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Can double-fortified salt in school mid-day meals help reduce anaemia?

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Micronutrient malnutrition is a major risk factor for more than half of the daily under-five deaths in India. It leads to iron-deficiency anaemia, which especially affects pregnant women, and young and adolescent children. Based on an intervention in Bihar, this article estimates the impact of supplying double-fortified salt in mid-day meals in schools on anaemia as well as cognition and educational outcomes of second-grade children.

Micronutrient malnutrition remains a significant policy challenge in India as micronutrient deficiencies are a major risk factor for more than half of the daily under-five deaths in the country. Micronutrient malnutrition is caused primarily due to lack of iron, vitamins, iodine, zinc, etc. Deficiency of iron due to poor diet quality leads to iron-deficiency anaemia (IDA). Although IDA affects members of both sexes and all age groups, pregnant women, and young and adolescent children are at higher risk of being anaemic. Micronutrient deficiency in early childhood also affects human capital formation including education, cognition, and adult health (Currie and Vogl 2013).

The National Family Health Survey-4 (NFHS-4) indicates that the anaemia prevalence among 6-59 months old children is 58.5% and has seen some improvement in the last 10 years (69.5% in

2005-06 to 58.5% in 2015-16). However, the anaemia prevalence rate of 63.5% among young children in Bihar is consistently higher than the national average.

Among possible solutions to combat anaemia (food fortification, micronutrient supplementation, dietary diversification), salt fortified with iron could be an effective strategy in a resource-poor setting of Bihar. This is because salt is universally consumed irrespective of location, socioeconomic status, and food preferences. However, whether fortified salt should be delivered through the market (village shops, PDS (public distribution system)) or non-market institutions (schools, health clinics) remains an open question as the empirical evidence on the effectiveness of different types of delivery channels to supply fortified salt is far from settled (Banerjee *et al*. 2018, Berry *et al*. 2017). In a recent study conducted in Bihar, we estimate the impact of supply of double-fortified salt (DFS) – fortified with iron and iodine – in mid-day meal preparation on anaemia as well as cognition and educational outcomes of second-grade children in Bihar (Kramer *et al.* 2018).

Evaluation of use of DFS in mid-day meals in primary schools

The evidence on the efficacy of DFS in improving haemoglobin and in reducing IDA among school-age children is mixed and unclear. Two recent studies conducted in India were unable to find a significant impact of DFS on anaemia, cognition, and educational outcomes (Banerjee *et al*. 2018, Berry *et al*. 2017). In contrast, another Indian study conducted among 6-12 years old school children found a significant increase in haemoglobin level as a result of DFS intervention.

The treatment in our project was subsidised supply of DFS, to prepare mid-day meals for one school year. We purchased the DFS, Tata Salt Plus, from a large Indian private company (Tata Salt) and the salt was fortified with 0.86 mg of iron per gram of iodised salt. Treated children received at least 3.5 mg of iron per mid-day meal, which accounts for one-third of the daily iron requirement. On average, treated children received 17.5 mg of iron per week from our DFS intervention (we assumed 80% attendance).

We randomly enrolled 108 schools in the study, and then randomly assigned half each to the 'treatment' and the 'control' groups. The study was conducted in two blocks, Kako and Modanganj in Jehanbad district in Bihar.

1. The treatment schools received DFS at a discounted price for one school year for mid-day meal preparation.
2. The control schools did not receive any treatment and continued to use the regular iodised salt.

We conducted a follow-up survey after 12 months to measure the impact of DFS on haemoglobin level, anaemia, cognition, and educational outcomes.

Main results

In order to isolate the causal impacts, we use difference-in-differences – a method that basically compares the pre- to post-intervention change in the outcome variables for the treated schools relative to the control schools.

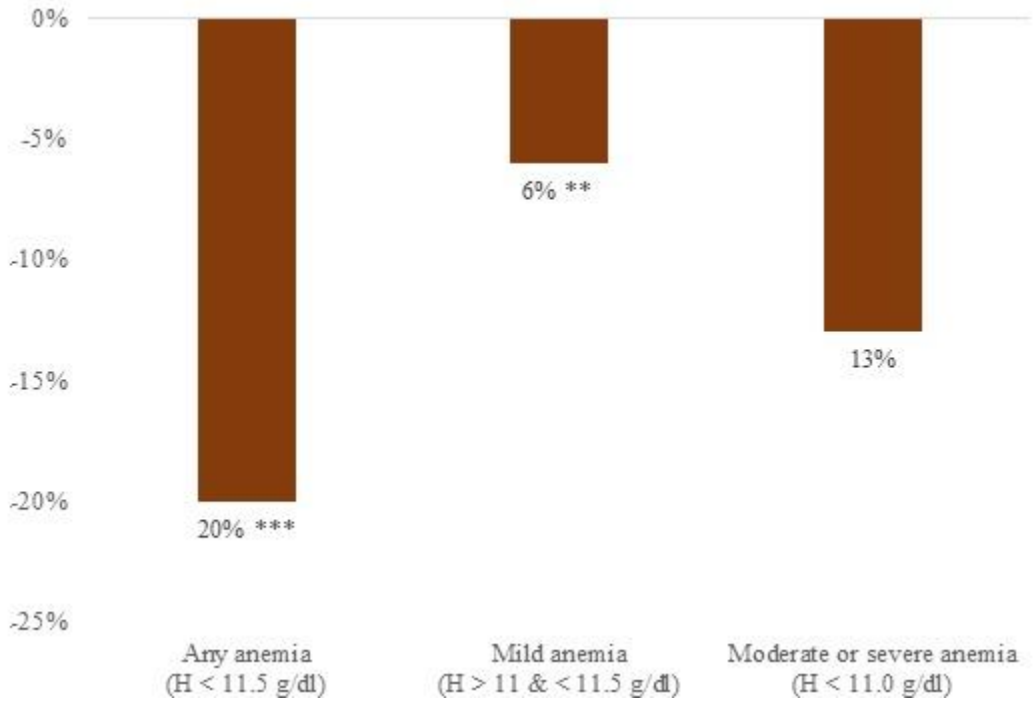
Anaemia

Our findings show statistically significant impacts on haemoglobin and anaemia among school children. The DFS supply for mid-day meal preparation increases haemoglobin levels by 1.2% and reduces prevalence of any form of anaemia by 20% among the treated children (see Figure 1).

The reduction in mild anaemia is 6 percentage points or approximately 30%; the point estimate for moderate or severe anaemia is also quite large and negative (13 percentage points) but the effects are not statistically significant. Some of the prior studies reported similar effect

size: Nair *et al.* (2013) found a reduction in anaemia by 20% in India; Chong *et al.* (2016) reported an effect size of 34.5% in Peru; while Banerjee *et al.* (2018) and Berry *et al.* (2017) were unable to find any significant impacts of DFS on anaemia in India.

Figure 1. Impact of double-fortified salt on anaemia



Notes: (i) H= Haemoglobin levels. (ii) *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

Cognition and test scores

Even though the DFS treatment decreased the prevalence of anaemia by 20%, on average the one-year intervention of 0.86 mg of iron per gram of salt was not (yet) sufficient to improve the cognitive ability of second-grade students. The cognitive index increased by 0.03 standard deviations[1] due to the treatment but the results are statistically insignificant (see Figure 2). The math and reading scores increased by 0.13 and 0.11 standard deviation, respectively, but these are not statistically significant.

Heterogeneous impacts

Treatment intensity varies by school attendance in our study. Students who attended school more frequently are likely to have greater exposure to the treatment compared to students with irregular attendance. We find evidence of heterogeneous treatment effects: DFS treatment had larger impacts on children with higher school attendance (higher treatment compliance). For children with high school attendance the treatment effects for math and reading scores were statistically significant and had a magnitude of nearly 0.2 standard deviations. However, the analysis by household caste does not indicate differential treatment effect by the caste of the children.