PRENATAL INVESTMENTS, BREASTFEEDING, AND BIRTH ORDER

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Abstract

- Objective: Using a panel data set that allows us to observe mothers' behavior across births, we show differences in investments in health and in the incidence of breastfeeding by birth order.

- Methods: Data are from the National Longitudinal Study of Youth 1979 (NLSY79) Child and Young Adult Survey, which provides detailed information on pre- and post-natal behaviors of women from the NLSY79. The sample includes births between 1973 and 2010. We use fixed effects regression models to estimate within-mother differences in pre- and post-natal behaviors across births.

- Results: Mothers are significantly and increasingly less likely to take prenatal vitamins, reduce salt intake, receive prenatal care in the first trimester, and breastfeed for higher-order births. Mothers are 7 percent less likely to take prenatal vitamins in a fourth or higher-order birth than in a first and are 11 percent less likely to receive early prenatal care. Mothers are 15 percent less likely to breastfeed a second-born child than a first, and are 21 percent less likely to breastfeed a fourth or higher-order child. These results are not explained by changing attitudes toward investments over time.

- Conclusion: Our results show that women are less likely to make investments in their health and that of their children in higher-order pregnancies. This finding suggests that providers may want to target efforts to increase these behaviors at women with higher parity. The results also identify a potential mechanism for the emergence of differences in health and other outcomes across birth orders.

Mothers have many opportunities to invest in their own or their child's health and well-being during pregnancy and immediately after birth. For example, the American College of Obstetrics and Gynecology recommends that most women take a prenatal vitamin that includes folic acid and iron to reduce the risk of neural tube defects and anemia.[1] Receiving early prenatal care has been shown to decrease the likelihood of adverse birth outcomes, including prematurity.[2,3] After birth, women may begin breastfeeding their child; the American Academy of Pediatrics recommends breastfeeding as a means to improve infant health and possibly increase neurodevelopment.[4]

Given the value of these investments, previous research has attempted to identify characteristics that predict patient behavior. Campbell et al.[5] develop a model to predict prenatal care utilization, and find that attitudes toward the pregnancy, prenatal care, and the provider were important indicators. Dubay et al.[6] show that the timing of prenatal care initiation varies by maternal race, education, and marital status. Race and education have also been found to be correlated with breastfeeding initiation, as well as ethnicity, immigration status, income, and marital status.[7,8] And while research on predictors of prenatal vitamin use is more limited, there is a vast literature that documents correlates of compliance with prescription medications (see Vermeire et al.[9] for a review).

In this study, we investigate a potential predictor of pre- and post-natal investments in health and infant well-being that has received little attention: birth order. Birth order is easily observed by the provider, and there is reason to believe that women may not invest equally in children of different order. Price[10] shows that

later-life investments like time spent reading to or playing with a child are greater for first-born children. If these differences in investments are a reflection of increased constraints on resources (time or financial) for higher-order births, we may see differences in very early investments as well. Mothers may also update their beliefs about the costs or benefits of certain investments with each successive pregnancy. We hypothesize that pre- and post-natal investments in health and child well-being will decrease for higher-order pregnancies. Evidence of such an effect would be useful for providers, as it would identify parity as a risk factor for under-investment in maternal or child health. Differences in investments by birth order could also contribute to observed birth order effects for later life outcomes.

Methods

Data

Data on the mothers in our study come from the 1979 National Longitudinal Survey of Youth (NLSY79). The NLSY79 is a publicly available, nationally representative panel survey of persons who were ages 14-22 in 1979. Respondents were surveyed annually until 1994, and have been surveyed biennially since. The most recent data available are from the 2010 survey, when the respondents were ages 45-53—so that for women, complete fertility histories are observed. In fact, over 99 percent of births used in this study occur by 2002. Data on prenatal care behaviors, breastfeeding, and child characteristics come from the NLSY79 Child and Young Adult Survey (NLSY-CYA), which is a separate survey that collects information on all children born to women in the original NLSY79. The two surveys together give

us a panel data set with multiple observed pregnancies for each mother, which is important for the estimation strategy described below.

We limit the NLSY79 sample to women who have more than one birth. This leaves us with 3,755 women (60 percent of the original NLSY79 women), who have a total of 10,328 children. For some of the analysis, we stratify the results by family size. 52 percent of the women in our sample have 2 children, 30 percent have three children, and 18 percent have four or more children.

Statistical analysis

To investigate the relationship between birth order and early investments, we begin by estimating multivariate regression modules using ordinary least squares (OLS). Our dependent variables are dummy variables indicating specific investments, so we estimate linear probability models. The independent variables of interest are dummies indicating that the child has birth order of two, three, or four or more. The OLS regressions include controls for mother's age and marital status at birth, child gender, and dummies for child year of birth. These characteristics are chosen to be consistent with our preferred fixed effects model, described below. It is particularly important to include the controls for year of birth, so not to conflate birth order effects with cohort effects that might exist if technologies, recommendations, or attitudes toward certain investments change over time.

The OLS estimates will identify population-level differences in investments by birth order. However, the results of this analysis will not tell us whether the average mother has different levels of investment in her own children across birth

orders. For example, suppose that mothers of four are less likely to make investments than mothers of two. We would observe lower rates of investment for fourth-born children on average than for second-born children, even if mothers invest in each of their own children equally. For this reason, our preferred estimates are from a fixed-effects model, in which the coefficients are estimated using only within-mother variation in investments across birth order. Intuitively, the fixed effects estimates tell us whether the average mother is less (or more) likely to invest in her later-born children. An additional advantage of the fixed effects approach is that it eliminates the need to control for time-invariant characteristics of the mother (like race, family background, or chronic health conditions). We do continue to control for observable characteristics that may change across births, like the mother's age at birth, marital status, and child gender.

For our fixed effects estimates, we show results for the full sample and separated by family size, to determine whether any relationship between birth order and investments is driven by large or small families. In all results, we use sampling weights to produce estimates that are nationally representative. Standard errors for the regressions are clustered by the mother to account for serial correlation. All analysis is conducted using Stata 12.0.

Measures of Investment

For our dependent variables, we use four measures of pre- and post-natal investment in health and child well-being: (1) an indicator for whether the mother took prenatal vitamins during the pregnancy, (2) an indicator for whether she

received prenatal care during the first trimester, (3) an indicator for whether she reduced salt intake while pregnant, and (4) an indicator for initiation of breastfeeding. These data are missing for a fraction of the sample (22, 13, 22, and 6 percent, respectively), and are more likely to be missing for first births, which in some cases occur before the survey began.

Results

Study Population

Table 1 summarizes the characteristics of our sample, in total and by birth order. Prenatal vitamins were used in 95.6 percent of pregnancies, and vitamin use is highest among first-born children. 82.9 percent received care in the first trimester, and women are less likely to receive early care for higher-order (3^{rd}-plus) births. Women reduced salt intake in 48 percent of pregnancies, and there is a steady decline in this rate across birth order. Finally, 53.6 percent of the children in the sample were breastfed, but there is no clear pattern by birth order.

Table 1 also summarizes the demographic characteristics of our sample. The average age of the mother at birth was 26.2 years, and 72.7 percent of births were to married mothers. 16.4 percent of the children are black, 48.7 percent are female, and the mean year of birth in the sample is 1987. The average completed education by the mother of each child in the sample is 13.5 years. Mothers of high birth order children have less education on average and are more likely to be black.

Birth Order and Prenatal Vitamins

The results of our OLS and fixed effects regression analysis are presented in Table 2. In the first panel, the dependent variable is the indicator for prenatal vitamin use. The OLS estimates in the first column show that prenatal vitamin use is less common in higher-order pregnancies than in first pregnancies. However, this could be due to differences in vitamin use by family size; our fixed effects estimates in the second column use only within-mother variation to identify the effects of birth order. Here, we see that mothers are increasingly and significantly less likely to use prenatal vitamins in higher-order pregnancies. Compared to their first births, women are 3.6 percentage points less likely to use vitamins in the second birth ($p<0.002$), 5.9 percentage points less likely in the third birth ($p<0.01$), and 6.5 percentage points less likely in fourth and higher-order births ($p<0.05$).

In the remaining columns of Table 2, we show results by family size. For two-child families, vitamin use is very similar across pregnancies. The effects we see in column 2 are therefore driven by lower rates of use in higher-order pregnancies among three- and four-plus child families. In a three-child family, mothers are 10.9 percentage points less likely to take vitamins during the third pregnancy than in the first ($p<0.01$).

Birth Order and Salt Intake

Results for salt intake are shown in the second panel of Table 2. The OLS results in the first column show that reduction of salt intake is more common in first pregnancies than in higher-order pregnancies. In the fixed effects model in the second column, we see large, statistically significant effects. Mothers are 12.0, 16.5, and 19.7 percentage points less likely to reduce salt intake in second, third, and fourth-plus pregnancies, respectively ($p<0.001$, $p<0.001$, $p<0.01$). In this case, there are significant differences by birth order for even two-child families,

where the mother is 14.0 percentage points less likely to reduce salt intake in the second pregnancy than in the first ($p<0.01$).

Birth Order and Early Prenatal Care

The third panel of Table 2 shows results for receipt of prenatal care in the first trimester. Again, the OLS estimates in the first column show a lower level of investment for higher-order children than for first-born children on average. The same pattern is observed in the fixed effects specification, though results are generally not statistically significant at conventional levels. Mothers are 8.8 percentage points less likely to receive early prenatal care in their fourth- and higher-order births than in their first ($p<0.1$).

Birth Order and Breastfeeding

The last panel in Table 2 shows results for initiation of breastfeeding. The OLS results indicate that children are significantly and increasingly less likely to be breastfed as birth order increases ($p<0.001$). This result is confirmed by the fixed effects results in the second column. Mothers are 8.2 percentage points less likely to breastfeed their second child than their first ($p<0.001$), and are 9.4 and 11.5 percentage points less likely to breastfeed their third and fourth-plus children, respectively ($p<0.001$, $p<0.01$). This effect is observed for all family sizes—women with two children are 11.9 percentage points less likely to breastfeed their second child than their first ($p<0.001$).

Percent Differences in Investments

In Figure 1, we show differences in investments as the percent change in the investment relative to the first-born child. Percent changes are calculated using the fixed effects coefficients in Table 2; results are shown for vitamin use, early prenatal care, and breastfeeding. Salt intake is omitted to make the figure easier to read, as the percent changes for the measure are so large (and salt intake is arguably less important for child well-being, as we discuss below). Here, we see that women are less likely to make investments in child well-being with each successive pregnancy. On average, women are 6.6 percent less likely to take prenatal vitamins and 10.6 percent less likely to receive early prenatal care in a fourth- or higher-order pregnancy than a first. Mothers are 20.9 percent less likely to breastfeed a fourth or higher-order child than a first.

Discussion

The results of this study confirm our hypothesis that mothers invest less in health and child well-being for higher-order children. Using a fixed effects approach that identifies birth order effects using within-mother variation, we find that mothers are significantly and increasingly less likely to take prenatal vitamins or to reduce salt intake in higher-order pregnancies. Mothers are less likely to receive early prenatal care in a fourth or higher-order pregnancy than in a first. They are most likely to breastfeed a first-born child, and breastfeeding declines monotonically as birth order increases. These effects are not due to changes in recommendations or attitudes toward investments across year-of-birth cohorts.

There is some heterogeneity in the relationship between birth order and investments by family size. For prenatal vitamin use, there is no difference in investment between the first and second child in a two-child family, but there is in larger families. For salt intake and

breastfeeding, however, even two-child families show a decrease in investment after the first birth.

We believe these results are important for providers, as they identify high birth order as a risk factor for under-investment in maternal or child health and well-being. Providers may want to emphasize the importance of prenatal vitamins, early prenatal care, breastfeeding, and other behaviors to their higher-order patients. Similarly, researchers interested in modeling or explaining pre- and post-natal behaviors will likely want to include birth order in their models.

Our results also contribute to the vast literature documenting a relationship between birth order and later outcomes like health, ability, education, and earnings.[11,12,13,14,15] These studies typically find that firstborn children experience significantly better outcomes than the siblings born after them, and that the difference in outcomes relative to the first-born increases with each increase in birth order. One potential channel for birth order effects is differential investments in children—as parents have limited resources at any given point in time to divide among existing children, cumulative investment is lower for later-born children.[16] Price[10] finds empirical support for this hypothesis in the case of later-life investments of parental time. Our study shows that these differential investments may begin at conception.

One limitation of our study is the small number of observable pre- and post-natal investments in the NLSY-CYA. Further, our measures vary in how strongly they are linked to maternal, infant, or child outcomes. For example, salt intake was once thought to reduce the chance of pre-eclampsia, but has rarely been advised in recent decades.[17] And as Black[18] points out in his review of the literature on micronutrients and prenatal outcomes, 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. Nevertheless, we believe our indicators are useful as measures of a mother's willingness to invest in her own health and well-being or that of her children. It is possible, for example, that women who take vitamins are also more likely to get adequate nutrition or rest during pregnancy.

Our study also does not explain *why* mothers decrease investments in higher-order pregnancies. There are at least two possible explanations for our results. The first is that parents' resources (including time, money, and energy) are diluted for higher-order births, constraining their ability to invest.[12] A second explanation is that women may update their beliefs about the benefits or costs of certain investments with each pregnancy. For example, if the first child is born without complications, a mother may conclude that pregnancy is less risky than she previously thought and therefore decrease her level of investment. Or, a mother who found breastfeeding to be more costly than anticipated for a first-born child may decide not to breastfeed a subsequent child. Understanding the channels that generate our results is an area for future research.

Conclusion

In this study, we find that rates of pre- and post-natal investments in maternal and child health are lower in higher-order births. Women are less likely to take prenatal vitamins or receive prenatal care in the first trimester in higher-order pregnancies, and are less likely to breastfeed a higher-order child. These results have

important implication for providers, as they identify higher parity as a risk factor for under-investment in healthy behaviors. The results may also help explain birth order differences in later outcomes like health, ability, and earnings. However, as our limited measures of investment were not strongly linked to observable child outcomes in the NLSY79 (including birth weight and gestation) we were not able to explore this hypothesis. Future work is needed to determine whether birth order is related to other meaningful pre- and post-natal investments, and whether these differences contribute to birth order differences in outcomes. Further research is also needed to explain why these birth order differences in investments exist.

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Table 1: Study Population Characteristics

		Birth Order			
	Full Sample	1	2	3	4+
% Took Prenatal Vitamins	95.6	97.4	94.8	93.9	94.5
	(20.6)	(15.8)	(22.2)	(24.0)	(22.8)
	8052	2667	3064	1493	828
% Received Care in First Trimester	82.9	83.0	84.9	81.4	76.1
	(37.7)	(37.6)	(35.9)	(38.9)	(42.7)
	8945	3376	3234	1517	818
% Reduced Salt Intake	48.0	55.0	46.3	42.4	38.0
	(50.0)	(49.8)	(49.9)	(49.4)	(48.6)
	8039	2661	3059	1492	827
% Breastfed	53.6	54.9	52.4	54.0	52.2
	(49.9)	(49.8)	(49.9)	(49.9)	(50.0)
	9725	3632	3512	1650	931
Mothers' Characteristics:					
Mean Age	26.2	23.2	27.0	28.9	30.8
	(5.9)	(5.2)	(5.4)	(5.4)	(5.3)
	10325	3750	3751	1789	1035
% Married at Birth	72.7	68.4	78.3	74.1	64.8
	(44.5)	(46.5)	(41.2)	(43.8)	(47.8)
	10328	3750	3751	1789	1038
Mean Years of Education	13.5	13.6	13.6	13.4	12.9
	(2.7)	(2.6)	(2.6)	(2.7)	(2.8)
	10325	3750	3751	1789	1035
% Black	16.4	14.9	14.9	18.3	24.8
	(37.0)	(35.6)	(35.6)	(38.7)	(43.2)
	10328	3750	3751	1789	1038
Child Characteristics:					
% Female	48.7	49.3	47.5	48.1	52.9
	(50.0)	(50.0)	(49.9)	(50.0)	(49.9)
	10327	3749	3751	1789	1038
Mean Year of Birth	1987.1	1984.0	1987.8	1989.7	1991.8
	(6.4)	(5.8)	(6.0)	(5.9)	(5.9)
	10326	3750	3751	1789	1036

Values in parenthesis are standard deviations. Numbers under standard deviations indicate sample size.

Table 2: OLS and Fixed Effects Regression Results for Effect of Birth Order on Pre- and Post-Natal Investments

		Fixed Effects			
	OLS	All	Two-Child Family	Three-Child Family	Four-Plus Child Family
Took Prenatal Vitamins					
2nd Child	-0.0363	-0.0361	-0.0086	-0.0545	-0.0284
	(0.000)	(0.001)	(0.681)	(0.009)	(0.090)
3rd Child	-0.0478	-0.0588		-0.1093	-0.0511
	(0.000)	(0.004)		(0.004)	(0.018)
4th Child+	-0.0415	-0.0647			-0.0693
	(0.000)	(0.022)			(0.017)
Mean	0.9556	0.9556	0.9600	0.9512	0.9538
Observations	8052	8052	3279	2626	2147
Reduced Salt Intake					
2nd Child	-0.075	-0.1201	-0.1403	-0.1238	-0.0863
	(0.000)	(0.000)	(0.009)	(0.005)	(0.076)
3rd Child	-0.1018	-0.1651		-0.2058	-0.1148
	(0.000)	(0.000)		(0.003)	(0.080)
4th Child+	-0.1238	-0.1968			-0.1180
	(0.000)	(0.003)			(0.156)
Mean	0.4804	0.4804	0.5024	0.4930	0.4244
Observations	8039	8039	3273	2624	2142
Received Care in First Trimester					
2nd Child	-0.0265	-0.0212	-0.0255	-0.0156	-0.0165
	(0.014)	(0.268)	(0.505)	(0.620)	(0.673)
3rd Child	-0.0745	-0.0487		-0.0602	-0.0182
	(0.000)	(0.144)		(0.232)	(0.727)
4th Child+	-0.1319	-0.0878			-0.0611
	(0.000)	(0.065)			(0.333)
Mean	0.8288	0.8288	0.8662	0.8252	0.7718
Observations	8945	8945	3456	2951	2538
Breastfed					
2nd Child	-0.1555	-0.0824	-0.1186	-0.0543	-0.0571
	(0.000)	(0.000)	(0.000)	(0.024)	(0.029)
3rd Child	-0.1784	-0.0944		-0.0931	-0.0719
	(0.000)	(0.000)		(0.015)	(0.075)
4th Child+	-0.2269	-0.1149			-0.0888
	(0.000)	(0.002)			(0.055)
Mean	0.5360	0.5360	0.5407	0.5509	0.5099
Observations	9723	9723	3712	3196	2815

Values in parenthesis are p-values.

Figure 1: Percent change in behaviors, by birth order

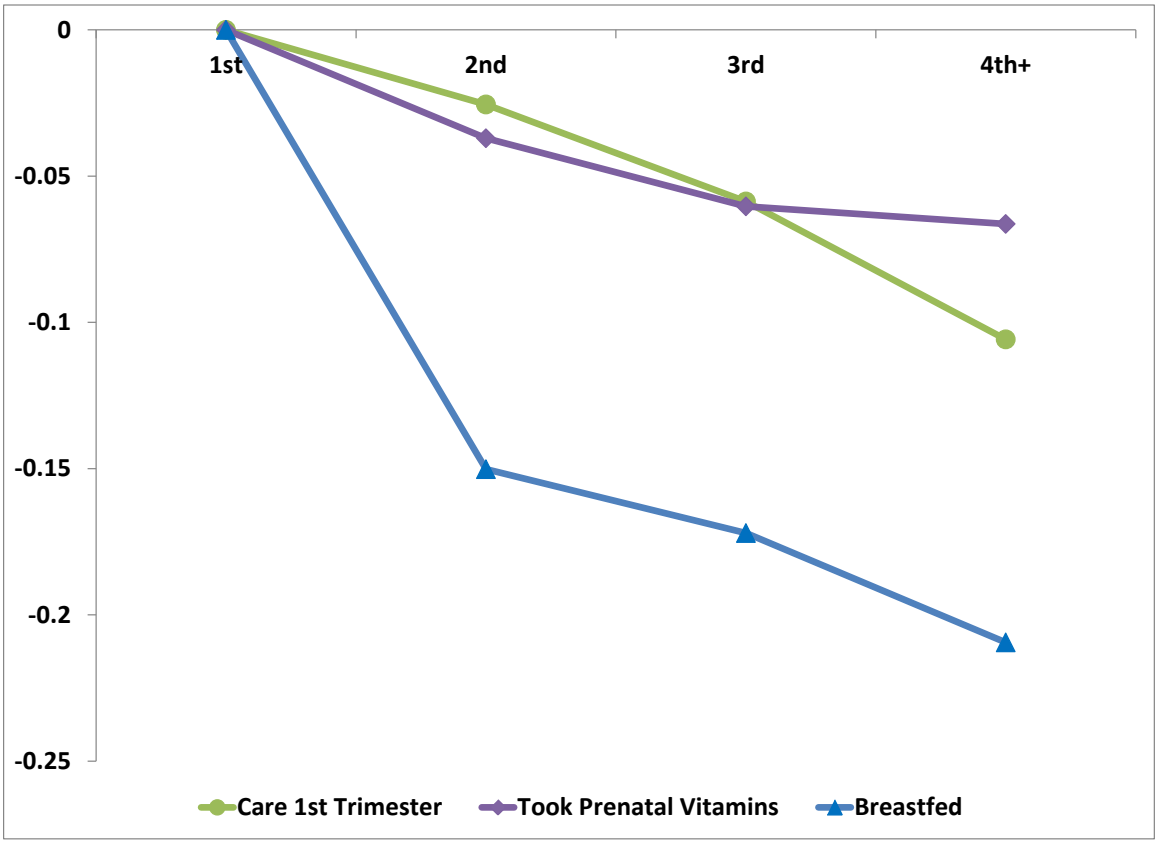

Figure shows percent changes in behavior relative to the first birth. Percent changes are calculated using fixed-effects estimates from the full sample.