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Revisiting Birth Order Effects on Child Health: Evidence from Bangladesh

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May 20, 2024

Abstract

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Keywords: "Child Nutrition", "Health, Stunting", "Birth Order", "DHS", "Bangladesh"

JEL Classification: "I14", "I15", "I18", "J12", "J13", "O15", "N35"

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May 16, 2024

Abstract

Despite significant economic growth in many developing countries, malnutrition in children remains a daunting challenge. Recent studies indicate that later-born children in these countries often face health disadvantages. This study reexamines the effects of birth order on child nutrition using the latest four rounds of the Demographic and Health Survey in Bangladesh. Using fixed effect models, we find a nutritional disadvantage for later-born children. Specifically, children who are second in birth order are approximately 0.055 standard deviations shorter in height and 2.7 percentage points more likely to be stunted than their first-born siblings. Additionally, our heterogeneity analysis reveals sharp differences in birth order effects across key individual and household characteristics. A negative association between birth order and height exists among girls, children in households headed by males, children in rural households, and children in poor households. Finally, we find that the birth order effect emerges two years after a child is born and can persist over the long run.

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1 Introduction

Improving children's nutrition is one of the most crucial but insufficiently addressed issues in developing countries (World Bank, 2023a). Globally, the incidence of stunting among children under age five has declined rapidly over the past three decades (UNICEF et al., 2023b) but the economic burden of childhood stunting is still substantial— a roughly 5% to 7% loss in per capita gross domestic product (GDP) (Galasso & Wagstaff, 2019). The rates of return on nutrition-related projects are expected to be high in many countries, especially in South Asia (Galasso & Wagstaff, 2019). Therefore, from a policy perspective, further study is needed to disentangle the causes and factors hampering improvements in childhood nutrition and support further growth in these countries.

Similar to trends observed in other developing countries, Bangladesh has substantially reduced the incidence of stunting among children under five, from 73% in 1991 to 28% in 2019. Still, the level of stunting remains high (World Bank, 2023b). In the economics and public health literature, various studies examine the determinants and consequences of undernutrition in children and show that, among other causes, poor water hygiene and sanitation are the main determinants in Bangladesh and other countries (Bekele et al., 2020; Luby et al., 2018; Spears, 2020). Studies focused on Bangladesh examine various causes of undernutrition in children, including weather shocks, the level of income and assets, family size, birth intervals, open defecation, wider health access, and parental factors, particularly women's education (Headey et al., 2015; Homma et al., 2024; Nisbett et al., 2017).

Importantly, a seminal work by Jayachandran and Pande (2017) reveals that the role of birth order in children's height, namely that later-born children are short for their age, is greater in India than in Africa. Following Jayachandran and Pande (2017), Dhingra and Pingali (2021) show that this birth order effect is observed specifically for those with shorter preceding birth intervals.[1] In contrast, Sahn and Stifel (2002) and Kabubo-Mariara et al. (2008) find a positive association and no association between birth order and a child's height-for-age z-score (HAZ) score in sub-Saharan Africa and Kenya, respectively. Moreover, the later-born in India and Austria have better health endowments such as lower neonatal mortality rates and a lower likelihood of a preterm birth (Coffey & Spears, 2021; Pruckner et al., 2021). Some studies show that results vary depending on empirical methodologies. Therefore, to date the evidence on the relationship between birth order and child health is mixed (Chandna & Bhagowalia, 2024).

In this study, we shed light on less-addressed issues of birth order differences in child undernutrition using Bangladesh as the focus of our analysis. Using data from the Demographic and Health Survey (DHS) in Bangladesh, we document further evidence on birth order effects on child nutrition by showing the heterogeneous effects of birth order on child nutritional status. First, consistent with previous studies (Dhingra & Pingali, 2021; Jayachandran & Pande, 2017), we confirm later-born disadvantages in height in Bangladesh. Our heterogeneity analyses reveal this later-born disadvantage with respect to nutrition is observed among girls and children from poorer or rural households, and that it emerges at two years of age. Interestingly, the strong negative effect of birth order is found only among households headed by males.

This study makes two contributions to the existing literature. Our first and main contribution is that we show children suffering from later-born health disadvantages in Bangladesh are likely to be girls, and are likely from poor or rural households, where one in three children are stunted — most people in Bangladesh live in rural areas (DHS, 2020). Our findings suggest that properly targeting policies to improve child health is necessary to maximize effectiveness and efficiency. Therefore, understanding the health impact of birth order is of great importance, particularly for Bangladesh and other emerging

[1] Similarly, Chandna and Bhagowalia (2024), Chen (2021), and Kebede (2005) find a negative association between birth order and height in children from Ethiopia, Vietnam and India, respectively.

countries who seek to achieve middle-income status on the path to becoming developed countries. Second, we find the birth order effects appear two years after birth, indicating the importance of intrahousehold resource allocation as a household nurtures a child. Little is known about why birth order effects do not emerge prior to second year of a child's life.

The remainder of this study is organized as follows. Section 2 provides background and discusses the prior literature on child health and birth order relevant to this study. The data, summary statistics, and empirical framework are introduced in Section 3. Section 4 presents the study results, followed by a discussion and conclusions.

2 Background

2.1 Child Nutrition in Bangladesh and South Asia

While Bangladesh has achieved significant economic growth since 2000, the prevalence of child stunting is still high. Between 2000 and 2022, the annual increase in GDP per capita was approximately 9% (reaching USD 2,688 in 2022) in Bangladesh compared to 4.5% (USD 1,690 in 2022) in sub-Saharan Africa (World Bank, 2023b). Over that period, child stunting decreased in both regions—estimates from UNICEF, WHO, and World Bank (2023a) show that in 2022 the prevalence of child stunting in Bangladesh was roughly 26%, compared to 31% in sub-Saharan Africa.

Other South Asian countries exhibit a similar counterintuitive pattern in terms of economic growth and health improvements; in fact, the high rate of undernutrition relative to economic advancement is known as the Asian Enigma (Headey et al., 2015). Figure 1 shows the rate of stunting for children younger than five years old in countries in South Asia. Although child stunting decreased remarkably over the period except in Pakistan and Sri Lanka, it remains high as of 2022 (the latest data point available).

[Figure 1 About Here]

2.2 Potential Birth Order Effects on Child Health and Human Capital

To the best of our knowledge, Behrman (1988) and Horton (1988) were the first to empirically examine the relationship between birth order and child nutritional status, showing that later-born children may have nutritional disadvantages relative to their older siblings. Although it varies by country, this negative birth order effect can be attributable to differences in parental health investments or intrahousehold allocations, as health conditions at birth do not necessarily differ by birth order (Behrman, 1988; Pruckner et al., 2021).

Two important empirical studies recently looked at the effects of birth order on child nutrition. A groundbreaking study by Jayachandran and Pande (2017) compares child height (related to chronic undernutrition) in India and sub-Saharan countries and reveals that later-born children in India have greater height disadvantages relative to African children.[2] Following their findings, Dhingra and Pingali (2021) examine the Indian birth order height gradient by focusing on differences in the amount of time since an older sibling's birth. They find that the height disadvantage is smaller if this birth spacing is longer than three years, as a longer interval allow parents more time to care for younger children. Furthermore, a recent study in India shows that the HAZ score is negatively related to birth order, and this association is stronger for mothers who have a moderate or high degree of preference for having sons. The study also finds that maternal characteristics, such as education, could mitigate the negative relationship between birth order and height, but only when this son preference is low (Chandna & Bhagowalia, 2024).

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[2] Certain arguments have been presented that challenge the implications of this result. Chen (2021) shows the Indian-African height gap is narrowing, and the remaining difference in height can be attributed to maternal heights, as African women tend to be taller than Indian women on average. They conclude that if Indian and African women were of equal height, Indian preschool children would likely be taller than those in Africa.

Aside from those studies in India, Bishwakarma and Villa (2019) examine birth order effects on birth and current nutritional outcomes using data on children in South Africa up to 18 years old, showing similar results that earlier-born children have, on average, better nutritional outcomes. Rahman (2016) uses the 2011 Bangladesh DHS to show a correlation between birth order and an increased probability of children being stunted, but it lacks tests of the robustness of the results and an investigation of heterogeneity effects using credible approaches.

Negative nutrition and health conditions during childhood can have a profound negative influence on socioeconomic outcomes later in life (Bleakley, 2010; Currie & Almond, 2011; Currie & Vogl, 2013). Birth order is associated with several unfavorable consequences, observed in both developed and developing countries. Some notable studies show negative birth order effects on adult health (Black et al., 2016), educational attainment (Black et al., 2005; Chandna & Bhagowalia, 2024; Esposito et al., 2020; Pavan, 2015), and economic circumstances (Black et al., 2005, 2018; Brown et al., 2021).[3]

3 Data and Empirical Methods

3.1 Data Sources and Description of Main Variables

To explore the association between birth order and child nutritional status, we use the latest four rounds of the Bangladesh DHS conducted in 2007, 2011, 2014, and 2017–18.[4] Using these rounds, we construct four-period repeated cross-section datasets, as the DHS is a cross-sectional survey. We do not include data from earlier survey rounds as they lack

[3] In contrast, an empirical study in Ecuador shows that earlier-born children have delayed human capital development from infancy to adolescence, especially in poor and low-educated families (Haan, Plug, and Rosero, 2014). A study from Brazil also documents that earlier-born children are less likely to attend school than their younger siblings (Emerson and Souza, 2008). In India, gender discrimination is also a major issue in terms of equal child development. Makino (2018) finds the birth order effect due to discrimination becomes insignificant as children reach elementary school age.

[4] The DHS dataset is available at the following website: https://dhsprogram.com/Countries/Country-Main.cfm?ctry_id=1&c=Bangladesh&Country=Bangladesh&cn=&r=4.

some of the key variables in our analysis, such as children's anthropometric measures or household wealth indicators.

The samples drawn from all surveys are nationally representative and cover the entire population living in non-institutional housing units in Bangladesh. The surveys use a stratified two-stage sampling design. Women aged 15–49 were interviewed, and the height and weight of their children below five years old were measured. The response rates in each survey were more than 95%.[5] Figure A.1 in Appendix A shows the location of the survey clusters in the four rounds of the Bangladesh DHS.

Our sample includes children less than five years old because the key anthropometric measures are available only for this age group. We use HAZ as an indicator of child nutrition to examine how child nutritional status varies by birth order, as it reflects the cumulative effect of nutritional inputs over time. The measure indicates the extent to which a child's height deviates from the median of the reference population, expressed as the number of standard deviations from the median. HAZ is defined by the WHO and is universally applicable to children under five years old. A HAZ of zero, equal to the median, is the score for the reference population based on age and gender. HAZ values more than two standard deviations below the median are classified as (moderately) stunted, and more than three standard deviations below as severely stunted (WHO, 2023). We use both HAZ, a continuous measure, and a dummy variable of stunting status as our main outcome variables. We also use other common nutritional indicators, namely weight-for-age z-score (WAZ) and weight-for-height z-score (WHZ). While HAZ represents chronic undernutrition or stunting, WAZ combines elements of chronic and acute undernutrition (underweight) and WHZ reflects acute undernutrition (wasting). They are measured and interpreted using the same standard deviation-based approach as HAZ. Estimation results using WAZ, underweight, WHZ, and wasting as outcomes are

[5] For more details on survey methodology and information, see the Sample Design of Section 1 of the DHS final reports for each round, available at https://dhsprogram.com/data/available-datasets.cfm?ctryid=1.

provided in Table B.1 in Appendix B.

Our primary independent variable of interest is birth order. Considering that nearly 83% of children in the sample are the first, second, or third child born in their families, we create a birth order variable with categories 1, 2, and 3 or more. This categorization allows us to examine whether earlier-born children have nutritional and height advantages compared to their later-born siblings. We also include various child, parental, and household characteristics to explore the heterogeneous effects of birth order on child nutrition, as discussed in Section 3.2.

Summary statistics for the main variables used in our analysis are reported in Table 1, and statistics for the control variables are shown in Table A.1 in Appendix A. Our sample comprises 29,843 children less than five years old (including 2,082 for whom HAZ is missing, approximately 7% of the total). This includes 5,743 children from DHS 2007, 8,281 from DHS 2011, 7,507 from DHS 2014, and 8,312 from DHS 2017–18. We observe that the average HAZ has improved over the decade covered by these survey rounds; thus, the rates of stunting and severe stunting have declined.

[Table 1 About Here]

3.2 Empirical Framework

Although child undernutrition has several underlying causes, in this study, we examine the effects of birth order on a child's health status. Birth order is significant as it captures potential inequalities in the allocation of nutritional resources and health care among siblings in a household. The conceptual model is specified as

$$H = f\{Born, X\,;\, Z\},$$

where H is child health status, $Born$ is an indicator variable of birth order, X is a vector of covariates, and Z is a vector of unobserved factors. The effect of birth order is described as follows:

$$\frac{\partial H}{\partial Born} = \frac{\partial f\{Born,\, X;\, Z\}}{\partial Born} < 0. \tag{1}$$

Based on past studies, we expect to find that birth order negatively affects child nutritional and health outcomes, and that later-born children experience poorer nutritional and health outcomes due to inequalities within their households. We thus hypothesize $\frac{\partial f}{\partial Born} < 0$ in Equation 1. Based on this discussion, we explain the specification of our empirical model below.

Our analysis builds on prior studies that investigate the association between birth order and child health, and our model includes dummy variables for birth order as explained above. Specifically, to examine the association between birth order and child nutritional outcomes, we estimate the following equation using ordinary least squares (OLS) analogous to the method in Jayachandran and Pande (2017):

$$H_{ijct} = \alpha + \beta_1 \text{2nd}Born_{ijct} + \beta_2 \text{3rd(+)}Born_{ijct} + \delta X_{ijct} + \gamma_j + \mu_c + \lambda_t + u_{ijct}, \tag{2}$$

where *i* denotes a specific child, *j* is the sampling unit, *c* is the child's birth cohort, and *t* is the DHS survey year-month.

The outcome variable H_{ijct} is either HAZ or stunting status. In estimating the stunting effect, our model is a linear probability model. As explained in Section 3.1, we also use WAZ, underweight, WHZ, and wasting as outcomes and report the results in Table B.1 in Appendix B. The variables $\text{2nd}Born_{ijct}$ and $\text{3rd(+)}Born_{ijct}$ are dummy variables that have a value of one if a child was born second, was born third or later, respectively. Therefore, β_1 and β_2 are parameters to be estimated to capture the gaps in nutritional status across children based on birth order. We expect that $|\beta_1| < |\beta_2|$ since later-born children benefit less due to inequalities in intrahousehold resource allocation. The main analysis uses these birth order groups, as explained in the previous section. In addition to the main analysis estimated with Equation 2, we test the sensitivity of the coefficients β_1 and β_2 to distinguish birth order with more granularity (i.e., distinguishing among 4th and 5th or later-born children) in Section 4.3 to confirm whether the choice of the birth order dummies alters our main findings.

X_{ijct} is a vector of child, parent, and household characteristics. Child-level variables include age, gender, and birth desirability. When considering birth order effects, hypothesizing that later-born children benefit less than their older siblings, whether or not the birth of the child was desired by the parents should also be considered (Rahman, 2015).[6] Using the mothers' answers regarding the ideal number of children, we construct the distance between the ideal number of children and a child's actual birth order and include these dummy variables as controls.[7] Parent-level variables include age and its square term, years of education, and an indicator for the mother's working status. Using the square terms of the parents' ages accounts for the nonlinear relationship between parental age and child health outcomes (Fall et al., 2015). Household-level characteristics include a wealth index, dummy variables for urban versus rural location, fertility completion, female-headed household, access to piped water for drinking, and use of open/pit latrine.[8] The variables related to the mother capture her position in the household and are expected to have a positive influence on the growth of the children (Kabir et al., 2020; Pratley, 2016). Fertility completion could account for potential differences in parents' ability to spend resources on their children. For example, if fertility

[6] Although the level of unwanted births in Asia has declined over the last 20 years, controlling for this factor makes our analysis of birth order effects more convincing (Günther & Harttgen, 2016).
[7] Specifically, we first calculate distance = (parents' ideal number of children) − (child's birth order). Then, create five dummy variables where the distance is −2 or below, −1, 0, 1, and 2 or above.
[8] The household wealth index is divided into five quantiles: poorest, poorer, middle, richer, and richest. The classification is based on the characteristics and possession of assets, facilities, and consumer goods, and is estimated using a principal component analysis. For more information, see https://www.dhsprogram.com/topics/wealth-index/wealth-index-construction.cfm.

is completed, the parents may be able to afford to spend more on their children compared to families where the mother is still fertile. These variables are potentially key factors that could influence and explain differences in children's growth and their health conditions.[9] To retain the sample size, we impute missing values for the control variables in X_{ijct} using their mean values.[10]

In addition to controlling for the variables explained above, we check the robustness of our estimates by conditioning on primary sampling unit (PSU, or cluster) fixed effects, γ_j, another source of confounding factors correlated with unobserved economic, health, and environmental conditions specific to the locations. We also test whether the estimates remain stable by incorporating fixed effects for the birth cohort μ_c and year-month of the survey λ_t in the model. By accounting for these influences, we seek to control for unobserved cohort and time-specific nutritional shocks that are consistent across the time of birth and survey period.[11] u_{ijct} captures this unobserved component. In all of our regression analyses, standard errors are clustered at the mother level to account for existing associations within the same mother.

4 Results

In Section 4.1, we present the main results estimated using Equation 2. Analyses of heterogeneous associations between birth order and child health from splitting the

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[9] Importantly, birth spacing might confound the effects of birth order on child nutritional status (Dhingra & Pingali, 2021; Miller et al., 1992). However, this variable is missing for 36.8% of the observations in our sample, and 99% of those that are available are for first-born children, which is obvious. As its effect is not our primary focus, we exclude it from our main and heterogeneity analyses and verify whether the main regression results change by controlling for birth spacing in Table 8.

[10] Ten variables had missing values, with the highest percentage of missing observations being 1.5% for the father's age. Our regression models do not include dummy variables for missing values in the estimations.

[11] A common approach to address unobserved heterogeneity is to include mother (or sibling/within-family) fixed effects. However, employing mother fixed effects would restrict the sample to households with two or more children younger than age five, which does not suit our sample as all children included in our analysis are less than five years old, and such a restriction would substantially reduce the sample size.

subsample follow in Section 4.2. Finally, we test the robustness and sensitivity of the main results in Section 4.3.

4.1 Birth Order Effects on Health Outcomes

First, we present a graphical analysis disaggregating nutritional disadvantage by birth order. Figure 2 shows the average HAZ values for the first-, second-, and third(+) born. Relative to first-born children, we observe a lower HAZ in the second-born group, and the gap grows in third- and later-born children. This analysis reveals that HAZ for the first and third(+) child differ by roughly 1.0 standard deviations (SDs).

[Figure 2 About Here]

Next, we explore birth order effects on a child's HAZ and stunting by estimating Equation 2 and report the results in Table 2. Column (1) displays the association between birth order and HAZ without controls and fixed effects. Being second- or third(+) born is negatively associated with HAZ, and the coefficient for the latter is statistically significant at the 1 percent level, indicating that relative to first-born children, those born third or later have a significant disadvantage in height. When the child-, parent-, and household-level control variables are included in column (2), the coefficient on second- born increases in magnitude and becomes significant, while the coefficient on third(+) is virtually unchanged.

In columns (3) to (5), we test the robustness of the coefficients by adding various fixed effects that are expected to remove biases caused by unobservables that are correlated with child health, economic, and environmental conditions. The estimates that control for PSU fixed effects in column (3) decrease in magnitude compared to column (2), and remain stable when additional fixed effects are included in columns (4) and (5). Our preferred results in column (5) suggest that relative to first-born children, those born second are about 0.055 SDs shorter (or have smaller HAZ score), and those born third or later have a height deficit of 0.162 SDs, nearly triple the effect of being second-born. While the magnitudes differ slightly, these findings of negative effects and later birth order gradient align with our hypothesis $|\beta_1| < |\beta_2|$ as explained in Section 3.2.

In addition, we examine the birth order effects on stunting and severe stunting, which are defined based on HAZ values as described in Section 3.1. Since these are binary variables, we estimate a linear probability model using OLS. For both outcomes shown in columns (6) and (7), the effects of being later in the birth order and its gradient remain large and significant. The estimates suggest that being second-born is associated with a probability of being stunted or severely stunted of approximately 2.7 and 2.6 percentage points, respectively. Similarly, the probabilities of being stunted or severely stunted for those who are third or later-born are larger, at roughly 7.3 and 4.4 percentage points, respectively.

[Table 2 About Here]

Next, we investigate the association between birth order and WAZ, underweight, WHZ, and wasting by estimating Equation 2 using the same specifications for columns (5) to (7) as in Table 2. The estimation results are reported in Table B.1 in Appendix B. While HAZ is considered to represent the long-term accumulation of health-related inputs more accurately, we find the same pattern of negative birth order effects, albeit smaller in magnitude, for WAZ and underweight. In contrast, WHZ represents a short-term index for acute undernutrition, and we find almost no birth order difference for WHZ or wasting. The results in Table 2 and Table B.1 imply that children born later in the birth order tend to become more stunted and underweight. In the following sections, we focus on the analysis using HAZ as an outcome for further investigation.

4.2 Heterogeneity Analysis

The underlying causes of the negative associations between birth order and child health could be attributed to parental behavior or a higher preference for older children or sons (Bishwakarma & Villa, 2019; Jayachandran & Pande, 2017), indicating the existence of a household resource allocation effect. We hypothesize that the adverse birth order effects on health found in the previous section differ across children with child- and household-specific characteristics and backgrounds. Therefore, in this section, we investigate heterogeneous associations between birth order and child health using various subsamples. We estimate Equation 2 to seek detailed explanations behind the effects to produce policy-relevant findings.

4.2.1 Heterogeneity by Child and Household Head's Gender, and Household Location

We begin by exploring the heterogeneity arising from a child's gender. The results in Panel A of Table 3 indicate that while small and negative correlations between birth order and HAZ exist for boys, as shown in column (2), there are significant and negative birth order effects on HAZ for girls, seen in column (1). This implies that, compared to boys, the health of later-born girls may be considered less important by their parents. Next, we investigate the heterogeneous associations between birth order and HAZ based on the gender of the household head and the household's location, shown in Panels B and C of Table 3. Most households (nearly 92%) are headed by males. Column (2) in Panel B shows a significant negative association between birth order and HAZ for male-headed households, but not among children in female-headed households, as shown in column (1). Women's autonomy or bargaining power in households is known to raise children nutritional health (Rahman et al., 2015; Holland & Rammohan, 2019); thus, the negative relationship between birth order and HAZ could be mitigated when the household head is female. In addition, Panel C shows a negative association between birth order and HAZ only for those living in rural areas, which represents the majority of people in Bangladesh.

[Table 3 About Here]

4.2.2 Heterogeneity by Household Wealth Index

Next, we examine whether the observed negative associations between birth order and HAZ vary among children from households at different wealth levels, which can affect parental preferences and the availability of household resources. For the household wealth index, we use a variable in the DHS dataset that is based on information about household assets, facilities, and consumer goods. The estimates based on the wealth index, as reported in Table 4, clearly show that significant negative birth order effects are found among children from the poorest and poorer households. Moreover, the magnitude and gradient are higher for those in groups with less wealth relative to the other groups.[12]

[Table 4 About Here]

4.2.3 Heterogeneity by Age of Child

Finally, we examine whether the negative relationship between birth order and HAZ differs by the child's age. Our sample consists of children under age five. Here, we split the sample into age cohorts by year and present the estimation results in Table 5, from age zero (below one year) in column (1) to age four in column (5). We obtain low and insignificant coefficients for birth order variables for ages zero and one in columns (1) and (2). In contrast, columns (3) to (5) show the decreasing effects of being born later increase as a child's age increases. In particular, the associations are more pronounced in the group of two and three-year-old: children born third or later in the birth order have a HAZ that is 0.30 to 0.36 SDs lower the HAZ of those born first. We attribute the insignificant results

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[12] This finding contrasts with Jayachandran and Pande (2017), who suggest the effect is steeper for children from richer families (however, their results are not presented in their study).

for ages zero and one, in part, to the high rate of breastfeeding in Bangladesh (DHS, 2020). Moreover, as HAZ represents the accumulation of nutritional inputs, a deterioration in nutritional status for infants may not be apparent before age two. Additionally, a general phenomenon observed in developing countries, known as growth faltering, whereby children's growth stagnates in the first two years of life, may also explain the sharp decline in HAZ at the age of two (Rieger & Trommlerová, 2016).

[Table 5 About Here]

4.3 Robustness Checks

In this section, we check the robustness of our main findings presented in Table 2 by examining two ways that may introduce biases in our estimates. The first arises from the possibility that the effects may be larger for, or specific to children whose mothers might have more children, as households with completed fertility may be able to allocate more resources for their later-born children than households where fertility is completed. If this is the case, the estimates shown in Tables 2 and onward may suffer from bias. Here, we re-estimate our model using the preferred specification (i.e., with a full set of controls) after dividing the sample into children from mothers whose fertility is completed versus those whose mothers might still have more children. To do so, we rely on a variable based on a question that asks women whether their fertility is completed. We consider the mothers' responses of "wants no more" and "sterilized" as indicators of completed fertility, and all other responses as not completed. Nearly 40% of mothers have not completed their fertility. The results in Table 6 indicate that while the coefficients are larger for the households where fertility is incomplete, shown in columns (1) to (3), the pattern and significance remain consistent with the results in Table 2. These relationships may indicate that children in fertility-incomplete households may receive fewer resources from their parents, which is the scenario we hypothesized previously.

[Table 6 About Here]

While our models using variables up to the third child in the birth order are based on prior studies as described in Section 3.2, there is no theoretical justification for selecting this number of dummy variables for birth order. The negative birth order gradient we have seen thus far should not be substantially altered if the third(+) born variable is disaggregated further. Here, we examine the stability of the results in columns (5) to (7) of Table 2 by using birth-order dummies up to five(+).[13] The estimation results presented in Table 7 show the coefficients remain virtually unchanged, ruling out the possibility of subjective selection of the birth order dummies included in our main specification. In addition, consistent with our hypothesis noted in Section 3.2, the estimated coefficients for later birth orders are larger than those for the second- and third-born and are statistically significant. This implies that nutritional and height disadvantages are larger for later-born children, which is consistent with our hypothesis.

[Table 7 About Here]

Beyond concern about the way our dummy variables are specified, family size may also influence our observed effects, as larger families have been associated with more pronounced negative impacts of birth order on educational outcomes (Black et al., 2005). Table B.2 in Appendix B shows the estimation results by the total number of children per household. While the observed patterns align with our main findings and are consistent across columns (1) to (3) in Table B.2, they reveal an intensifying negative impact of birth order on later-born children within larger families. This may be attributed to several

[13] Note that children born fourth represent roughly 8% (2,556) of the total sample; those born fifth or later comprise 9% (2,538) of the sample.

factors, including the dilution of parental resources and attention.

Finally, as Dhingra and Pingali (2021) find in India, the length of the preceding birth interval might confound the effects of birth order on child nutritional status. In their study, more pronounced negative birth order effects are observed in children born after shorter preceding birth intervals. However, we can only observe birth spacing starting with the second-born child. Therefore, we restrict our sample to children whose birth order is second or later and examine how the estimation result changes after controlling for the number of months since the end of the preceding pregnancy. To assess several birth-order coefficients, we use the specification employed in Table 7. The results in Table 8 show that while the sizes of the coefficients differ from those in Tables 2 and 7 due to the change in the reference group to second-born children, the pattern remains identical to our previous findings. These results together imply that birth spacing does not introduce a significant bias in our estimates.

[Table 8 About Here]

5 Discussion

Despite consistent efforts by the international community to address the issue, and the significant economic growth Bangladesh has experienced, the prevalence of child undernutrition remains high in the country. In this study, we investigate associations between birth order and child nutritional status in Bangladesh using data from the latest four rounds of the DHS, a nationally representative survey.

We first confirm that later-born children in Bangladesh exhibit health disadvantages, in line with previous findings (Dhingra & Pingali, 2021; Jayachandran & Pande, 2017), with third or later-born children being approximately 0.162 SDs smaller than their older siblings. This is not unique to Bangladesh; for example, as adults, first-borns tend to be taller in Sweden (Myrskylä et al., 2013) and HAZ scores are negatively associated with birth order in India (Chandna & Bhagowalia, 2024). In contrast, Pruckner et al. (2021) show that later-born children have better health endowments at birth in Austria, and Black et al. (2016) find that first-borns are more likely to be overweight or obese, and to have high blood pressure and high triglycerides. We also explore heterogeneous associations across key characteristics of children, parents, and households in Bangladesh. Our results suggest the negative birth order effect is specific to certain groups, with no significant positive associations found for any of the groups examined. Female children, children from poorer households, those living in rural areas, and those with a male household head have significantly lower HAZ scores, while none of these significant associations are found among their counterparts. These results are in line with Chandna and Bhagowalia (2024). Moreover, the negative birth-order gradient becomes apparent after one or two years of birth and diminishes by the age of four. This is new empirical evidence in the literature that indicates inequality in intrahousehold resource allocation is more important than physical characteristics at birth.

Finally, considering the potential existence of confounding factors due to the use of observational data, we examine the stability of the coefficients from our main analyses by estimating key variables with alternative specifications and conduct several robustness checks to assess the validity of our estimation results. Our findings are stable and not sensitive to the alternative specifications, confirming that the adverse nutritional effects observed are consistently associated with higher birth order, rather than any other unobserved heterogeneous factors. The findings in this study highlight an important relationship between birth order and child health in Bangladesh, suggesting that small family size has a role to play in reducing child malnutrition. Furthermore, this study identifies several factors such as child gender, households' income quintile, rural versus urban location, and the gender of the household head can impede or mitigate factors that should be considered in future policies and investments directed at improving children's health and achieving sustainable development goals in developing countries like

Bangladesh.

6 Conclusion and Policy Implication

We identify heterogeneous relationships between birth order and child health in Bangladesh, and find evidence that later-born children in the country are likely to benefit less from intrahousehold allocation, worsening their nutritional status. Moreover, later-born girls in contrast to boys are more likely to suffer from malnutrition. The adverse effects of birth order are mitigated when the household head is female, the household is relatively wealthy, or the family lives in an urban area. Furthermore, the effect of birth order on HAZ, which represents the accumulation of nutrition intakes, is found as children grow to age two and older. These heterogeneity analyses can be used to target health improvement interventions toward the most affected children and households, to maximize their impact and cost-effectiveness. While policy interventions providing micronutrients and nutritional education are important, other socioeconomic and demographic interventions are recommended to improve child food and nutritional security. Our findings offer important insights for future nutrition projects in Bangladesh and other countries with similar socioeconomic contexts. In particular, future projects, programs, investments, and policies aimed at improving child health need to account for birth order differences within households to tailor responses effectively.

Several issues in our study remain unaddressed. The major concern stems from the non-randomness of parents' decisions about whether to have more children and how much to invest in them. Our empirical specification includes a set of controls for parental and household characteristics, including whether the parents wanted to have more children, as explained in Section 3.2. The estimation results are stable whether or not these controls and various fixed effects are included, suggesting the effects of selection on unobserved characteristics might not bias our estimates significantly. It would be interesting to investigate how long the negative birth order effects persist, but we are unable to do so here because the DHS does not include anthropometric measures for children older than age five. If a persistent relationships exist and varies across groups of children, nutritional interventions should be targeted toward the most vulnerable populations.

Understanding the key drivers of deteriorating child health is imperative for better policymaking (Currie and Vogl, 2013). Future research should further explore the dynamics of birth order effects on child nutrition and human capital formation to enhance our understanding of these causal relationships and enable the design of more effective policy interventions.

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Tables and Figures

Table 1: Summary Statistics for Key Variables by Survey Periods

Variable	2007 (N = 5,743)	2011 (N = 8,281)	2014 (N = 7,507)	2017–18 (N = 8,312)
HAZ	−1.72	−1.67	−1.54	−1.38
	[1.36]	[1.41]	[1.34]	[1.32]
Stunted	0.42	0.41	0.37	0.31
	[0.49]	[0.49]	[0.48]	[0.46]
Severely Stunted	0.16	0.15	0.12	0.09
	[0.37]	[0.36]	[0.32]	[0.29]
First Born	0.33	0.35	0.39	0.38
	[0.47]	[0.48]	[0.49]	[0.49]
Second Born	0.26	0.29	0.30	0.32
	[0.44]	[0.45]	[0.46]	[0.47]
Third Born	0.17	0.17	0.16	0.17
	[0.37]	[0.38]	[0.36]	[0.37]
Fourth Born	0.11	0.09	0.08	0.07
	[0.31]	[0.29]	[0.27]	[0.26]
Fifth(+) Born	0.13	0.09	0.08	0.05
	[0.34]	[0.29]	[0.26]	[0.22]

Note: This table reports the mean and standard deviation values (in brackets) for children surveyed in the DHS 2007, 2011, 2014, and 2017–18. The sample consists of children below age five.

Table 2: Association between Birth Order and HAZ and Stunted

Dependent Variable	HAZ					Stunted	Severely Stunted
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Second Born	−0.0236	−0.0929***	−0.0599**	−0.0585**	−0.0546*	0.0275**	0.0256***
	(0.0194)	(0.0283)	(0.0292)	(0.0292)	(0.0291)	(0.0107)	(0.00780)
Third(+) Born	−0.289***	−0.282***	−0.172***	−0.166***	−0.162***	0.0725***	0.0439***
	(0.0198)	(0.0414)	(0.0435)	(0.0434)	(0.0433)	(0.0156)	(0.0118)
Control Variables	No	Yes	Yes	Yes	Yes	Yes	Yes
PSU FE	No	No	Yes	Yes	Yes	Yes	Yes
Survey Year-Month FE	No	No	No	Yes	Yes	Yes	Yes
Birth-Cohort FE	No	No	No	No	Yes	Yes	Yes
Observations	27,761	27,761	27,759	27,759	27,759	27,759	27,759
R-squared	0.00939	0.157	0.231	0.232	0.238	0.185	0.130

Note: Standard errors are clustered by mother and reported in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. For brevity, this table reports only the coefficients of interest based on Equation 2. Control variables include child, parent, and household characteristics described in Section 3.2 and listed in Table A.1 in Appendix A. PSU denotes the primary sampling unit.

Table 3: Heterogeneous Association between Birth Order and HAZ by Gender of Child and Household Head, and Household Location

Dependent Variable	HAZ	
	(1)	(2)
Panel A: Heterogeneity by Child's Gender		
	Girls	Boys
Second Born	−0.0981**	−0.00600
	(0.0437)	(0.0420)
Third(+) Born	−0.240***	−0.0936
	(0.0636)	(0.0622)
Observations	13,492	14,224
R-squared	0.301	0.280
Panel B: Heterogeneity by Household Head's Gender		
	Females	Males
Second Born	0.0757	−0.0569*
	(0.119)	(0.0309)
Third(+) Born	−0.142	−0.156***
	(0.173)	(0.0460)
Observations	2,266	25,048
R-squared	0.450	0.244
Panel C: Heterogeneity by Household Location		
	Rural	Urban
Second Born	−0.0723**	−0.000904
	(0.0357)	(0.0506)
Third(+) Born	−0.165***	−0.114
	(0.0524)	(0.0790)
Observations	18,699	9,057
R-squared	0.230	0.276
Control Variables	Yes	Yes
PSU FE	Yes	Yes
Survey Year-Month FE	Yes	Yes
Birth-Cohort FE	Yes	Yes

Note: Standard errors are clustered by mother and reported in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. For brevity, this table reports only the coefficients of interest based on Equation 2. Control variables include child, parent, and household characteristics described in Section 3.2 and listed in Table A.1 in Appendix A. PSU denotes the primary sampling unit. Panels A to C show the results with samples divided as indicated in the titles.

Table 4: Heterogeneous Association between Birth Order and HAZ by Wealth Index

Dependent Variable	HAZ				
	Poorest	Poorer	Middle	Richer	Richest
	(1)	(2)	(3)	(4)	(5)
Second Born	−0.195***	−0.0717	0.00537	−0.0305	−0.0169
	(0.0746)	(0.0729)	(0.0760)	(0.0707)	(0.0697)
Third(+) Born	−0.313***	−0.235**	−0.126	−0.0985	−0.0603
	(0.104)	(0.109)	(0.112)	(0.105)	(0.110)
Observations	5,784	5,258	5,013	5,196	5,375
R-squared	0.294	0.369	0.365	0.358	0.304
Control Variables	Yes	Yes	Yes	Yes	Yes
PSU FE	Yes	Yes	Yes	Yes	Yes
Survey Year-Month FE	Yes	Yes	Yes	Yes	Yes
Birth-Cohort FE	Yes	Yes	Yes	Yes	Yes

Note: Standard errors are clustered by mother and reported in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. For brevity, this table reports only the coefficients of interest based on Equation 2. Control variables include child, parent, and household characteristics described in Section 3.2 and listed in Table A.1 in Appendix A. PSU denotes the primary sampling unit.

Table 5: Heterogeneous Association between Birth Order and HAZ by Child Age

Dependent Variable	HAZ				
	Age 0	Age 1	Age 2	Age 3	Age 4
	(1)	(2)	(3)	(4)	(5)
Second Born	0.0963	0.00159	−0.0560	−0.268***	−0.160**
	(0.0797)	(0.0765)	(0.0764)	(0.0734)	(0.0678)
Third(+) Born	0.0800	−0.126	−0.300***	−0.364***	−0.192**
	(0.113)	(0.115)	(0.110)	(0.102)	(0.0961)
Observations	5,370	5,364	5,186	5,284	5,322
R-squared	0.318	0.367	0.388	0.378	0.394
Control Variables	Yes	Yes	Yes	Yes	Yes
PSU FE	Yes	Yes	Yes	Yes	Yes
Survey Year-Month FE	Yes	Yes	Yes	Yes	Yes
Birth-Cohort FE	Yes	Yes	Yes	Yes	Yes

Note: Standard errors are clustered by mother and reported in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. For brevity, this table reports only the coefficients of interest based on Equation 2. Control variables include child, parent, and household characteristics described in Section 3.2 and listed in Table A.1 in Appendix A. PSU denotes the primary sampling unit.

Table 6: Robustness Checks: Dividing Sample by Fertility Completion Status

Dependent Variable	Fertility-Incomplete Households HAZ	Fertility-Incomplete Households Stunted	Fertility-Incomplete Households Severely Stunted	Fertility-Completed Households HAZ	Fertility-Completed Households Stunted	Fertility-Completed Households Severely Stunted
	(1)	(2)	(3)	(4)	(5)	(6)
Second Born	0.00164	0.0133	0.0111	−0.0673	0.0304*	0.0321***
	(0.0448)	(0.0162)	(0.0119)	(0.0418)	(0.0159)	(0.0117)
Third(+) Born	−0.223***	0.0912***	0.0629***	−0.147**	0.0707***	0.0422***
	(0.0753)	(0.0275)	(0.0212)	(0.0585)	(0.0213)	(0.0161)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
PSU FE	Yes	Yes	Yes	Yes	Yes	Yes
Survey Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Birth-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,977	10,977	10,977	16,402	16,402	16,402
R-squared	0.320	0.264	0.213	0.270	0.222	0.166

Note: Standard errors are clustered by mother and reported in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. For brevity, this table reports only the coefficients of interest based on Equation 2. Control variables include child, parent, and household characteristics described in Section 3.2 and listed in Table A.1 in Appendix A. PSU denotes the primary sampling unit.

Table 7: Robustness Checks: Including Further Birth Order Dummies

Dependent Variable	HAZ	Stunted	Severely Stunted
	(1)	(2)	(3)
Second Born	−0.0630**	0.0302***	0.0281***
	(0.0292)	(0.0108)	(0.00781)
Third Born	−0.154***	0.0693***	0.0413***
	(0.0437)	(0.0157)	(0.0118)
Fourth Born	−0.245***	0.100***	0.0684***
	(0.0577)	(0.0208)	(0.0162)
Fifth(+) Born	−0.356***	0.132***	0.100***
	(0.0673)	(0.0242)	(0.0190)
Control Variables	Yes	Yes	Yes
PSU FE	Yes	Yes	Yes
Survey Year-Month FE	Yes	Yes	Yes
Birth-Cohort FE	Yes	Yes	Yes
Observations	27,759	27,759	27,759
R-squared	0.239	0.185	0.130

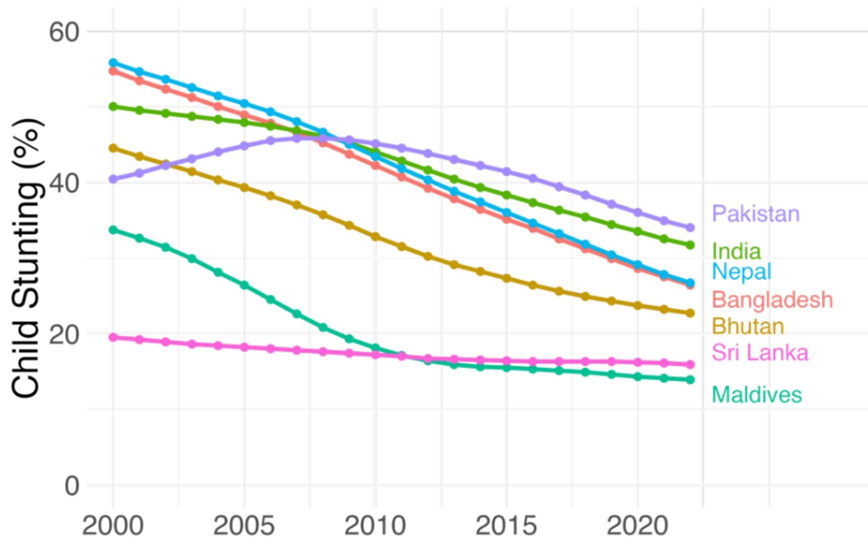
Note: Standard errors are clustered by mother and reported in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. For brevity, this table reports only the coefficients of interest based on Equation 2. Control variables include child, parent, and household characteristics described in Section 3.2 and listed in Table A.1 in Appendix A. PSU denotes the primary sampling unit.

Table 8: Robustness Checks: Controlling for Preceding Birth Spacing

Dependent Variable	HAZ	Stunted	Severely Stunted
	(1)	(2)	(3)
Third Born	−0.0703*	0.0336**	0.0112
	(0.0365)	(0.0131)	(0.00991)
Fourth Born	−0.158***	0.0631***	0.0314**
	(0.0539)	(0.0193)	(0.0153)
Fifth(+) Born	−0.238***	0.0827***	0.0531***
	(0.0665)	(0.0239)	(0.0190)
Control Variables	Yes	Yes	Yes
Preceding Birth Spacing	Yes	Yes	Yes
PSU FE	Yes	Yes	Yes
Survey Year-Month FE	Yes	Yes	Yes
Birth-Cohort FE	Yes	Yes	Yes
Observations	17,592	17,592	17,592
R-squared	0.270	0.217	0.166

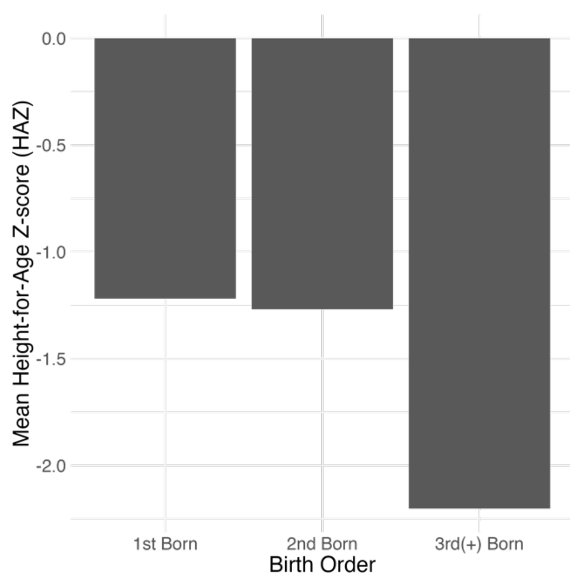
Note: Standard errors are clustered by mother and reported in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. For brevity, this table reports only the coefficients of interest based on Equation 2. Control variables include child, parent, and household characteristics described in Section 3.2 and listed in Table A.1 in Appendix A. PSU denotes the primary sampling unit.

Figure 1: Percentage of Child Stunting in South Asia from 2000 to 2022



Note: The figure shows the percentage of stunting in children under age five from the years 2000 to 2022 for South Asian countries. Data are from the UNICEF/WHO/World Bank joint child malnutrition estimates, which can be downloaded from: https://data.unicef.org/topic/nutrition/malnutrition/.

Figure 2: Child Height-for-Age Z-score by Birth Order



Note: The figure plots the mean child height-for-age z-score (HAZ) of children in our sample by birth order. 3rd(+) Born includes children born third or later in the birth order.

Online Appendix for

Revisiting Birth Order Effects on Child Health: Evidence from Bangladesh

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This Online Appendix accompanies the paper "Revisiting Birth Order Effects on Child Health: Evidence from Bangladesh" and is not for publication. Section A includes a figure and table that provide further detail on the discussions in the main text. Section B presents the results of supplementary analyses using other nutritional outcome variables, weight-for-age z-score (WAZ), underweight, weight-for-height z-score (WHZ), and wasting.

Appendix A Supplementary Figure and Table

Figure A.1: Location of Survey Clusters in Bangladesh DHS

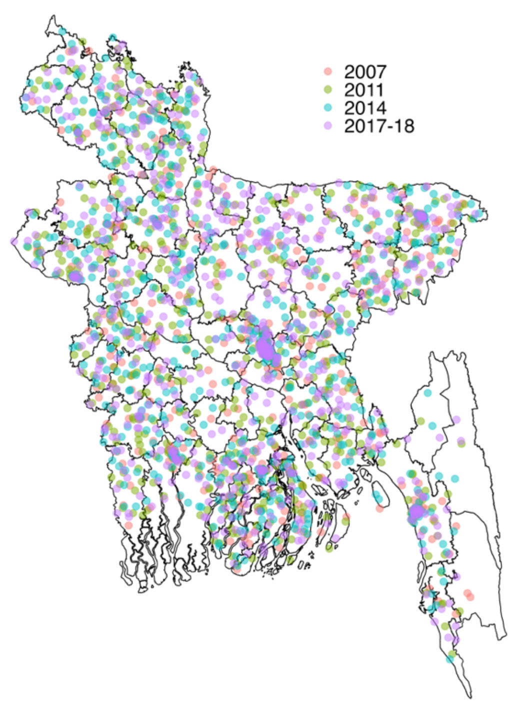

Table A.1: Summary Statistics for Other Outcomes and Control Variables by Survey Periods

Variable	Description	2007 (*N* = 5,743)	2011 (*N* = 8,281)	2014 (*N* = 7,507)	2017–18 (*N* = 8,312)
WAZ	Weight-for-Age Z-score	−1.704 [1.124]	−1.590 [1.151]	−1.491 [1.124]	−1.178 [1.123]
Underweight	WAZ < −2SD	0.398 [0.490]	0.358 [0.479]	0.324 [0.468]	0.224 [0.417]
Severely underweight	WAZ < −3SD	0.116 [0.321]	0.099 [0.298]	0.079 [0.270]	0.043 [0.203]
WHZ	Weight-for-Height Z-score	−1.026 [1.091]	−0.921 [1.199]	−0.893 [1.142]	−0.541 [1.149]
Wasted	WHZ < −2SD	0.169 [0.375]	0.155 [0.362]	0.144 [0.351]	0.085 [0.279]
Severely Wasted	WHZ < −3SD	0.031 [0.173]	0.038 [0.191]	0.031 [0.172]	0.016 [0.124]
Female	1 if a child is female	0.493 [0.500]	0.488 [0.500]	0.485 [0.500]	0.479 [0.500]
Child's age (month)	Age in month	29.69 [17.07]	30.13 [17.50]	29.53 [17.08]	28.81 [17.58]
Distance-2	1 if child's birth order is 2 or more higher than ideal number of children	0.183 [0.384]	0.148 [0.354]	0.120 [0.322]	0.091 [0.287]
Distance-1	1 if child's birth order is 1 higher than the ideal number of children	0.159 [0.362]	0.160 [0.365]	0.151 [0.355]	0.151 [0.358]
Distance0	1 if child's birth order is same as the ideal number of children	0.273 [0.445]	0.311 [0.463]	0.311 [0.463]	0.325 [0.468]
Distance+1	1 if child's birth order is 1 lower than ideal number of children	0.314 [0.459]	0.340 [0.471]	0.366 [0.479]	0.376 [0.484]
Distance+2	1 if child's birth order is 2 or more lower than ideal number of children	0.142 [0.509]	0.081 [0.391]	0.104 [0.442]	0.114 [0.463]
Mother's age	Age in years	25.82 [6.182]	25.61 [5.906]	25.55 [5.855]	25.81 [5.675]
Mother's education	Attendance in years	4.893 [4.316]	5.556 [3.875]	6.094 [3.873]	6.815 [3.797]
Mother working	1 if a mother currently works	0.237 [0.425]	0.095 [0.293]	0.247 [0.431]	0.403 [0.491]
Father's age	Age in years	35.29 [8.494]	34.59 [8.851]	34.01 [7.724]	33.73 [7.085]
Father's education	Attendance in years	4.852 [4.855]	5.364 [4.684]	5.615 [4.686]	6.342 [4.595]
Poorest	1 if HH wealth is in the lowest quintile	0.198 [0.399]	0.220 [0.415]	0.218 [0.413]	0.220 [0.414]
Poorer	1 if HH wealth is in the second lowest quintile	0.207 [0.405]	0.193 [0.395]	0.189 [0.391]	0.201 [0.400]
Middle	1 if HH wealth is in the middle quintile	0.186 [0.389]	0.190 [0.392]	0.194 [0.395]	0.178 [0.383]
Richer	1 if HH wealth is in the second highest quintile	0.187 [0.390]	0.196 [0.397]	0.203 [0.402]	0.197 [0.398]
Richest	1 if HH wealth is in the highest quintile	0.222 [0.415]	0.201 [0.401]	0.196 [0.397]	0.205 [0.403]
Fertility completed	1 if HH completed fertility	0.620 [0.481]	0.626 [0.484]	0.585 [0.490]	0.564 [0.492]
Female HH head	1 if HH head is female	0.092 [0.289]	0.081 [0.272]	0.093 [0.291]	0.125 [0.331]
Rural	1 if HH is in rural area	0.655 [0.475]	0.696 [0.460]	0.683 [0.465]	0.655 [0.476]
Open pit latrine	1 if HH uses open pit latrine	0.537 [0.499]	0.604 [0.489]	0.606 [0.489]	0.542 [0.498]
Piped water	1 if HH use piped water for drinking	0.058 [0.233]	0.081 [0.272]	0.057 [0.232]	0.059 [0.236]

Note: This table reports the mean and standard deviation values in the square bracket for children surveyed in the DHS 2007, 2011, 2014, and 2017–18. The sample consists of children below the age of five. HH means Household. The variables in this table are described in Section 3.2.

Appendix B Additional Regressions

Birth Order Effects on Other Nutrition Status. We use height-for-age z-score (HAZ) and corresponding stunting variables in our regression analyses because HAZ is a longer-term indicator of chronic undernutrition or stunting. However, as discussed in Section 3.1, there are other nutritional variables available from DHS, namely weight-for-age z-score (WAZ) and weight-for-height z-score (WHZ). WAZ indicates both acute and chronic undernutrition, defining underweight. In contrast, WHZ is a short-time nutritional index that represents acute undernutrition, defining wasting caused by a deficiency in recent nutritional intake.

The estimation results using Equation 2 are presented in Table B.1. For WAZ and (severely) underweight in columns (1) to (3), we observe similar negative association between birth order and the outcome variables. Almost no association with WHZ and (severe) wasting in columns (4) to (6) suggest that birth order effects appear in the measures of the accumulation of nutrition, but not in the those representing a recent manifestation of nutritional intake. These results are not surprising as there would be no conceivable pathway for birth order to disrupt nutritional status in the short term.

Birth Order Effects by the Number of Children. As discussed in Section 4.3, here, we assess whether household size influences birth order effects. Table B.2 details the estimation results for households with two to four children. Estimations for one-child households are not applicable as they lack subsequent birth order for comparison, and our dataset lacks a sufficient sample size for families with five or more children to estimate our model specification. The findings confirm negative associations with increasing family size.

Table B.1: Association between Birth Order and WAZ (Underweight) and WHZ (Wasting)

Dependent Variable	WAZ	Under weight	Severely Under weight	WHZ	Wasted	Severely Wasted
	(1)	(2)	(3)	(4)	(5)	(6)
Second Born	−0.0503**	0.0196*	0.0157**	−0.0255	0.000789	−0.00475
	(0.0245)	(0.0104)	(0.00648)	(0.0266)	(0.00808)	(0.00385)
Third(+) Born	−0.146***	0.0415***	0.0215**	−0.0653*	−0.0115	−0.00040
	(0.0352)	(0.0152)	(0.00955)	(0.0381)	(0.0116)	(0.00569)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
PSU FE	Yes	Yes	Yes	Yes	Yes	Yes
Survey Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Birth-Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	27,960	27,960	27,960	27,741	27,741	27,741
R-squared	0.320	0.264	0.213	0.270	0.222	0.166

Note: Standard errors are clustered by mother and reported in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. For brevity, this table reports only the coefficients of interest based on Equation 2. Control variables include child, parent, and household characteristics described in Section 3.1 and listed in Table A.1 in Appendix A. PSU denotes the primary sampling unit.

Table B.2: Association between Birth Order and Child Health by the Number of Children

	Total Number of Children Born to the Household		
	2 Children	3 Children	4 Children
	(1)	(2)	(3)
Panel A: Dependent Variable = HAZ			
Second Born	−0.0155	−0.181	−1.527**
	(0.0564)	(0.166)	(0.612)
Third(+) Born		−0.311*	−2.166***
		(0.180)	(0.614)
R-squared	0.355	0.404	0.481
Panel B: Dependent Variable = Stunted			
Second Born	0.0219	0.0861	0.597**
	(0.0220)	(0.0643)	(0.249)
Third(+) Born		0.146**	0.737***
		(0.0702)	(0.0460)
R-squared	0.293	0.364	0.442
Panel C: Dependent Variable = Severely Stunted			
Second Born	0.0319**	0.115***	0.414**
	(0.0162)	(0.0437)	(0.206)
Third(+) Born		0.0887*	0.622***
		(0.0472)	(0.198)
R-squared	0.228	0.337	0.432
Observations	8,890	4,729	2,268
Control Variables	Yes	Yes	Yes
PSU FE	Yes	Yes	Yes
Survey Year-Month FE	Yes	Yes	Yes
Birth-Cohort FE	Yes	Yes	Yes

Note: Standard errors are clustered by mother and reported in parentheses. *, **, and *** denote statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively. For brevity, this table reports only the coefficients of interest based on Equation 2. Control variables include child, parent, and household characteristics described in Section 3.2 and listed in Table A.1 in Appendix A. PSU denotes the primary sampling unit.