table 2 summarizes the variables of interest, including the tested behaviors and the measures of birth outcomes. For the measures of mothers’ behavior during pregnancy, each statistic is the proportion of mothers who engaged in a given behavior. For the variables measuring birth outcome, pre-term delivery is measured in terms of the proportion of children who were born pre-term, and birth weight is measured in ounces.





IV. APPROACH

An OLS regression will be used to estimate the effect of birth order on the likelihood that a mother engages in certain behaviors during pregnancy. The basic regression will estimate the probability of a mother engaging in behavior (i) during pregnancy dependent on the birth order of that child plus various mother-specific characteristics, or:

where the subscript *i* indicates one of the behaviors being tested, the subscript j indicates a child’s birth order ranging from 1 to 6 (where 6 includes births of order 6 or higher), and where is a vector of birth order dummies equal to 1 if j is the birth order of that child. is a vector of mother-specific characteristics including race, religion, age at birth, weight before pregnancy, whether she grew up in a rural area or not, and education. All regressions will include fixed effects for birth year to account for the changing information regarding prenatal care over the years, so the standard errors are clustered. Additionally, sample weights assigned to mothers in the initial year (1979) of the NLSY survey are used to account for oversampling of certain populations in the survey.

Several different behaviors will be tested: (1)whether the mother reduced salt intake during pregnancy, (2) whether the mother took vitamins during pregnancy, (3) whether the mother visited a doctor for prenatal care in the first trimester of pregnancy, (4) if a mother smoked in the 12 months before giving birth, (5) if, given that the mother smoked in the 12 months before birth, the mother reports that she reduced smoking during pregnancy, (6) if a mother drank in the 12 months before birth and (7) if, given that the mother drank in the 12th months before birth, a mother reports that she reduced alcohol intake during pregnancy.

As mentioned in the literature review, smoking has been conclusively linked to negative outcomes for infants. A test of a mother’s willingness to reduce smoking would thus be a good indication of both a mother’s effort and an example of how variation in effort might have negative consequences. Both (4) and (5) are included because (5) has the ability to capture the mother’s effort to engage in a healthy behavior during pregnancy. (5) is also included because the phrasing of question (4) in the NLSY seems to capture some women who smoked in the 12 months before giving birth but stopped when they became pregnant (because many of the women who answered “yes” to (4) answered “never” to a follow up question about how often they smoked during pregnancy). Thus there is a chance that the variable for “smoked during pregnancy” is not an accurate gauge of smoking behavior. Including the variable for “reduced smoking” will help to catch discrepancies and provide an additional measure of mother’s smoking to evaluate. The same rationale applies to why both items (6) and (7) were tested.

Additionally, in order to test whether variation in pregnancy behaviors might be partially responsible for producing birth order effects by affecting the in utero development of children, the effects of these tested behaviors on birth outcomes was tested. These regressions will measure the effect of drinking, smoking, reducing salt, taking vitamins and the early initiation of prenatal care on birth weight and a dummy for pre-term delivery (which is defined as one when length of gestation was less than 37 weeks). The purpose of these regressions were twofold: to (1) gauge whether or not these behaviors actually contribute to the birth of a healthy baby and to (2) gauge whether the variation in these behaviors accounts for birth order variation in birth outcomes. If the inclusion of mothers’ behaviors as controls changes the effect that birth order has on birth outcomes, there would be reason to believe that variations in mothers’ behavior during pregnancy by birth order plays a role in determining birth order effects.

V. RESULTS

A. Birth Order on Mothers’ Behavior During Pregnancy

OLS regressions were run separately for each tested behavior. In tables 4-10, the first column presents the results of a regression that included all children, without controls for family size. The second column presents the results of a regression that included all children with dummies variables as a control for each family size. In the next five columns the sample was separated by family size, and separate regressions were run for each family size. For instance, the third column presents the results of birth order on behavior only for families with two children.

Table 3 presents the regression results of birth order on the likelihood to reduce salt intake. In the first four columns, nearly every coefficient on birth order is significant at the α=0.05 level, indicating that a mother’s propensity to reduce salt intake did in fact vary with birth order. The coefficients are negative and large in magnitude. For instance, in a two-child family this indicates that while pregnant with her second child a mother was 11.6 percentage points less likely to reduce salt intake during pregnancy than she was while pregnant with her first child. This 11.6 percentage point difference seems especially large in magnitude when one considers that only approximately 53% of women in the sample reduced salt intake during pregnancy in the first place. Importantly, not only are the coefficients negative, but as birth order increases the magnitude of the coefficient on birth order tends to increase as well. According to these results, a mother was significantly and increasingly less likely to reduce salt intake during pregnancy for higher order births. For instance, a mother in a three-child family was only 6.97 percentage points less likely to reduce salt intake while pregnant with her second child than with her first, but 10.5 percentage points less likely to reduce salt intake while pregnant with her third child than with her first. In other words, a mother is less likely to reduce salt intake while pregnant with her second child, but even *less* likely to reduce salt intake while pregnant with her third child, and so on.

For families with more than four children few of the coefficients are significant, but this is hardly surprising given the increasingly small sample size for these larger family regressions. Even though most of these coefficients were not significant, though, it is interesting to note that they are still primarily negative and increasing in magnitude with birth order. Overall, the results in Table 3 suggest that mothers are increasingly less likely to reduce salt intake with each additional pregnancy.

The results in Table 4 are very similar to the results on salt reduction. Table 4 presents the regression results for the effect of birth order on a mother’s likelihood to take vitamins during pregnancy. Like the results for the effect of birth order on salt reduction, the coefficients for the first four regressions are highly significant. In addition, the coefficients for the third and fourth children in four-child families are highly significant. Again the coefficients are negative and increase in magnitude with birth order. These results suggest that, for instance, in a three-child family a mother is less 2.15 percentage points less likely to take vitamins than she was when pregnant with her first child, and 4.49 percentage points less likely to take vitamins wen pregnant with her third child than she was when pregnant with her first. While the magnitude of these coefficients is much smaller than the magnitudes of the coefficients in Table 3, considering that over 96% of mothers in the sample took vitamins during pregnancy, even a two percentage point decrease in the likelihood that a mother took vitamins seems to signal that mothers’ behavior was significantly different across birth orders.

As family size increases the coefficients become less significant, suggesting that the small sample size for large families may have something to do with the decreased significance. Again the coefficients are negative and generally increasing in magnitude, suggesting that mothers are significantly and increasingly less likely to take prenatal vitamins as birth order increases.

Figures 1 and 2 below illustrate the similar pattern found for the effect of birth order on propensity to reduce salt or take vitamins during pregnancy.

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Table 5 presents the results of birth order on the likelihood to initiate prenatal care in the first trimester. The results do not follow the same pattern as the results in Tables 3 and 4. While the results for higher order births tend to be highly negative and significant, the coefficients on the lower order births are rarely significant, and sometimes in the positive direction. The coefficient on children born second in a family is not significant in any of the regressions, and is in fact positive in some of the regressions.

Regardless, overall the coefficients on birth order are negative and tend to increase in magnitude as birth order increases. The general picture presented by this table is that mothers are increasingly less likely to initiate prenatal care in the first trimester with each successive birth.

Table 6 demonstrates the effect of birth order on a woman’s likelihood to smoke in the 12 months before pregnancy. Table 7 then illustrates the effect of birth order on a woman’s likelihood to reduce smoking during pregnancy, given she had indicated that she had smoked in the 12 months before pregnancy. Looking at the column two in Table 6, the coefficients on birth order are significant, positive and increasing. This suggests that a woman is significantly more likely to smoke



in the 12 months before giving birth with each successive pregnancy. Surprisingly, in the regressions that separate the effects of birth order by family size, the coefficients on birth order only remain significant for five- and six plus-child families (and only some of the coefficients in each of these regressions are significant). One possible explanation for this is that the effect of birth order on likelihood to smoke during pregnancy might just be much more pronounced in large families. The magnitudes of the coefficients on birth order for five- and six plus-child families may corroborate this story – the magnitudes of the coefficients are much larger for large families than for small families. For instance, a mother pregnant with her fourth child in a four-child family is 2.78 percentage points more likely to smoke than during her first pregnancy (although this coefficient is not significant), whereas a mother pregnant with her fourth child in a five-child family is 21 percentage points more likely to smoke. On the other hand, the magnitude of the coefficients on five- and six plus-child families is almost too large to be realistic, suggesting that the estimates for these families may not be precise (which could be a function of the small sample size for large families).

Turning to Table 7, it seems that in addition to being more likely to smoke in the 12 months before giving birth, mothers are less likely to reduce smoking while pregnant with each successive pregnancy. The coefficients in Table 7 are less consistently significant than in many of the previous tables, but as with smoking in Table 6, the effect of birth order on likelihood to reduce smoking seems most pronounced in large families. Again, though, the large coefficients on birth order in the regressions on large family sizes suggest that these estimates may not be precise for large families.

While the regression results on mothers’ smoking behavior during pregnancy do not present consistently significant or precise estimates of the effect of birth order on, taken together, the results from the several regressions in Tables 6 and 7 suggest a trend wherein mothers are more likely to smoke with each additional pregnancy, and less like to reduce smoking with each additional pregnancy.

Table 8 presents the effects of birth order on the likelihood of a mother drinking in the 12 months before giving birth. Table 9 subsequently lays out the effects of birth order on the likelihood a mother reduced drinking during pregnancy. Given what has been found in the previous tables, it is somewhat surprising to find that the coefficients on birth order for drinking in the 12 months before birth are negative and often significant. Few of the coefficients on the separate regressions for family size are significant, but the overall pattern is consistent. This table indicates mothers are less likely to drink in the 12 months before birth with higher order births.





On the other hand Table 9 suggests that despite mothers’ being less likely to drink during the 12 months before giving birth, those who did drink were less likely to reduce alcohol consumption during pregnancy with each successive birth. Few of the coefficients are significant, however, and while most of them are negative, the pattern of increased magnitude with increased birth order is not consistently present in the Table 9 results.

Overall, the results for a birth order effect on mothers’ drinking behavior during pregnancy are mixed. While the evidence suggests that mothers are less likely to drink during higher order pregnancies, it also suggests that those who do drink are less likely to reduce their alcohol intake during pregnancy.

B. Effects of Birth Order and Mothers’ Behavior on Birth Outcomes

The results in Section A suggest that there is considerable variation in mothers’ behavior during pregnancy by birth order. Most of the results suggest that mothers are less likely to engage in healthy behaviors during pregnancy for higher order births. Given these results, the next step is to try and test whether or not these behavior variations might be producing birth order effects in birth outcomes. Birth outcomes are linked to future health and economic outcomes, so birth order variation in birth outcomes could partially explain the existence of birth order effects on future economic outcomes. In order to evaluate whether mothers’ behavior during pregnancy might be producing birth order effects on birth outcomes, OLS regressions with fixed effects for birth year (keeping the standard errors clustered and using the sampling weights from the NLSY 1979) were run using two common measures of birth outcomes as dependent variables: pre-term delivery and birth weight. Dummies for birth order were used as independent variables, and mothers’ pregnancy behaviors were added in as controls in selected regressions. Controls for family size and other mother-specific characteristics were included in all regression, as were fixed effects for a child’s year of birth.

In Table 10 birth weight, in ounces, was the dependent variable of interest. All controls for mothers’ behavior were included in the regression presented in the second column of Table 10. In the next five regressions each control is included separately. Smoking, taking vitamins, initiating prenatal care in the first trimester and salt reduction all significantly affected birth weight. Given the research reviewed in the Background section of this paper, it was expected that smoking would negatively affect birth weight, and that vitamin intake and early prenatal care would positively affect birth weight. It is also unsurprisingly that there was no significant effect of the dummy for drinking during pregnancy on birth weight, as research has found little evidence that low to moderate amounts of alcohol affect fetal development (and low, moderate and heavy drinkers were coded the same for the drinking dummy variable in this regression). The positive and significant effect of salt reduction is surprising. However, data limitations prohibited controls for mothers’ health from being used, and the significance of salt may be a result of these missing controls. For instance, in the early stages of this paper a mother’s weight before pregnancy was included as a control variable; because so many mothers failed to answer this question it was dropped from the analysis. When it was included, though, salt was no longer significant.

The first column of Table 10 demonstrates that when no controls for mothers’ behavior during pregnancy are included, there are strong positive effects of birth order on birth weight. A child born second in a given family weighs, ceteris paribus, 2.57 ounces more than a firstborn child. As birth order increases, higher order children weigh increasingly more at birth than their oldest sibling. The magnitude of the coefficients on birth order increases as birth order increases, and all coefficients on birth order are significant, with the exception of the coefficients on children who are born fifth in their family. The coefficient for the fifth child is consistently not significant and much lower in magnitude than the many of the other birth order coefficients. A possible reason for this is reviewed in the discussion of Table 11. Overall, though, the results indicate that higher order children may just naturally be born heavier than their older siblings.

The results of the regression in the second column show that when the controls for mothers' behavior during pregnancy are included, the magnitudes of the coefficients on birth order increase. This suggests that in the absence of variation in mothers' behavior by birth order, higher birth order babies would have been born even heavier than they actually were. While variations in mothers’ behavior with birth order may not produce birth order effects on birth outcomes, they seem to reduce birth order effects. In other words, it seems that mothers’ reduced engagement in healthy behaviors during higher order pregnancies may be reducing a natural birth weight advantage of higher order children.

The magnitudes of the coefficients on the controls for mothers’ behaviors suggest a possible way that behavior variations according to birth order may reduce or reverse a natural advantage in birth weight for higher order children. For instance, looking at the second column, a child born second in a family should weight, ceteris paribus, 3.34 ounces more than a firstborn child. However a child whose mother smoked during pregnancy should weigh 6.48 ounces less than a child whose mother did not smoke (all else held equal). However, if a second-born child’s mother smoked during her second pregnancy but not her first (and Table 6 suggests that a mother is more likely to smoke during a later pregnancy), the negative effect of smoking would wipe out the positive effect of birth order on that child’s birth weight, and that child would actually weigh less at birth than the average firstborn child.

Table 11 shows the results of a similar series of regressions run with pre-term delivery as the dependent variable. Pre-term delivery is a dummy variable equal to one if the child was born before 37 weeks of gestation. The results of these regressions are much less significant that the regressions that used birth weight as a dependent variable. For the mothers’ behavioral controls, only smoking and early prenatal care have significant effects on the likelihood of being born pre-term. While overall it seems that children are less likely to be born pre-term as birth order increases, only the coefficient on birth order that is negative and significant is the coefficient on the third child in a family. The only other birth order coefficient that is significant is for the fifth-born child, and all coefficients on fifth-born children are positive and significant. All other birth order coefficients are negative, however. Thus the effects of birth order on the likelihood of being born pre-term are unclear.

Table 11 might help shed some light on the unusual coefficients on fifth-born children in Table 10, however. In Table 10 the coefficients on all birth order dummy variables were positive, significant and increasing in birth order with the exception of the coefficients on the fifth child. In Table 11 it appears that the fifth-born children in this sample were significantly more likely to be born pre-term than any other children. Children who are born premature weigh less; this prematurity could be responsible for the lack of significant and large coefficients on fifth children in Table 10. This raises a possible concern with use of birth weight as a measure of birth outcome. Birth weight varies with gestational age – several studies have suggested that a more accurate gauge of birth health is to measure whether a child’s birth weight is small for their gestational age – which suggests underdevelopment (Heaman et. al. 2008). Future studies that wish to evaluate the effect of birth order and mothers’ behavior during pregnancy on birth outcomes might be better served to use a measure of weight that controls for gestational age.



V. CONCLUSION

This paper investigates whether or not mothers’ behavior during pregnancy varied with birth order, and whether this variation could be effects on the development of the fetus to produce birth order variations in birth outcomes. The study was motivated by the desire to investigate the causes of the birth order effect on economic outcomes observed by Black, Devereaux and Salvanes (2005) and Gary-Bobo, Prieto & Picard (2006). Having tested birth order against the probability of engaging in various “healthy” pregnancy behaviors, it seems that women are less likely to engage in healthy behaviors with higher order pregnancies. Mothers are less likely to reduce salt intake, take vitamins, reduce smoking, reduce drinking and initiate prenatal care in the first trimester, and more likely to smoke in the 12 months before giving birth. When these behaviors are added as controls to a regression of the effects of birth order on birth weight, the positive effect of birth order on birth weight becomes larger. This suggests that variations in mothers’ behavior by birth order may not produce birth order differences in birth outcomes, but they may reduce the positive effect of birth order on birth outcomes.

What the implication of these results are for evaluating the role that variations in prenatal care play in producing birth order effects on economic outcomes is open to interpretation. One possible explanation is that variations in prenatal care do play a role in producing, or at the very least exacerbating, birth order effects on future outcomes. For instance, if, as Price (2008) suggests, higher-order children do receive less time and resources throughout childhood, then being naturally being born heavier (and thus, hopefully, healthier and better-developed) could have served to at least somewhat mediate the effect of receiving less investment during childhood. By reducing the amount by which higher birth order children outweigh low birth order children at birth, variations in mothers’ pregnancy behaviors might be contributing to the exacerbation of birth order effects. As of now it is impossible to verify this hypothesis; Further research is needed on both birth outcomes and birth order, as well as on other possible channels for the effect of birth order on long-term economic outcomes.

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