Implementation and Effects of India's National School-Based Iron Supplementation Program

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Reducing the rate of anemia is a primary public health concern in many developing countries. This paper studies the Indian government's school-based Iron and Folic Acid (IFA) supplementation program. We provide a descriptive analysis of program implementation patterns across 377 schools in the state of Odisha. We document that the more advantaged blocks had more consistent tablet distribution, and that distribution *within* the less advantaged blocks was less predictable, and plausibly random. We use this quasi-random variation to estimate the causal effect of the policy using a difference-in-differences strategy. The IFA program had no effect on hemoglobin levels at the mean, but there is a significantly larger effect for moderately anemic students in schools that were more recently distributing tablets, relative to schools that had run out of tablets. These results suggest that school-based supplementation has the potential to improve hemoglobin levels, but that breaks in supplementation – either due to inconsistent tablet distribution or the constraints of a school calendar – limit the long-term efficacy of school-based supplementation programs.

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Introduction

Anemia is the most prevalent nutritional disorder in the world, causing irreparable damage to millions of individuals through poor health, early death, and lost wages (WHO 2015). It is particularly harmful to children, causing cognitive and physical developmental delays and weakened immune systems. Anemia can be caused by deficiencies of several nutrients, including iron and folate. India has one of the highest rates of anemia in the world, with prevalence rates of 60-70 percent among school-aged children. To combat anemia, the Government of India recently implemented a national school-based iron and folic acid (IFA) supplementation program. Similar to many other countries, the government often relies on school infrastructure to implement nutrition programs that target children, but there may be limitations to school-based distribution. Inconsistent implementation, either due to corruption or other leakages, and breaks in treatment, either due to school absence or scheduled school holidays, can limit the efficacy of school-based nutrient supplementation. More generally, implementation issues can plague the evaluation of any government policy, leading researchers and policy-makers to draw the wrong conclusion about a policy's potential impact (Duflo 2017). Using detailed survey data during the program's roll-out, this paper evaluates the IFA program along two dimensions: the pattern of program implementation, and the effect of the program on students' hemoglobin levels.

To examine the implementation patterns of this program, we focus on a sample of 377 schools across five administrative blocks in Kendujhar district in Odisha during the 2013-2014 school year, the first year that the IFA program was implemented. During this year, schools were to distribute tablets daily to primary school children for exactly 100 consecutive school days. All schools were meant to receive tablets, but there was substantial variation in how many schools per block reported actually receiving tablets from the government. In two blocks, more than 95 percent of schools received tablets from the government. In the remaining three blocks, 56, 83, and 81 percent of schools received tablets, respectively. Our survey data suggests that schools in the first two blocks serve a more advantaged population than schools in the remaining three blocks. Within the blocks that experienced more varied distribution of iron tablets, however, school receipt of the tablets appears random. Within those three high-variation blocks, we find no evidence of a systematic relationship between school characteristics or student demographics and tablet receipt from the government. This quasi-random variation in implementation allows us to causally identify the effect of the supplementation program on student outcomes.

We have two main findings with respect to child outcomes. First, estimating a differences-in-differences (DD) model comparing schools within a block, we find that attending a school that received tablets had no detectable effect on children's hemoglobin levels on average. Our parallel trends assumption is supported by the fact that there are few significant differences between the schools that received tablets and schools that did not within the high-variation blocks; nevertheless, we confirm that controlling for a host of baseline school and household characteristics does not affect this result. Motivated by a consensus in the nutrition literature that children with lower initial hemoglobin levels exhibit larger gains from iron supplementation (WHO 2001; Abrams et al. 2008), we examine heterogeneity by initial anemia status. We find larger coefficients for mildly anemic children, but not for moderately anemic children, possibly because of low attendance, and none of these groups experience statistically significant improvements.

Given the design of the program (100 consecutive school-days of supplementation within the school-year), it is plausible that these results may understate the effect of supplementation due to timing discrepancies between iron tablet distribution and hemoglobin measurement. To test this hypothesis, we exploit variation in how recently iron supplements were distributed. Even if students had experienced an increase in hemoglobin levels while receiving tablets consistently, these levels may have converged to those of students who had never received tablets by the time of hemoglobin measurement a few months later, particularly in schools that had run out of tablets earliest and for students who were initially the most anemic (who might have gone back to their initial diet, e.g.).

Our second finding is that, for the most anemic students at baseline, there are significantly larger gains in hemoglobin levels after IFA implementation in schools that distributed tablets most recently relative to schools that had not distributed tablets for at least three months. This result is robust to the inclusion of a wide range of baseline school and household characteristics.

We conclude that, on average, the time lag between when tablets were distributed and when hemoglobin levels were measured contributed to the lack of any detectable gains in hemoglobin, since many schools had run out of tablets before hemoglobin was measured. We believe these heterogeneous results, by initial hemoglobin status and how recently schools were distributing tablets, argue against large-scale leakages or non-compliance fully driving our null result. This result also highlights a key drawback to school-based supplementation even if implemented consistently: between rounds of supplementation in school, children's hemoglobin levels are likely to fall. The cause for the timing discrepancy in our case was unique to the program and study design, but breaks in the school calendar and long periods of absence, particularly in rural areas, are quite generalizable. A possible solution for breaks in supplementation is providing students with tablets to take home over vacations (as intended but not implemented in the first year of the IFA program). However, such a solution would require high rates of compliance at the household level, which many studies on a variety of health behaviors have found elusive.[2]

Our findings contribute to two strands of the literature. First, the descriptive results on the implementation of the IFA program contribute to the literature on public service delivery. A few recent papers have studied India's midday meals program, focusing on implementation (Debnath and Sekhri 2016), or on health and learning outcomes (Chakraborty and Jayaraman 2016; Krämer, Kumar and Vollmer 2018). A broader literature studies strategies to improve service delivery in other public sectors as well (Olken 2007; Bjorkman and Svensson 2009; Duflo et. al. 2012; Miller et. al. 2012; Muralidharan et. al. 2016; Rasul and Rogger 2018, among others). Duflo (2017) provides an overview of the role for economists in designing policy implementation, and argues that understanding the implementation of a well-intentioned policy is critical for drawing conclusions about its effectiveness.

Second, our findings on the impact of the program on child health contribute to the nutrition literature, by looking beyond the efficacy of increased iron intake and providing evidence for the effectiveness of a large-scale, school-based supplementation program. While many efficacy trials have established that the additional intake of iron can reduce the prevalence of anemia and improve physical health, nutrition, and cognitive development (see Gera et al. 2007 and Low et al. 2013 for reviews), it is unclear what policies are most effective at delivering iron supplementation to at-risk groups. Policies that aim to increase iron intake across a population may have very different effects from documented efficacy trials in which iron supplementation is largely regimented. Distribution of supplements through schools is often viewed as a viable policy that would use existing infrastructures to reach a large number of children. However, concrete evidence concerning the implementation and impact of large-scale iron supplementation programs is sparse – especially regarding distribution of the supplements in schools and school administrator, teacher, or student

[2] Closely related are papers looking at encouraging households to fortify foods with micronutrients; these studies find low take-up rates (Banerjee, Duflo, and Glennerster 2011; Banerjee, Barnhardt, and Duflo 2016). See Dupas (2011) for a review of literature seeking to understand take-up of health behaviors in developing countries more broadly.

compliance with program guidelines. While the magnitude of the empirical results presented here are obviously specific to a particular context (they depend on iron dosage, anemia prevalence and severity, compliance, etc.) they are some of the only estimates of the effects of a school-based IFA supplementation program implemented in the field.[3] Concerns about timing and consistent supplementation are likely relevant to school-based iron supplementation programs in general.

This paper is organized as follows. Section I describes background information on iron deficiency anemia, anemia in India, and the IFA supplementation program. Section II briefly discusses the existing literature on the effects of iron supplementation and the implementation of large-scale supplementation policies. Section III describes the data used in this analysis and Section IV.A presents the empirical methodologies used to estimate the effect of the supplementation program. Section IV.B provides an analysis of the implementation patterns of the program, which both supports necessary identifying assumptions and illustrates the elements of implementation that warrant attention in future years. Section V discusses the results of the empirical analysis, including the heterogeneity analysis suggesting that implementation issues, and not large-scale leakages, drive our null results. The final section concludes.

I. Background

I.A. Iron Deficiency and Iron Deficiency Anemia

Iron deficiency reflects different stages of iron depletion in the body and is diagnosed on a spectrum, with the most severe cases of iron deficiency resulting in iron deficiency anemia. Anemia is defined as a hemoglobin level more than two standard deviations below the mean hemoglobin level in a healthy population of the same gender and age and living at the same altitude (NIH 2015). Though anemia can be caused by other factors, the majority of anemia cases in India are caused by iron deficiency (Gupta et al. 2012). Iron-deficiency anemia is the most widespread nutritional deficiency in India today, affecting 70 percent of children under 5, 60-70 percent of school-aged children, and more than 60 percent of adolescent girls (Gupta et al. 2012; WHO 2008).

The effects of iron deficiency anemia on individual health range in severity. The functional deficits associated with low iron stores include gastrointestinal ailments, weakened immune systems, lethargy, and impaired cognitive and physical performance. In infants and children, untreated iron deficiency can cause psychomotor and cognitive abnormalities that persist

[3] We discuss related papers in the literature in Section II.

throughout adulthood as learning and cognitive impairments (NIH 2015; WHO 2001). Given that iron deficiency is both widespread and costly to measure, the WHO recommends that countries aiming to reduce rates of iron deficiency on a large scale target entire sub-populations with high rates of iron deficiency anemia (de Benoist et al. 2008; WHO 2001). School-based supplementation programs are often used in areas with high rates of child anemia. The potential advantages and disadvantages of school-based programs and alternative delivery methods are discussed below in Section II.

I.B. India's Iron and Folic Acid Supplementation Program

Beginning in January 2013, the national IFA supplementation program aimed to provide iron and folic acid tablets to all children and adolescents attending school, with the goal of reducing the prevalence and severity of anemia among school children. This paper examines the implementation patterns of the supplementation program over 377 schools in 5 administrative blocks of Kendujhar district, Odisha, and the effects of the program on student nutritional markers using panel data collected from 728 primary school students attending 157 schools in 3 of these blocks, before and after program implementation.

According to program guidelines distributed by central and state government officials, IFA supplements and deworming medication were to be distributed free of charge to all students attending school. Children 6-10 years old were to receive 30 mg of elemental iron and 250 mg of folic acid daily for 100 days out of a year, under supervision.[4] Students were also supposed to receive tablets to take home with them over school vacations. The program guidelines encouraged teachers to also take the tablets as role models for students, promoting supplement consumption. One dosage of deworming medication was also to be administered to each child every six months.

Implementation of the program relied on government officials at all administrative levels. The central government's Ministry of Health and Family Welfare was responsible for policy formation and technical support at the national level. In Odisha, the State Drug Management Unit (SDMU) procured IFA tablets and deworming medication at the state level and distributed the medications to each district drug store. There, the Deputy Manager of Reproductive and Child Health prepared lists detailing how many tablets were to be distributed to each block. The District

[4] The dosage and frequency of IFA supplementation for children aged 6-10 changed in the second year of the program to better align with the program design for older children.

Education Officer (DEO) then instructed the Block Education Officer (BEO) to acquire the medications as per the list prepared at the district drug store. Finally, the BEO had to supply each school in his block with the correct number of tablets. The calculations for the number of tablets per block were based on the school health plan for 2012-2013, which included enrollment data. Each block was supposed to receive 100 tablets per child enrolled in grades 1-5. Kendujhar district was responsible for distributing 20.5 million tablets for students in grades 1-5 (Government of Odisha 2012).

School headmasters were expected to receive the tablets and to provide them to the teacher in charge of IFA program implementation. This teacher was instructed to keep a ledger of supply and distribution, and was responsible for providing tablets to two adolescent female prefects, who distributed the IFA tablets to students. The central and state governments intended to monitor compliance intensively, with IFA program implementation information added to the school health records, along with information regarding the school lunch program. Every month, the BEO was supposed to monitor school compliance with both programs. A committee at the district level was supposed to monitor progress monthly, and a state committee quarterly.[5]

II. Literature Review

The research surrounding iron supplementation can be divided into two categories: efficacy trials and programmatic evaluations. Efficacy trials test the effects of increased iron intake, conditional on consumption of additional iron as a part of the treatment group or placebo as part of the control group. Compliance is highly monitored, and researchers play a key role in the distribution of supplements or fortified foods to the participants in the randomized controlled trial (RCT).

Efficacy trials of iron supplementation consistently find a decrease in the prevalence and severity of iron deficiency, despite varying locations, target groups, prevailing rates of iron deficiency, iron-providing intervention methods, and length of intervention. Two meta-analyses estimate that the overall effect of iron supplementation is to raise children's hemoglobin levels by 0.74-0.83 g/dL (Gera et al. 2007, Low et al. 2013). In general, the effects of supplementation on micronutrient deficiencies are largest for children who are deficient in that micronutrient and/or

[5] In a companion paper (Berry et al. 2019), we show that randomly-assigned increased monitoring of school lunches improved the implementation of the IFA program in its second year.

anemic at the outset of the study (Abrams et al. 2008, Tee et al. 1999). Across a variety of efficacy trials, the effect of iron supplementation on hemoglobin levels in the blood ranged from 0.95-1.8 g/dL for anemic children (Hirve et al. 2007; Ahmed et al. 2010; Tee et al. 1999; Gera et al. 2007; Abrams et al. 2008) and from 0-0.5 g/dL for non-anemic children (Hyder et al. 2007; Gera et al. 2007). Finally, folate deficiency often accompanies iron deficiency and can also cause anemia; as a result, simultaneously supplementing with iron and folic acid is common (WHO 2001).

These studies are valuable for their ability to inform policymakers of the potential impact of a supplement program under the best possible circumstances, i.e. close to 100 percent compliance, and for providing context for the magnitude of the effects of supplementation policies. However, they are not sufficient to fully inform policymakers on how to implement effective policy; policymakers also need to understand how iron supplements can best be delivered to individuals at risk of iron deficiency, and how to ensure increased iron intake among the target population. Possible delivery schemes include government distribution of supplements to local health clinics, households, or to schools. The health clinic, household, or school is then responsible for distributing tablets to children. All of these distribution methods face two similar limitations: (i) bureaucratic corruption and leakage within the system that affect government distribution of the tablets and (ii) large scale supplementation programs often must provide lower doses for safety reasons, which are ineffective at improving iron levels among the most anemic individuals. More targeted interventions (which can provide higher doses to more anemic members of the population) require baseline hemoglobin testing of large portions of the population, which is often prohibitively expensive and not recommended in contexts with widespread anemia (de Benoist et al. 2008; WHO 2001). Finally, ensuring continuous delivery such that iron stores do not get depleted is yet another important challenge, especially in the context of our study, where the delivery mechanism (namely, schools), is not available during school holidays.

Evidence further suggests that these limitations could render the IFA program ineffective and imply the importance of “at-scale” testing of iron supplementation interventions (Muralidharan and Niehaus 2017). In 1989, UNICEF provided India with millions of iron supplements to disburse to local health clinics. The state of Gujarat received millions of supplements, but they were poorly distributed to each health clinic, limiting the potential impact on health (Gillespie, Kevany, and Mason 1991). Banerjee, Barnhardt, and Duflo (2018) distribute double-fortified (iron and iodine) salt to households and find minimal effects on hemoglobin, which they attribute to the low levels of iron that can be safely added to food intended for large-scale distribution. The authors hypothesize that fortification in school may be more effective, since children respond more strongly to their intervention.

Other potential advantages of a school-based program include: (i) it does not require building additional infrastructure and therefore can be implemented quickly; (ii) teachers may serve as role models and encourage greater participation; and (iii) children who regularly attend school may receive supplements more regularly or frequently than if the supplements were distributed at a local health clinic (de Benoist et al. 2008; Stokols 1996; Anderman et al. 2009).

To evaluate school-based supplementation programs, several programmatic evaluations (RCTs randomized at the school level) provide supplements or fortified foods to schools, train teachers in supplementation distribution and monitoring of consumption, and report effects on school implementation outcomes as well as child health. These programmatic evaluations cannot offer insight on the limitations described above, since tablets are given directly to schools by researchers, but do provide evidence on additional limitations facing school-based distribution: low headmaster or teacher compliance in distributing tablets and low student compliance in consuming tablets.

The intake of iron supplements has potential side effects, which, while not harmful, can be uncomfortable or unappealing. Programmatic evaluations have found overall compliance rates ranging from 50-90 percent in a program in Indonesia, near 100 percent in rural China, and 80 percent in Sri Lanka; however these rates are likely positively influenced by random compliance checks researchers made to schools (Bloem et al. 2004; Luo et al. 2012; Ebenezer et al. 2013).

Supplementation programs with higher reported compliance rates find reduced prevalence of anemia and iron deficiency and improved knowledge of anemia (Luo et al. 2012; Vir et al. 2008). Other programs find no effect on anemia or iron deficiency prevalence and attribute the finding to poor compliance (Bloem et al. 2004; Ebenezer et al. 2013). The program most similar to the program evaluated in this paper was a school-based weekly IFA supplementation program in Uttar Pradesh, India, implemented by a non-governmental organization. The program incorporated a number of measures to ensure compliance, resulting in a relatively high compliance rate of 85 percent. A pre-post evaluation finds that over four years, the overall prevalence of anemia was reduced from 73 percent to 25 percent with weekly supplementation in schools (Vir et al. 2008). The national roll-out of the IFA supplementation program was, in part, modeled on this program.

Two final limitations of school-based programs have received less attention. First, teachers and school administrators may resent the use of their time to implement the program, especially if they already feel overworked (Kheirouri and Alizadeh 2014). Similarly, school-based nutrition programs could crowd out other school activities or other programs implemented in schools (Vermeersch and Kremer 2005, Berry et al. 2019). Second, these programs will only reach children enrolled in and regularly attending school – and more anemic children may have lower attendance rates. This issue is discussed further below.[6]

The results reported in this paper expand on the evidence from efficacy trials and programmatic evaluations by providing causal estimates of the effect of a large-scale iron supplementation program in a real-world context. Given the low levels of monitoring in India's IFA supplementation program, these findings are more generalizable than those of programmatic evaluations where supplements are distributed directly to schools. The programmatic evaluations described above randomize iron supplementation at the school level and thus cannot offer information about the patterns of distribution from the central government to schools. This paper's contribution is to combine the descriptive analysis of a national supplementation program's implementation with internally valid estimates of the effect of the program on children's hemoglobin levels.

III. Data

III.A. Timeline

The data were collected in Kendujhar District, Odisha, between 2012 and 2014 as part of an RCT studying the effects of school lunch fortification on children's health and schooling outcomes (see Figure 1 for a timeline overview). NGO partners were already operating in Odisha building a kitchen from which to distribute cooked meals to schools. We obtained a list of schools in the region from the local government and narrowed the sample to schools within the vicinity (roughly 50 kilometers) of the NGO's kitchen, which was located at the district headquarters. The

[6] One may also be concerned about school supplement provision crowding out household-based inputs. In our sample at baseline, 99 percent of students were not receiving any kind of supplement at home and only 9 percent of parents knew what the health condition 'anemia' was. Crowd-out of home inputs does not seem to be a concern in this context.

research team then approached the schools and randomly selected students from the roster of each school. Three children were randomly selected from each grade (1-5) in the school, and their households were then approached for participation in the surveys. The baseline survey for the RCT was completed between September 2012 and January 2013 and included a school survey and a household-level survey with detailed demographic questions. After obtaining parental consent, enumerators visited schools to measure the selected children's height, weight and hemoglobin levels.

In January 2013, following the completion of the baseline survey, the central government of India announced and began implementing the IFA supplementation program in schools. The RCT studying school lunch iron fortification was put on hold, given the potential for adverse impacts on health, as a result of the interactions between the two interventions. A year and a half later, in March and April 2014, the research team conducted an uptake survey to gauge the coverage and implementation of the IFA supplementation program (around the end of the school year). This survey asked school headmasters detailed questions about IFA tablet receipt from the government and distribution of the supplements to students attending school. The results from this uptake survey showed variation in program implementation at the school level, but only for three of the five administrative blocks. A midline child-level survey was completed in August and September 2014 (soon after the start of the next school year) in schools in these three blocks, which collected the same anthropometric measurements collected at baseline.[7] Due to budgetary constraints, only half of the study children were surveyed at midline. These baseline and midline surveys are the key to the analysis in this paper, as varied IFA program implementation took place among schools in the sample in the time period between the two surveys.

III.B. Sample

To understand the implementation patterns of the IFA program, we use all 377 schools sampled from five blocks in Kendujhar District. For each school, we observe a range of demographic information, details on implementation of the school lunch program, and measures of IFA program implementation. Of the 377 schools sampled, 157 schools are located in blocks that experienced variation in program implementation. In general, the blocks that experienced

[7] The original RCT intervention was implemented in the following 2014-2015 school year, and an endline survey was conducted in the spring of 2015. For details, see Berry et al. (2019). There was little variation in IFA implementation in its second year, and the endline data is not used in the analysis presented in this paper.

variation in IFA program implementation are located in poorer and more rural areas. We discuss differences between the high-variation and low-variation blocks in detail below.

To study the effect of the IFA program on student health, we focus on within-block comparisons and only include schools in the high-variation blocks. While this may impact the generalizability of this analysis, it is critical for internal validity; as we discuss further below, while schools in the high-variation blocks differ from schools in the low-variation blocks, the variation in tablet receipt *within* the high-variation blocks appears to be quasi-random. The final sample used to study the effect of the supplementation program includes 728 children attending the 157 schools in blocks with high variation in tablet distribution who were sampled at baseline and midline – approximately 2 children per grade in grades 1-5 in each school. The dataset is a balanced panel containing anthropometric measurements for each student before and after IFA program implementation, as well as a thorough set of baseline household and individual demographic characteristics. Approximately three-fourths of the children attended schools that reported receiving supplements from the government, while the other one-fourth attended schools that reported not receiving the supplements.

The federal Ministry of Health and Family Welfare introduced the IFA supplementation program on a national scale to address the very high levels of anemia in the school-age population. In our sample, more than half of the children tested at baseline present some level of anemia, and more than a third suffer from moderate or severe anemia.[8] In addition, this is a very poor population: more than 92 percent of households belong to a disadvantaged caste, and only three-quarters of schools have sufficient drinking water.

III.C. Measures of IFA Supplementation Program Implementation

We focus our analysis on the most straightforward measure of IFA program implementation: whether or not a school received tablets. We consider schools to be recipients of the IFA program (i.e. "treated") if they received either IFA tablets or deworming medication from their Block Education Officer (BEO) and non-recipients (i.e. "control") if they received neither.[9]

[8] We use guidelines from the World Health Organization (WHO) for labeling a child as anemic. For the majority of the sample (ages 5-11 years old), anemic students are those with hemoglobin levels below 11.5 g/dL, moderately anemic students are those with hemoglobin between 8-11 g/dL, and severely anemic students have levels below 8 g/dL (WHO 2015).

[9] All results are robust to two alternate definitions: (i) comparing schools that received both IFA and deworming tablets to schools that received neither (dropping schools that received only one or the other) and

Across the 377 schools with implementation data, 333 schools (88 percent) report receiving either IFA or deworming tablets and 44 report receiving neither. In the three blocks with high variation in IFA tablet distribution, 119 schools (76 percent) report receiving either IFA or deworming tablets and 38 schools report receiving neither. The most common reason that schools gave for why they didn't get the tablets (other than 'don't know') was that the BEO ran out of tablets.

The IFA uptake survey also asked headmasters how many tablets were received (as well as how many were distributed) but many headmasters were unable to provide clear records of this information. Unfortunately, we were unable to obtain any administrative records of the number of tablets disbursed to each BEO or to each school. Only 13 percent of headmasters were able to produce records from the school side. For this reason, we focus our analysis on headmaster report of IFA tablet receipt as the main treatment variable.

In addition, we corroborate this measure with other information on compliance reported not by the headmaster, but by children or by parents. As part of the school uptake survey, three children per school were randomly selected to answer several questions about the IFA program implementation in their school. For each school, we calculate the percent of those three children that reported receiving tablets daily. Several months later, at the time that their hemoglobin was measured, children were also asked whether or not they received any tablets during the previous school year. Consistent with the school reports within high-variation blocks, the percent of children reporting that they received supplements is higher among schools that reported receiving supplements, using both of these measures. School and child reports (from the time of hemoglobin measurement) match in 68 percent of the final sample of students. When hemoglobin was measured, we also asked parents whether their children had received supplements in school; this measure is also positively correlated with school reports.

Finally, we use school headmaster reports of whether or not they were still distributing tablets at the time of the school IFA uptake survey as a measure of how recently supplements were distributed. Across all five blocks, 45 percent of schools that had received tablets were still distributing them at the end of the school year. Given the intended design of the program (100

(ii) comparing schools that received IFA tablets to schools that did not receive IFA tablets, controlling for deworming receipt. These results are presented in the appendix. We are unable to disentangle the effects of IFA tablets and deworming medication; the second alternate definition of IFA receipt theoretically allows for such comparison, but the sample of schools receiving only IFA tablets or only deworming tablets is too small to infer the separate effects of IFA and deworming on hemoglobin levels from these results.

consecutive school-days of supplementation) and variation in when tablets were received, it is to be expected that some, but not all, schools would have completed tablet distribution by the time of the survey. We discuss this further below. Again, we corroborate this measure with student reports from the uptake survey. The three randomly chosen students were also asked whether they had received tablets the day before the survey. Among schools that were still distributing tablets, 59 percent of students reported receiving tablets the day before, but only 6 percent report receiving a tablet the day before in the remaining schools.[10]

IV. Empirical Strategy

IV.A. Effect of the IFA Supplementation Program

The main analysis in this paper uses a standard difference-in-difference (DD) strategy[11] comparing the change in hemoglobin levels for children who attended schools that received tablets and students who attended schools that did not, only within blocks that had quasi-random distribution of tablets (i.e. the "high variation" blocks). This specification takes the form:

$$Hb_{ist} = \beta_0 + \beta_1 IFA_s + \beta_2 post_t + \beta_3 (IFA_s \text{ x } post_t) + \varepsilon_{ist} \qquad (1)$$

where Hb_{ist} is the hemoglobin level of child i in school s at time t, IFA_s is an indicator for whether school s reported the receipt of IFA or deworming tablets, and $post_t$ is an indicator for whether hemoglobin measurement was taken after the IFA program was introduced (we have one pre-IFA and one post-IFA observation per child). Most specifications include age fixed effects and either block or school fixed effects.

In order to infer that β_3 is the causal effect of the IFA supplementation program, we need to assume that the health indicators of students in schools that received tablets and schools that did not would have been on the same trend in the absence of the IFA program. We discuss this assumption at length in Section IV.B. and point to few observable differences between schools that did and did not report receiving tablets, within the high-variation blocks. To ensure that these differences are not driving our results, we include school demographic controls interacted with $post_t$, and individual-level controls as additional control variables in our preferred specification.

[10] We provide more summary statistics comparing implementation by school classification in Section IV.B.
[11] We also estimate a lagged dependent variable (LDV) model; these results are largely consistent with results from the DD model and are presented in the appendix. This specification takes the form: $Hb^t_{is} = \beta_0 + \beta_1 IFA_s + \delta Hb^{t-1}_i + \varepsilon_{is}$.

School demographic controls include the distance from a school to block headquarters, whether or not a school has a kitchen, the percent of parents satisfied with implementation of the school lunch program, the percent of families per school employed in housework outside the home, the percent of families per school in a non-disadvantaged caste, average student BMI, an indicator for reporting receipt of midday meal rice on a regular schedule, and the percent of students who are moderately, mildly, and severely anemic. Individual demographic controls include gender, literacy, mother's education, caste status, housing quality, and whether or not the student's household has electricity. All school and individual controls are measured prior to IFA implementation.

Next, we estimate heterogeneous effects by comparing the difference in β_3 when Equation 1 is estimated separately for students at different points in the distribution of hemoglobin levels at baseline. This is an important estimate, since (biologically) we expect the impact of consistent iron supplementation to be largest for the most anemic students at baseline. As discussed in the introduction, however, lower school attendance among the most anemic students may counter this relationship.

The second heterogeneous effects estimation allows the effect of the IFA supplementation program to vary by whether or not students attended schools that were still distributing tablets at the time of the IFA uptake survey. This specification takes the form:

$$Hb_{ist} = \alpha_0 + \alpha_1 IFA_s + \alpha_2 post_t + \alpha_3 StillDist_s + \alpha_4(IFA_s \text{ x } post_t) + \alpha_5(IFA_s \text{ x } post_t \text{ x } StillDist) + \varepsilon_{ist} \qquad (2)$$

where $StillDist_s$ is an indicator variable that is equal to one if the school reported still distributing tablets at the time of the IFA survey and zero otherwise. To identify α_5, we assume that if all schools had stopped distributing tablets at the same time, students' health indicators would have been on the same trend in schools that were and were not actually still distributing tablets at the time of the IFA survey. As above, we find few differences between schools that were and were not still distributing tablets; we control for these to ensure they are not driving our results. We discuss additional evidence supporting the parallel trends assumptions for both specifications below.

IV.B. Implementation of the IFA Supplementation Program

Understanding the implementation patterns of the program in its first year is key to helping ensure that future waves of the program provide IFA tablets to every child in every school. It is also critical to the identifying assumptions necessary to estimate the causal effect of the IFA program on the children that received tablets in the first year of the program. There are many potential inefficiencies within this system: in order for the program to have any chance of improving the iron status of children, the IFA supplements need to be transported from the state headquarters and administered to each individual child. In this section, we focus on implementation at the block and school levels that might threaten the validity of our empirical strategy; in Section V.B. below, we discuss higher-level leakages and inefficiencies that might affect both this delivery mechanism for iron supplementation and other similar government-implemented programs.

More precisely, the validity of our empirical strategy could be threatened if receipt of tablets from the government is correlated either directly with anemia prevalence or with some other variable that also affects trends in hemoglobin levels. Recall that there is substantial variation in implementation at the block level. We show below that, while this variation *across* blocks matches patterns of school resource allocation we would expect (given little transparency or accountability and a weak incentive structure), the pattern of distribution to schools *within* the high-variation blocks appears to be quasi-random. Importantly, we provide evidence that students attending schools that received tablets in the high-variation blocks were not disproportionately more or less anemic. In addition, the patterns from our heterogeneity analysis by initial anemia status as well as our results on other outcome variables, such as height and weight, are consistent with the lack of differential trends in child health.

IV.B.1 Variation in IFA program implementation *across* blocks

Table 1 shows that the two blocks with over 95 percent of schools receiving tablets are systematically different from the three blocks with substantial variation in school receipt of tablets on a range of measures. Low variation (i.e., high implementation) blocks are more advantaged across a range of demographic variables (Panel A), have parents that are more involved in implementation of the school lunch program, and are more likely to receive rice for that meal on a regular schedule from the BEOs (Panel B). Interestingly, these blocks also have slightly higher anemia rates (Panel C). These differences suggest that, at some point in the tablet distribution schedule between the SDMU and the BEO, the less remote/more advantaged blocks systematically received more tablets.

In the blocks where almost all schools received tablets, implementation is more aligned with the stated IFA policy guidelines on every measurable dimension (Panel D).[12] In these low-variation blocks, 75 percent of children reported daily supplementation, 33 percent reported supplementation the previous day, and 53 percent of schools that received tablets were still distributing tablets at the time of the IFA uptake survey. On the other hand, in the high-variation blocks where only 76 percent of schools received tablets, only 43 percent of children reported receiving tablets daily, 18 percent reported receiving tablets the previous day, and only 34 percent of schools that received tablets were still distributing tablets at the time of the survey. Even conditioning on whether the schools in these high variation blocks received tablets, only 59 percent of children report daily supplementation and 25 percent report supplementation the previous day. The IFA program aimed to distribute 100 tablets per student to each school, but only 19 and 5 percent of schools reported receiving this many tablets in the low- and high-variation blocks, respectively.

IV.B.2 Variation in IFA program implementation *within* high-variation blocks

Though this low level of adherence to IFA policy implementation guidelines could limit the effect of the policy on children's hemoglobin levels (discussed in more detail below), the main concern for the identification strategy described above is whether schools within the high-variation blocks received IFA tablets systematically, or quasi-randomly. Within these three blocks, there are two possible explanations for why some schools report receiving tablets and others do not that could be particularly worrisome. First, this variation could be non-randomly influenced by the BEOs, if any unobservable characteristics are correlated with whether the BEO gave the school more tablets. Second, this variation could be non-randomly influenced by the schools, if unobservable characteristics are correlated with (a) how schools implement the IFA program or (b) how schools respond to the IFA survey. Of course, systematic distribution patterns would only introduce bias if they were correlated with hemoglobin level trends in children.

[12] The only statistically significant exception is whether children report tablet receipt at the time of hemoglobin measurement (4-6 months after the IFA uptake survey). Children were asked about ever receiving tablets in school and we suspect this may be confounded by the two types of tablets (iron and deworming). Parent reports of tablet receipt during the school year follow the same pattern as the other measures of implementation.

We first consider observable demographic differences between schools that received tablets and schools that did not, within the high-variation blocks (Table 2). There are several ways in which the BEO could decide to distribute tablets non-randomly. The BEO could choose to target or visit earlier schools closer to the block headquarters, schools that have more advantaged children, schools that he thinks need the tablets most, or schools that he thinks will be most effective in implementing the program. To test these hypotheses, we consider schools' distance to block headquarters and a set of demographic characteristics that proxy for socioeconomic status and student health (Panel A), and a set of variables that indicate a school's ability to implement a supplemental government program (Panel B).

As seen in Table 2, there are few observable differences between schools that received tablets and schools that did not on any of these measures.[13] The joint F-test that these variables explain whether or not a school received tablets has a p-value of 0.628. Appendix Tables 1 and 2 present results using the alternate definitions of 'IFA recipient' and 'non-recipient' described above; all conclusions are the same. Our preferred differences-in-differences specification is reported with and without a set of control variables that proxy for various decision-making processes that could influence BEOs, interacted with the indicator for the post-period. The inclusion of these control variables does not substantially alter the interpretation of the results, further supporting these conclusions.

Perhaps most importantly, there is no evidence that schools receiving tablets had students that were disproportionately more or less anemic. Overall within the three blocks with high variation in implementation rates, as well as within each block, there is no statistical difference in the prevalence of anemia, mild anemia, or moderate anemia between schools that received tablets from the government and schools that did not (Table 2, Panel C). Additionally, there is no difference in the mean hemoglobin level or in standard nutritional markers like BMI, weight and height (overall or differentiated by anemia status or gender). Figure 2 plots the kernel densities of students' hemoglobin levels in schools that did and did not get tablets and shows that the distribution of hemoglobin levels at baseline among study children is quite similar in both types of schools, for both anemic and non-anemic children.

[13] A similar analysis at the child-level with students who have anthropometric data at both baseline and midline (the final sample of children used in the analysis) confirms that there are no demographic or health differences in sample children at baseline between students in schools that receive tablets and those that do not (Appendix Table 13).

Additionally, there are several explanations founded in the data that support the idea that, in each of the blocks with variation in distribution, the BEO distributed tablets quasi-randomly. First, anemia rates in each village are not strongly correlated enough with any observable demographic characteristics to accurately target anemic students using observable characteristics. (Appendix Figure 1).[14] This fact is consistent with the literature that shows that in contexts with such widespread anemia and poverty, it is difficult to identify those most in need of iron supplementation without actually measuring iron deficiency (WHO 2015). Further, in this sample, only 9 percent of parents knew what the health condition called 'anemia' is before implementation of the IFA program, and this number increased to only 11 percent after IFA implementation. Of those who had heard of anemia before the IFA was implemented, only 21 percent (1.7 percent of the full sample) said they knew how to protect against anemia. This result suggests that few adults are aware of the use of iron supplements to treat the micronutrient deficiency, and thus that there is no market for iron supplements, even if a BEO wanted to sell them. Overall, these facts suggest that the BEO would distribute all of the provided tablets to schools, and that this would be done in a way unrelated to underlying trends in children's hemoglobin levels.

Of course, there could also be issues with implementation at the school level (e.g. tablets could be ruined due to poor storage, or tablets could be misplaced, misused, or sold on a market) which could keep tablets from reaching students. If this were the case, we would expect the headmasters to be less likely to report having received tablets from their BEO. Our measure of IFA receipt (schools' reports, since we unfortunately have no administrative records) would therefore be negatively correlated with such school-level compliance issues. However, as seen in Table 2, we find no evidence that IFA receipt, within high-variation blocks, is correlated with measures of MDM implementation, some of which were reported by parents (not headmasters), or other school-level variables such as the number of teachers or whether the school treats their water. In addition, in order for these implementation issues to negatively bias our estimates (and thereby

[14] Several of the variables tested do show statistically significant correlations with anemia rates and the signs of these significant correlations go in the direction one would expect: for example, the anemia rate is negatively correlated with the percent of households that have a phone or the percent of adults with no formal schooling. However, the plots in Appendix Figure 1 also show that (i) none of these variables alone explains more than 5 percent of the variation in anemia rates and (ii) the magnitude of the correlations suggest that it would be very impractical for BEOs to use these correlations to identify more anemic students (e.g. a 17 percentage point, or 1 standard deviation, increase in the percent of households with a phone indicates a 3 percentage point reduction in the anemia rate). With average anemia rates of 55 percent, this information would hardly be useful.

explain our estimated no effect), they would have to be positively correlated with anemia levels, which seems unlikely. Appendix Figure 1 shows that parent-reported measures of MDM implementation are negatively related to anemia levels (neither correlation is statistically significant). Percent anemic is also not correlated with a school having sufficient water or treating their water (results not shown). On the other hand, if headmasters still reported receiving tablets but did not distribute them due to these inefficiencies, this would not affect the causal interpretation of our results; it would be an issue of poor compliance and would lead to lower estimates of the effect of the program. We discuss the extent to which such compliance issues are driving our result in Section V.B. below.

IV.B.3 Variation in whether schools are still distributing tablets, within high-variation blocks

Finally, we consider the question of why some schools were still distributing tablets by the time of the IFA uptake survey while others were not. Mechanically, it must be related to when schools received tablets, the number of tablets provided per student, and/or patterns of distribution within school. Without administrative data or detailed data on timing of tablet receipt (only 9.9 percent of headmasters in high-variation blocks were able to provide records of tablet receipt, only 58 percent were able to say the month that they received tablets, and only 63 percent were able to say the month that they started distributing tablets), we are unable to provide precise explanations for this variation. Appendix Table 3 compares program implementation for the schools that were still distributing tablets and schools that had run out. Schools that had run out of tablets did receive fewer tablets (although this difference is not statistically significant), but do not appear to have distributed a higher fraction of tablets out of the number they received. They were also no more likely to halt distribution mid-way,[15] suggesting to us that the best explanation for why some schools ran out earlier has to do with the timing of tablet receipt from the BEO.[16] As discussed

[15] During the early months of the IFA program, there were well-publicized cases of children becoming sick after consuming IFA tablets (see, e.g. https://www.indiatoday.in/india/east/story/odisha-students-fall-ill-after-consuming-iron-supplements-212210-2013-09-25). It is possible that some schools paused IFA distribution at that time; some schools may have restarted distribution after it seemed safe to deliver supplements. It is also possible that some schools reported not receiving tablets to explain why they did not provide them to students, even if they did receive tablets but chose not to distribute them due to these news reports.

[16] Though there is variation in survey timing (IFA surveys spanned one month and midline hemoglobin measurement spanned three weeks), there are limited differences in timing between schools that received tablets and did not, or between schools that reported still distributing tablets or those that had run out. For example, schools that report that they are still distributing tablets were visited on average only 5 days before schools that had already run out and the distribution of dates is quite similar, suggesting that this variation

above, tablet receipt from the BEO could bias our results if it is correlated with school and household characteristics. Table 3 suggests that schools that are still distributing tablets at the time of the school survey appear very similar to schools that have run out on most dimensions, though the joint F-test across all variables is significant, due to three key differences that are worth noting:

First, schools that were still distributing tablets had a higher fraction of students classifying as anemic (although the difference in hemoglobin levels is very small and not statistically significant at conventional levels). This could be worrying if the BEO was targeting schools that had more anemic children to ensure consistent supplementation, but the magnitude of the difference is very small – approximately 4 kids out of more than 80 in primary school. It seems unlikely that the BEO or headmasters would perceive such a small difference, especially without universal testing. The fact that other socioeconomic differences sometimes go the other direction suggests it is unlikely the BEO was aiming to keep certain schools better stocked with tablets (or would have been able to, given which village characteristics are easily observable). Schools that ran out of tablets have slightly (not significantly) fewer households from disadvantaged castes and slightly more households with a phone or high-quality housing. Nevertheless, we control for the percent of students with the three different levels of anemia (which would add up to the percent with anemia) in our preferred specification.[17]

Second and third, schools that ran out of tablets are more likely to have a parent group operate the school lunch program and less likely to receive their rice for the school lunch program on a regular schedule. The latter indicates less frequent contact between the headmaster and the BEO, although this may be due to the participation of the parent group. This could be problematic if schools that were still distributing tablets were doing so because they were better managed or had a better relationship with the BEO. Again, other differences go in the other direction, suggesting this is unlikely to be the case. Schools that ran out of tablets are more likely to be

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stems from different numbers of tablets received and different distribution patterns during the school year, rather than differences in survey timing. Nevertheless, we control for school characteristics that may have been correlated with survey timing in our preferred specification.

[17] Appendix Table 14 presents similar analysis, at the child-level, for children in the high-variation blocks only. Children in schools that report still distributing tablets are more likely to be moderately anemic, have lower hemoglobin levels and weigh less at baseline, relative to schools that receive tablets but are not still distributing tablets. Our consistent results across both the DD and LDV models and with the inclusion of school and individual demographics make it unlikely that these differences are driving our results.

treating their water source (although not significantly) and parents report that their children receive just as many meals. Nevertheless, we control for these differences in our analysis.

A final question is what types of students were receiving tablets in school, conditional on school receipt of tablets from the government. On one hand, teachers could have tried to target the most anemic students, especially given the low number of tablets distributed to each school.[18] On the other hand, anemic students are more likely to be experiencing health effects that make them more likely to miss school and therefore less likely to receive tablets. Recall that, at the time of hemoglobin measurement, we asked children if they received tablets in school. Eighty-eight percent reported receiving tablets. Children who reported receiving tablets were significantly more likely to be female and less likely to be severely anemic (Appendix Table 4). When limiting the analysis to schools that are still distributing tablets at the time of the school survey, only the result for gender is statistically significant (Appendix Table 5). It is possible that teachers were targeting girls if they thought they were more likely to need supplementation, though gender differences in anemia rates do not appear until after puberty. It does seem that the most anemic students were less likely to receive supplements, likely due to lower attendance rates.[19] This is a note-worthy limitation of school-based supplementation programs.

V. Results

Table 4 presents results of the DD analysis estimating the effectiveness of the IFA program in raising student hemoglobin levels. The dependent variable is a child's hemoglobin level in g/dL and the key independent variable is an indicator for whether or not the school reported receiving tablets from the government interacted with an indicator for hemoglobin measurement after the implementation of the IFA program. Adding controls changes the magnitude of the estimated effect of the IFA program only slightly. Throughout, we will discuss the results from our preferred

[18] The IFA program was designed to have population-wide coverage of children in primary school. Schools are not required or expected to target the most anemic children with tablets. However, as part of the guidelines for the IFA program, teachers were to be trained to identify moderately and severely anemic students using the color of their nail beds in order to refer them to local health clinics for more treatment (Gupta et al. 2012). In the high-variation blocks, only 30 percent of school headmasters reported that training was delivered to school staff at the time that IFA tablets were delivered (40 percent reported no training, and 30 percent were unsure).
[19] In a companion paper, we show that in this setting, children's absence rate at school is monotonically decreasing in baseline hemoglobin level, where absences are proxied by the number of visits needed to measure children's hemoglobin levels (Berry et al. 2019).

specification which includes school fixed effects and additional demographic controls at both the school and child level (column 5).

As shown in Table 4, there is no measurable effect of the IFA program on student hemoglobin levels. In fact, the coefficients are quite small in magnitude, although the confidence intervals are large.[20] Appendix Tables 6 and 7 present analogous DD results using alternate definitions of IFA receipt and Appendix Table 8 presents analogous results using the LDV model. All conclusions are the same.[21]

Table 5 presents heterogeneous effects of the IFA program by baseline anemia status, motivated by the nutrition literature that finds larger impacts of supplementation for more anemic children. It is possible that the imprecise null effect on average is masking heterogeneity by initial baseline status. If tablet receipt was uniform across anemia levels within a school, and there were no differential trends in health between schools that received tablets and schools that did not (i.e. the parallel trends assumption held), we would expect bigger effects for more anemic children. However, if the most anemic children are less likely to attend school (e.g. due to lethargy), then there may be larger effects of the program for mildly anemic students relative to moderately anemic students. We divide the sample by baseline anemia status: non-anemic students (>11.5 g/dL), mildly anemic students (11-11.5 g/dL), and moderately anemic students (8-11 g/dL).[22] Note that there are substantial adverse health impacts of anemia even for children classified as "mildly" anemic (WHO 2011). The majority of the children in this sample are mildly or moderately anemic.

The estimates by baseline anemia status are largely too noisy to interpret conclusively. The point estimate of the effect of the IFA program is largest for mildly anemic children, consistent with the prediction above that mildly anemic students may benefit more from iron supplementation that is conditional on school attendance. That said, the effect is not significantly different from

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[20] To put the point estimates in context with other school-based supplementation programs, Krämer, Kumar and Vollmer (2018) provide double-fortified (with iron and iodine) salt to be used in midday meals in schools in Bihar and find that hemoglobin increases by 0.14 g/dL (se = 0.076). Luo et al. (2012) provide iron supplements in school to 4th graders in rural China and find that, on average, hemoglobin increases by 0.23 g/dL (se = 0.043) after one year.

[21] Appendix Table 15 presents results for this DD analysis with height, weight, and BMI as the outcome variables. Existing literature shows no effect of iron supplementation on height and mixed, inconclusive effects on weight (Low et al. 2013; Vucic et al. 2013). Appendix Table 15 shows that the IFA program had no effect on height, a small but significant effect on weight, and a marginally significant effect on BMI, both of which disappear with school-level controls.

[22] These hemoglobin cutoffs are as defined by WHO standards and apply to the majority of the sample (5-11yo). Several students outside this age range are classified by alternate age-appropriate cutoffs (WHO 2011).

zero for any group, and the p-value for the test that the effect across all three groups is equal is 0.31. The fact that the coefficient is negative for the moderately anemic group is surprising, but the large standard error supports a large confidence interval; we attribute this negative point estimate to noise. Appendix Tables 9 and 10 contain the results using alternate definitions of IFA receipt and Appendix Table 11 presents analogous results using the LDV model. All models yield similar results. Appendix Figure 2 displays results from a local linear regression of children's change in hemoglobin from baseline to midline on baseline hemoglobin; the results are consistent but similarly inconclusive.

V.A. Possible explanations

Having established the lack of a precisely estimated impact for even the most anemic children, we now turn to possible explanations for this result. We consider two possibilities: 1) leakages along the supply chain and 2) challenges in implementing school-based programs.

Recall the complicated distribution process for transporting tablets from the central government to students described in detail in Section I.B and that 76 percent of schools in the three high variation blocks received tablets from their BEO. While this suggests there are clearly some leakages within the first three stages of the chain of distribution (from the state to district, district to block, and block to schools), the leakages do not appear first order. The majority of schools did receive tablets, reaching almost 100 percent in the low-variation blocks, and schools that received tablets gave out most of the tablets they received (schools in both blocks also gave out 2 deworming doses as intended, on average). It is also worth noting that leakages along the supply chain would be problematic for alternative delivery models as well, as discussed in Section II.

Critically, the fact that we see no impact on child health on average even for the schools within high variation blocks that did receive tablets, as corroborated by reports from headmasters, children and parents, suggests that leakages higher up along the supply chain are not fully responsible for the null effect.[23] While we find few differences across schools (and control for the ones we find, ensuring they are not driving our result), we might also expect such leakages to positively bias our coefficients due to negative correlations with both tablet distribution and socio-economic status.

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[23] We also observe no significant relationship between reported tablets received per student and change in hemoglobin levels (results not shown).

It is also possible that leakages within school are driving our null result. However, as argued in Section IV.B.2, households in these villages are unaware of anemia and of how to treat it, even after the first year of IFA implementation (11 percent of parents knew what anemia was, only 1.7 percent of the parents knew how to treat it), suggesting there is little market for iron supplements even if BEO or school headmaster wanted to sell them. At the same time, poor compliance at the school level such as poor tablet storage or headmasters forgetting to distribute tablets could also explain our results. The fact that iron tablet receipt is corroborated by child and parent reports is supportive of the idea that headmasters are generally distributing the tablets when they receive them. Appendix Table 12 re-estimates our main results using child reports of tablets and parent reports of tablets and finds very similar results.[24] We acknowledge that these measures of IFA implementation are endogenous and likely suffer from recall bias, but we suspect most omitted variables would cause a positive bias. The fact that we still see no impact at the mean suggests to us that leakages and compliance within the school are not driving our null results.[25]

Finally, we turn to the challenges of implementing school-based supplementation. We distinguish these challenges from compliance: these limitations are related to headmasters implementing the IFA program as specified by the government, subject to the constraints inherent in a school-based program. Recall that the program specified children were to receive tablets for 100 consecutive school days per school year. Even if all schools had received the correct number of tablets, the school year is longer than 100 days, leaving long periods of time where children were not receiving supplements. While this feature may be specific to this program, breaks in the school year and periods of low attendance, especially in rural areas, would have the same effect and are more generalizable. Recall that, in our study, the children's hemoglobin was measured 4-6 months after our measures of IFA implementation. Based on the dates that schools reported

[24] Child attendance could also be considered a compliance issue within school– children need to attend school in order to receive the tablet. Recall that one of the child-reported measures was taken in school during the IFA uptake survey – three children in school were randomly chosen to be surveyed, making this measure conditional on attendance. The other measure, however, was recorded at the time of hemoglobin measurement and the sample was chosen from the school roster, not conditional on attendance. We see similar results with both measures.

[25] A related explanation is that children received the tablets but did not swallow them. Our data suggests that conditional on school and student receipt of IFA tablets, student compliance was high: surveys confirm that students who were receiving tablets in school were swallowing the tablets upon receipt. The student-reported compliance rate, conditional on receiving a tablet, was over 99 percent. While this high compliance rate may be over-reported due to interviewer scrutiny, it may also stem from student experience participating in the other school-based nutrition programs (i.e. the midday meal program) and the fact that students often took their supplements with the school meal.

receiving tablets and the number of tablets received per student, schools would have run out of tablets at least two months before children's hemoglobin levels were measured, if they were distributing tablets daily. Thus, the lack of an effect on student hemoglobin levels could be explained by timing: students' hemoglobin increased while they were receiving tablets but had returned to original levels by the time hemoglobin was measured. It can take several months for hemoglobin levels to build in the bloodstream and similarly, the effects on hemoglobin levels may decrease over the months after active supplementation ceases (Institute of Medicine, 2001).[26] To test this hypotheses, we examine heterogeneous effects by whether or not schools report running out of tablets by the time of the school survey, 4-6 months before hemoglobin was measured.

Tables 6 and 7 present the results. Table 6 uses the full sample; we estimate a larger effect of IFA supplementation among students with more recent iron supplementation than in schools that had already finished distributing tablets at the time of the IFA uptake survey, although the coefficient is not statistically significant in our preferred specification.[27] Table 7 splits the sample by baseline anemia status. We find positive point estimates for mildly anemic children whose schools ran out of tablets (consistent with the results in Table 5) and a larger effect for mildly anemic children who received tablets more recently, although both estimates and the difference between them are insignificant. Moderately anemic students whose schools ran out of tablets earlier have a negative point estimate (again consistent with the results in Table 5), and the effect for moderately anemic students who received tablets more recently is positive and significantly larger.[28] This result is consistent with the expectation that the students with the lowest baseline hemoglobin would experience the most rapid decline in hemoglobin after ending consistent supplementation (for example, if they went back to their initial diet).[29] These results suggest that

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[26] The amount of iron loss depends on several factors, including gender, blood volume, body weight, and weight velocity. Decreases in iron concentrations due to basal losses and growth of blood volume can be non-trivial. For example, for an average 8-year-old male, these losses total 0.87 mg of absorbed iron per day (Institute of Medicine, 2001).

[27] Appendix Tables 11 and 12 confirm that alternate definitions of IFA receipt yield the same conclusions, as does the LDV model (Appendix Table 13).

[28] Appendix Tables 14, 15, and 16 display these results using alternate definitions of IFA receipt and the LDV model, respectively; conclusions are the same. We also obtain similar, though insignificant, results using a child-reported measure of more recent supplementation – the percent of three children randomly surveyed during the school IFA uptake survey who report receiving tablets the previous day (see Appendix Tables 20 and 21). Given the measurement error in child-reported measures, the lack of precision is not surprising.

[29] We focus on hemoglobin as our primary outcome variable to maximize power; however, it is worth considering the magnitude of our results in terms of anemia classifications. Appendix Table 24 presents the effect of the IFA program on the likelihood of being anemic, mildly anemic, and moderately anemic using the

hemoglobin may have been measured too late to be able to detect an effect of supplementation in the majority of schools (68 percent of schools had already finished distributing tablets at the time of the IFA uptake survey), but that there was likely a positive effect of supplementation on hemoglobin while students were consistently receiving tablets. Note, however, that even among moderately anemic students receiving tablets more recently, the overall effect is still not significantly different from zero; while promising as an explanation for our null results, these heterogeneous results do not significantly alter the cautionary implications for school-based supplementation programs.

In sum, while leakages along the supply chain and compliance issues within school could explain our null result, our analysis suggests a lack of an effect on average even when children did receive the tablets. Digging further, we find suggestive evidence that the IFA tablets improved hemoglobin levels when tablets were being distributed but that hemoglobin levels fell back to baseline levels between periods of consistent supplementation.

VI. Conclusion

We examine the implementation of India's national school-based iron and folic acid supplementation program in its first year, and use quasi-random variation in tablet distribution to schools to evaluate the impact on child health. We find no evidence for an effect of the IFA program at the mean, but a larger effect for students that received tablets more recently relative to those that have gone at least four months without supplementation. The effect of the timing of when children received tablets was especially strong for the most at-risk children – that is, those with the lowest baseline hemoglobin.

There are several possible explanations for the null results at the mean. First, it is possible that students received too little iron to impact their hemoglobin levels. Second, they may have experienced an increase in hemoglobin while receiving supplements consistently, but their hemoglobin levels then fell due to an extended period without supplementation. In general, our findings that students receiving tablets more recently had a larger effect, and that this timing effect was largest for the most anemic students, lend more credence to the second explanation. This

preferred specifications from Tables 3-6. All results are similar to those discussed above; the IFA program had no effect on anemia rates at the mean, but for moderately anemic students in schools that were distributing tablets more recently, anemia rates fell by 14.4 percentage points (p-value = 0.101) more than they did in schools that had stopped distributing tablets earlier, relative to schools that did not receive tablets.

conclusion is largely consistent with other programmatic evaluations that find no effect of supplementation on hemoglobin levels and attribute their findings to poor compliance.

We conclude that India's school-based supplementation program may have the potential to improve children's hemoglobin levels, particularly if its implementation were more in line with policy guidelines. However, even with perfect tablet distribution to schools, the timing effect suggests that between rounds of supplementation in school, children's hemoglobin levels will fall. This could occur whenever schools run out of tablets or more systematically when students are out of school for long periods of time. There are two obvious solutions, although they may be difficult to implement: ensuring that schools receive enough tablets and providing students with tablets to take home over school vacations.[30]

In the second year of the program, 99 percent of the sample schools in all five blocks of Kendujhar District reported receiving tablets from the government. Of the schools in our sample that had received tablets in the first year and reported the number of tablets they received in both years (42 schools), more than half of them received more tablets per student in the second year than they did in the year before. The policy also changed from daily to weekly supplementation (with the appropriate change in dosage), which may lead to more consistent supplementation throughout the school year. If schools are able to provide more consistent supplementation, we are cautiously optimistic that the IFA program may have been more effective at improving children's hemoglobin levels in its second year.

[30] Of course, out-of-school tablet provision and student compliance will likely be different from in-school provision and compliance. Studies that rely on households to fortify food with micronutrients have found that ensuring consistent take-up is a significant challenge (Banerjee, Duflo and Glennerster 2011; Banerjee, Barnhardt and Duflo 2016).

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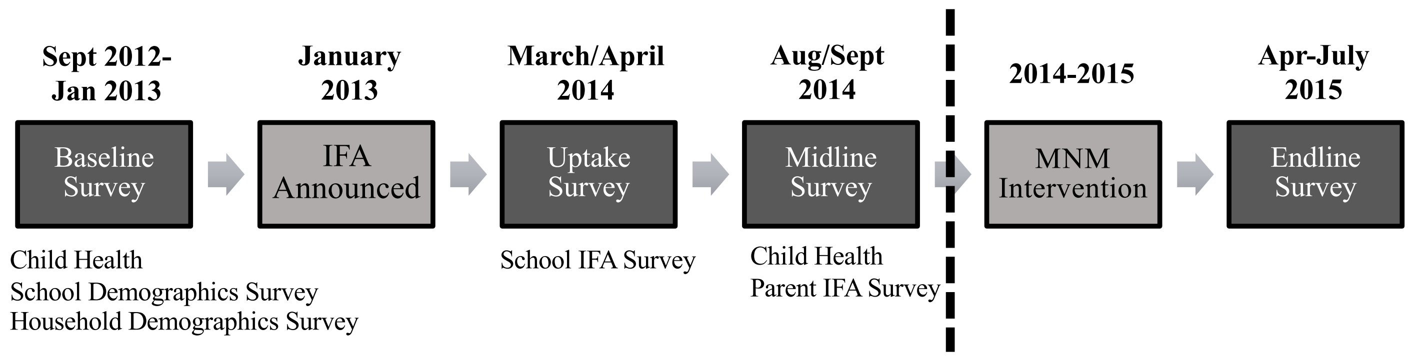
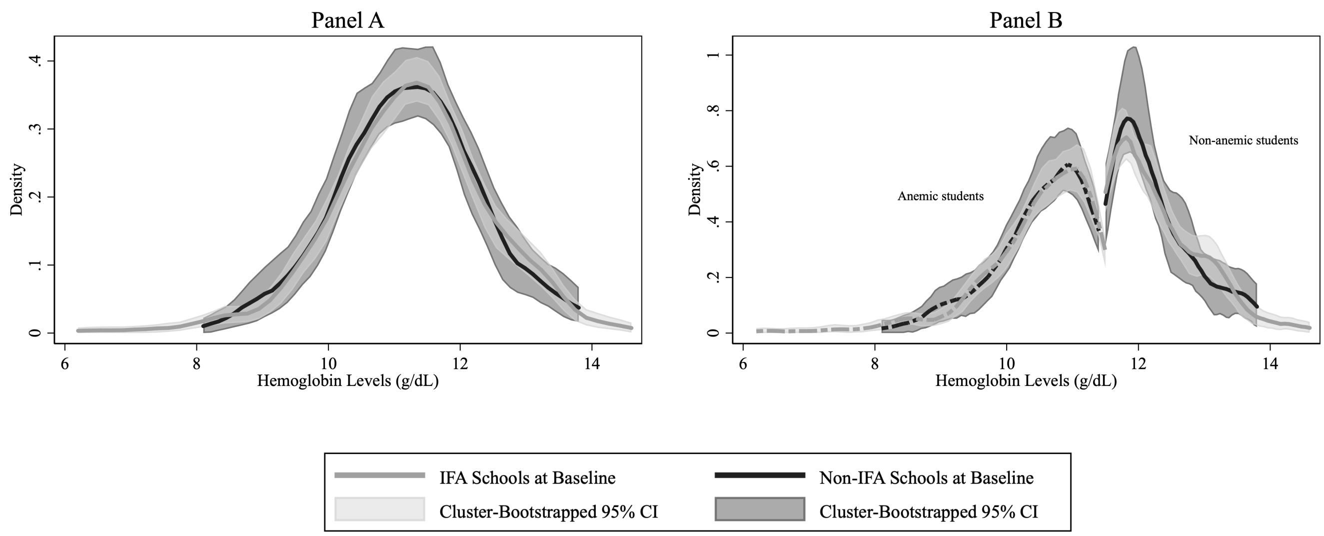
Figure 1: Timeline of key activities



Notes: The summer holidays occur from the beginning of May to mid-June. The household survey includes demographic information about household demographics, assets, etc. The child health survey includes height, weight, mid-upper arm circumference, and hemoglobin level. The school survey includes information on teachers, school assets, infrastructure, and systems, and implementation of existing school programs. Only the baseline, IFA uptake, and midline surveys are used in the current analysis. For an analysis of the MNM intervention, see Berry et al. (2019).

Figure 2: Distribution of child hemoglobin levels at baseline in IFA and non-IFA schools



Notes: This figure displays kernel density plots of child hemoglobin levels at baseline with cluster-bootstrapped 95-percent confidence intervals. Each plot compares the distribution of hemoglobin levels in schools that were recipients of tablets through the IFA program and those that weren't. Schools are considered recipients of the IFA program if they received either IFA or deworming tablets from the government, and non-recipients if they received neither. Panel A estimates the density over the entire distribution of baseline hemoglobin levels. Panel B estimates the density separately for anemic and non-anemic students; age-specific hemoglobin cutoffs used to determine anemia status are defined in WHO (2011).

Table 1: Comparison of high-variation and low-variation blocks

	High variation (1)	Low variation (2)	*p-value* (3)
Panel A: Demographic Characteristics			
Primary enrollment	88.943	72.600	0.002
Secondary enrollment	15.548	12.541	0.338
Number of teachers	2.529	2.400	0.443
School distance to the block headquarters (km)	21.308	24.168	0.015
School has a kitchen	0.734	0.806	0.105
School has at least one latrine	0.852	0.857	0.882
School has sufficient water	0.743	0.656	0.073
School's water is treated	0.323	0.235	0.066
Percent of students that are female	0.500	0.506	0.580
Percent of households in a non-disadvantaged caste	0.041	0.104	0.000
Percent of adults in students' households in agricultural work	0.190	0.196	0.528
Percent of adults in students' households work in own home	0.252	0.232	0.039
Percent of adults in students' households work in others' homes	0.263	0.180	0.000
Percent of adults in students' households work as laborers	0.163	0.266	0.000
Percent of adults in students' households with no formal schooling	0.575	0.465	0.000
Percent of households have a phone	0.313	0.392	0.000
Percent of households with electricity	0.518	0.551	0.260
Percent of households live in high-quality housing	0.095	0.126	0.010
Panel B: MDM Implementation Variables			
Uses parent group for MDM	0.118	0.631	0.000
School representative attended MDM training	0.584	0.149	0.000
Received MDM rice on a regular schedule	0.379	0.455	0.144
Average number of MDM received by student per week	4.806	4.675	0.060
Percent of parents satisfied with MDM	0.902	0.869	0.002
Panel C: Anthropometric Measures at Baseline			
Percent of students with anemia	0.546	0.612	0.000
Percent of students with mild anemia	0.215	0.222	0.538
Percent of students with moderate anemia	0.323	0.382	0.000
Percent of students with severe anemia	0.007	0.008	0.803
Mean student Hb level	11.264	11.097	0.000
Mean student BMI	13.643	13.532	0.143
Mean BMI, anemic students	13.562	13.555	0.916
Mean BMI, non-anemic students	13.771	13.534	0.058
Mean student weight	18.844	18.594	0.089
Mean weight, anemic students	18.261	18.258	0.988
Mean weight, non-anemic students	19.779	19.152	0.011
Mean BMI, female students	13.502	13.395	0.259
Mean BMI, male students	13.786	13.644	0.052
Panel D: IFA Program Implementation Variables			
Received IFA tablets	0.707	0.968	0.000
Received deworming tablets	0.662	0.876	0.000
Received IFA or deworming tablets	0.758	0.972	0.000
Received both IFA and deworming tablets	0.611	0.872	0.000
Number of IFA tablets received per student (conditional)	42.841	68.130	0.000
Received at least 100 IFA tablets per student (conditional)	0.046	0.194	0.000
Number of IFA tablets distributed per student (conditional)	38.827	52.901	0.000
Number of deworming doses per student (conditional)	2.070	1.946	0.581
Still distributing tablets at IFA Uptake survey (conditional)	0.343	0.525	0.002
School halted distribution of IFA tablets mid-way	0.247	0.318	0.144
Percent of 3 kids saying they receive tablets daily	0.430	0.747	0.000
Percent of 3 kids saying they received tablets the previous day	0.178	0.329	0.000
Percent of children reporting IFA receipt at Hb measurement	0.771	0.600	0.000
Parent report of child receiving IFA during the prior year	0.355	1.000	0.000
Number of schools	157	220	

Notes: This table provides school-level summary statistics by whether or not a block had high or low variation in school reports of tablet receipt from the government. Column (1) includes schools in the three blocks that have high variation in schools' receipt of IFA tablets from the goverment and are therefore included in the analysis sample. Column (2) includes schools in the two blocks that have low variation and therefore are not included in the analysis sample. The p-value in Column (3) tests the difference in means, unconditional on block, using standard errors robust to heteroskedasticity. Variables in panels A and B come from school and household baseline surveys. Variables in Panel C come from anthropometric measurements of children at the baseline survey. Variables in Panel D come from the IFA Uptake school survey, except for the last two variables, which were asked 4-6 months later during hemoglobin measurement.

Table 2: Comparison of schools by tablet receipt in high-variation blocks

	Received tablets (1)	No tablets (2)	*p-value* (3)
Panel A: Demographic Characteristics			
Primary enrollment	88.739	89.579	0.936
Secondary enrollment	15.008	17.237	0.657
Number of teachers	2.588	2.342	0.402
School distance to the block headquarters (km)	20.780	22.947	0.229
School has a kitchen	0.761	0.649	0.207
School has at least one latrine	0.863	0.816	0.504
School has sufficient water	0.777	0.639	0.127
School's water is treated	0.316	0.342	0.771
Percent of students that are female	0.503	0.491	0.451
Percent of households in a non-disadvantaged caste	0.035	0.061	0.168
Percent of adults in students' households in agricultural work	0.195	0.174	0.167
Percent of adults in students' households work in own home	0.265	0.212	0.007
Percent of adults in students' households work in others' homes	0.250	0.305	0.014
Percent of adults in students' households work as laborers	0.153	0.195	0.052
Percent of adults in students' households with no formal schooling	0.565	0.603	0.317
Percent of households have a phone	0.310	0.319	0.808
Percent of households with electricity	0.519	0.513	0.891
Percent of households live in high-quality housing	0.092	0.104	0.604
Panel B: MDM Implementation Variables			
Uses parent group for MDM	0.105	0.161	0.440
School representative attended MDM training	0.612	0.485	0.200
Received MDM rice on a regular schedule	0.357	0.447	0.329
Average number of MDM received by student per week	4.848	4.675	0.200
Percent of parents satisfied with MDM	0.907	0.886	0.294
Panel C: Anthropometric Measures at Baseline			
Percent of students with anemia	0.539	0.568	0.330
Percent of students with mild anemia	0.214	0.219	0.794
Percent of students with moderate anemia	0.316	0.345	0.335
Percent of students with severe anemia	0.008	0.003	0.034
Mean student Hb level	11.283	11.204	0.296
Mean student BMI	13.627	13.692	0.521
Mean BMI, anemic students	13.560	13.571	0.901
Mean BMI, non-anemic students	13.738	13.873	0.458
Mean student weight	18.859	18.796	0.817
Mean weight, anemic students	18.332	18.039	0.410
Mean weight, non-anemic students	19.659	20.151	0.357
Mean BMI, female students	13.480	13.570	0.490
Mean BMI, male students	13.771	13.834	0.562
P-value from joint F-test			0.628
Number of schools	119	38	

Notes: This table provides school-level summary statistics by whether or not a school received tablets from the government. Schools are considered recipients of the IFA program if they received either IFA or deworming tablets from the government (Column 1), and non-recipients if they received neither (Column 2). The p-value in Column (3) tests the difference in means, unconditional on block, using standard errors robust to heteroskedasticity. Variables in panels A and B come from school and household baseline surveys. Variables in Panel C come from anthropometric measurements of children at the baseline survey. The joint F-test is across all variables in Panels A-C.

Table 3: Comparison of schools by tablet receipt and tablet distribution in high-variation blocks

	Still Dist. Tablets (1)	Not Still Dist. (2)	No Tablets (3)	*p-value* (1)=(2)	*p-value* (1)=(2)=(3)
Panel A: Demographic Characteristics					
Primary enrollment	85.216	89.506	89.579	0.647	0.881
Secondary enrollment	7.649	18.456	17.237	0.043	0.072
Number of teachers	2.541	2.620	2.342	0.780	0.695
School distance to the block headquarters (km)	20.694	20.975	22.947	0.882	0.520
School has a kitchen	0.757	0.766	0.649	0.913	0.435
School has at least one latrine	0.892	0.844	0.816	0.473	0.621
School has sufficient water	0.829	0.757	0.639	0.381	0.189
School's water is treated	0.270	0.338	0.342	0.463	0.726
Percent of students that are female	0.495	0.506	0.491	0.547	0.663
Percent of households in a non-disadvantaged caste	0.025	0.041	0.061	0.199	0.101
Percent of adults in students' households in agricultural work	0.175	0.204	0.174	0.142	0.117
Percent of adults in students' households work in own home	0.275	0.258	0.212	0.394	0.024
Percent of adults in students' households work in others' homes	0.232	0.259	0.305	0.179	0.021
Percent of adults in students' households work as laborers	0.176	0.144	0.195	0.193	0.047
Percent of adults in students' households with no formal schooling	0.609	0.544	0.603	0.058	0.104
Percent of households have a phone	0.281	0.326	0.319	0.226	0.474
Percent of households with electricity	0.557	0.498	0.513	0.267	0.524
Percent of households live in high-quality housing	0.083	0.099	0.104	0.437	0.647
Panel B: MDM Implementation Variables					
Uses parent group for MDM	0.031	0.143	0.161	0.035	0.050
School representative attended MDM training	0.543	0.641	0.485	0.334	0.278
Received MDM rice on a regular schedule	0.543	0.260	0.447	0.005	0.009
Average number of MDM received by student per week	4.825	4.865	4.675	0.744	0.398
Percent of parents satisfied with MDM	0.924	0.899	0.886	0.121	0.153
Panel C: Anthropometric Measures at Baseline					
Percent of students with anemia	0.584	0.513	0.568	0.028	0.050
Percent of students with mild anemia	0.232	0.204	0.219	0.301	0.476
Percent of students with moderate anemia	0.341	0.302	0.345	0.175	0.223
Percent of students with severe anemia	0.011	0.008	0.003	0.512	0.082
Mean student Hb level	11.196	11.330	11.204	0.128	0.167
Mean student BMI	13.491	13.597	13.692	0.444	0.247
Mean BMI, anemic students	13.448	13.572	13.571	0.318	0.535
Mean BMI, non-anemic students	13.528	13.653	13.873	0.602	0.167
Mean student weight	18.840	18.863	18.796	0.934	0.973
Mean weight, anemic students	18.008	18.497	18.039	0.184	0.314
Mean weight, non-anemic students	19.848	19.548	20.151	0.532	0.508
Mean BMI, female students	13.251	13.484	13.570	0.178	0.184
Mean BMI, male students	13.685	13.736	13.834	0.731	0.497
P-value from joint F-test				0.000	–
Number of schools	37	79	38		

Notes: This table provides school-level summary statistics by whether or not a school received tablets from the government and whether or not the school is still distributing tablets at the time of the IFA uptake survey. Schools are considered recipients of the IFA program if they received either IFA or deworming tablets from the government (Column 1), and non-recipients if they received neither (Column 2). The p-values in Columns (4) and (5) test equality of means for the indicated groups, unconditional on block, using standard errors robust to heteroskedasticity. Variables in panels A and B come from school and household baseline surveys. Variables in Panel C come from anthropometric measurements of children at the baseline survey. The joint F-test is across all variables in Panels A-C.

Table 4: Overall effect of the IFA program on hemoglobin levels (DD)

	(1)	(2)	(3)	(4)	(5)
Received tablets*Post	-0.086	-0.086	-0.086	0.066	0.066
	(0.149)	(0.150)	(0.158)	(0.156)	(0.156)
Number of observations	1456	1456	1456	1456	1456
Age fixed effects	✓	✓	✓	✓	✓
Block fixed effects		✓			
School fixed effects			✓	✓	✓
Added school controls				✓	✓
Added individual controls					✓

Notes: This table presents estimates of the overall effect of the IFA program on child hemoglobin levels in g/dL using a difference-in-differences specification. In each column, the dependent variable is regressed on an indicator for whether or not a school was a recipient of tablets through the IFA program, an indicator for whether hemoglobin measurement was taken after IFA implementation, and their interaction, which is the coefficient of interest. Schools are considered recipients of the IFA program if they received either IFA or deworming tablets from the government, and non-recipients if they received neither. Added school-level controls include the following variables interacted with *Post*: distance from the school to block headquarters, whether or not a school has a kitchen, the percent of parents satisfied with MDM implementation, whether or not the school receives rice for the MDM on a regular schedule, the percent of families employed in housework outside the home, the percent of families in a non-disadvantaged caste, the average BMI of students in the school at baseline, and the percent of students in each school that are mildly, moderately, or severely anemic at baseline, including missing indicators in all variables. Added individual-level controls include the following characteristics measured at baseline: child gender, whether or not the child is literate, whether or not the child's mother has more than 6 years of education, whether or not the family is in a disadvantaged caste, the quality of housing the child lives in, and whether or not the household has electricity. Standard errors, clustered by school, are reported below each coefficient in parentheses. Significance at the 0.10, 0.05, and 0.01 levels indicated by *, **, and *** respectively.

Table 5: Effect of the IFA program on hemoglobin levels by baseline anemia status (DD)

	(1)	(2)	(3)	(4)	(5)
Panel A: Non-anemic (Hb $\geq$ 11.5g/dL)					
Received tablets*Post	-0.082	-0.082	-0.082	0.063	0.063
	(0.195)	(0.196)	(0.221)	(0.227)	(0.229)
Number of observations	620	620	620	620	620
Panel B: Mildly anemic (11 $\leq$ Hb < 11.5g/dL)					
Received tablets*Post	0.057	0.057	0.057	0.301	0.301
	(0.188)	(0.188)	(0.237)	(0.264)	(0.270)
Number of observations	276	276	276	276	276
Panel C: Moderately anemic (8 $\leq$ Hb < 11g/dL)					
Received tablets*Post	-0.131	-0.131	-0.131	-0.068	-0.068
	(0.174)	(0.174)	(0.201)	(0.236)	(0.238)
Number of observations	548	548	548	548	548
P-value, test three groups equal	0.726	0.692	0.692	0.309	0.309
Age fixed effects	✓	✓	✓	✓	✓
Block fixed effects		✓			
School fixed effects			✓	✓	✓
Added school controls				✓	✓
Added individual controls					✓

Notes: This table presents estimates of the effect of the IFA program on child hemoglobin levels in g/dL, by children's baseline anemia status, using a difference-in-differences specification. Each panel presents estimates from separate regressions for non-anemic, borderline anemic, mildly anemic, and moderately anemic students. Hemoglobin cutoffs in each panel title are defined in WHO (2011) and apply to the majority of the sample (ages 5-11). In each column, the dependent variable is regressed on an indicator for whether or not a school was a recipient of tablets through the IFA program, an indicator for whether hemoglobin measurement was taken after IFA implementation, and their interaction, which is the coefficient of interest. Added school-level controls include the following variables interacted with *Post*: distance from the school to block headquarters, whether or not a school has a kitchen, the percent of parents satisfied with MDM implementation, whether or not the school receives rice for the MDM on a regular schedule, the percent of families employed in housework outside the home, the percent of families in a non-disadvantaged caste, the average BMI of students in the school at baseline, and the percent of students in each school that are mildly, moderately, or severely anemic at baseline, including missing indicators in all variables. Added individual-level controls include the following characteristics measured at baseline: child gender, whether or not the child is literate, whether or not the child's mother has more than 6 years of education, whether or not the family is in a disadvantaged caste, the quality of housing the child lives in, and whether or not the household has electricity. Standard errors, clustered by school, are reported below each coefficient in parentheses. Significance at the 0.10, 0.05, and 0.01 levels indicated by *, **, and *** respectively.

Table 6: Heterogeneous effect of the IFA program for students receiving tablets more recently (DD)

	(1)	(2)	(3)	(4)	(5)
Received tablets*Post	-0.193	-0.193	-0.193	0.004	0.004
	(0.154)	(0.154)	(0.163)	(0.161)	(0.162)
Still Distributing*	0.318**	0.318**	0.318*	0.181	0.181
Received tablets*Post	(0.153)	(0.154)	(0.162)	(0.138)	(0.138)
Number of observations	1456	1456	1456	1456	1456
P-value, test Recvd + Still Dist = 0	0.510	0.510	0.533	0.310	0.311
Age fixed effects	✓	✓	✓	✓	✓
Block fixed effects		✓			
School fixed effects			✓	✓	✓
Added school controls				✓	✓
Added individual controls					✓

Notes: This table presents estimates of the effect of the IFA program for schools that were still distributing tablets at the time of the IFA survey and those that were not, using a difference-in-differences specification. In each column, the dependent variable is regressed on an indicator for whether or not a school was a recipient of tablets through the IFA program, an indicator for whether hemoglobin measurement was taken after IFA implementation, and their interaction, as well as an indicator for being a school that is still distributing tablets at the time of the IFA survey and its interaction with IFA receipt and the *Post* indicator. Schools are considered recipients of the IFA program if they received either IFA or deworming tablets from the government, and non-recipients if they received neither. Added school-level controls include the following variables interacted with *Post*: distance from the school to block headquarters, whether or not a school has a kitchen, the percent of parents satisfied with MDM implementation, whether or not the school receives rice for the MDM on a regular schedule, the percent of families employed in housework outside the home, the percent of families in a non-disadvantaged caste, the average BMI of students in the school at baseline, and the percent of students in each school that are mildly, moderately, or severely anemic at baseline, including missing indicators in all variables. Added individual-level controls include the following characteristics measured at baseline: child gender, whether or not the child is literate, whether or not the child's mother has more than 6 years of education, whether or not the family is in a disadvantaged caste, the quality of housing the child lives in, and whether or not the household has electricity. Standard errors, clustered by school, are reported below each coefficient in parentheses. Significance at the 0.10, 0.05, and 0.01 levels indicated by *, **, and *** respectively.

Table 7: Heterogeneous effect of the IFA program for students receiving tablets more recently, by baseline anemia level (DD)

	(1)	(2)	(3)	(4)	(5)
Panel A: Non-anemic (Hb ≥ 11.5g/dL)					
Received tablets*Post	-0.055	-0.055	-0.055	0.094	0.094
	(0.202)	(0.203)	(0.228)	(0.235)	(0.237)
Still Distributing*	-0.171	-0.171	-0.171	-0.223	-0.223
Received tablets*Post	(0.193)	(0.194)	(0.218)	(0.229)	(0.231)
Number of observations	620	620	620	620	620
P-value, test Recvd + Still Dist = 0	0.354	0.354	0.411	0.653	0.656
Panel B: Mildly anemic (11 ≤ Hb < 11.5g/dL)					
Received tablets*Post	0.009	0.009	0.009	0.242	0.242
	(0.194)	(0.194)	(0.244)	(0.262)	(0.268)
Still Distributing*	0.169	0.169	0.169	0.228	0.228
Received tablets*Post	(0.257)	(0.258)	(0.324)	(0.319)	(0.326)
Number of observations	276	276	276	276	276
P-value, test Recvd + Still Dist = 0	0.529	0.531	0.617	0.224	0.235
Panel C: Moderately anemic (8 ≤ Hb < 11g/dL)					
Received tablets*Post	-0.290	-0.290	-0.290	-0.220	-0.220
	(0.185)	(0.185)	(0.213)	(0.249)	(0.252)
Still Distributing*	0.442**	0.442**	0.442**	0.425**	0.425**
Received tablets*Post	(0.173)	(0.174)	(0.200)	(0.206)	(0.208)
Number of observations	548	548	548	548	548
P-value, test Recvd + Still Dist = 0	0.461	0.462	0.522	0.437	0.442
P-value, test three groups equal (Recieved)	0.382	0.382	0.380	0.144	0.144
P-value, test three groups equal (Still Dist)	0.050	0.050	0.048	0.060	0.060
Age fixed effects	✓	✓	✓	✓	✓
Block fixed effects		✓			
School fixed effects			✓	✓	✓
Added school controls				✓	✓
Added individual controls					✓

Notes: This table presents estimates of the effect of the IFA program for schools that were still distributing tablets at the time of the IFA survey and those that were not, using a difference-in-differences specification, separately by children's baseline anemia status. In each column, the dependent variable is regressed on an indicator for whether or not a school was a recipient of tablets through the IFA program, an indicator for whether hemoglobin measurement was taken after IFA implementation, and their interaction, as well as an indicator for being a school that is still distributing tablets at the time of the IFA survey and its interaction with IFA receipt and the *Post* indicator. Each panel presents estimates from separate regressions for non-anemic, borderline anemic, mildly anemic, and moderately anemic students. Hemoglobin cutoffs in each panel title are defined in WHO (2011) and apply to the majority of the sample (ages 5-11). Schools are considered recipients of the IFA program if they received either IFA or deworming tablets from the government, and non-recipients if they received neither. Added school-level controls include the following variables interacted with *Post*: distance from the school to block headquarters, whether or not a school has a kitchen, the percent of parents satisfied with MDM implementation, whether or not the school receives rice for the MDM on a regular schedule, the percent of families employed in housework outside the home, the percent of families in a non-disadvantaged caste, the average BMI of students in the school at baseline, and the percent of students in each school that are mildly, moderately, or severely anemic at baseline, including missing indicators in all variables. Added individual-level controls include the following characteristics measured at baseline: child gender, whether or not the child is literate, whether or not the child's mother has more than 6 years of education, whether or not the family is in a disadvantaged caste, the quality of housing the child lives in, and whether or not the household has electricity. Standard errors, clustered by school, are reported below each coefficient in parentheses. Significance at the 0.10, 0.05, and 0.01 levels indicated by *, **, and *** respectively.