Improving Child Health and Cognition: Evidence from a School-Based Nutrition Intervention in India

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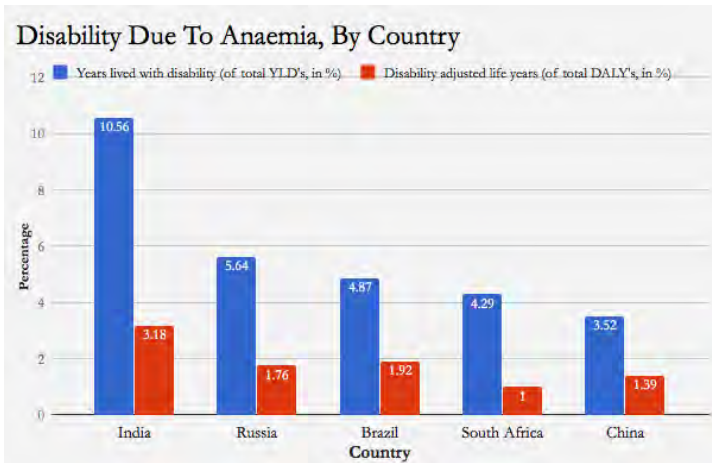[2]**Sam Houston State University**

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ASSA 2019 (Atlanta)

- Widespread and pervasive poverty in SSA and South Asia.
  - close to 1 billion people still live on less than $2/day
  - poverty is linked to nutrition, especially micronutrient deficiencies
  - 1.6 billion people are anemic (lack iron)
- Human capital is a critical determinant of economic growth (Lucas, 1988; Mankiw, Romer and Weil, 1992).
- Strong link between health and human capital formation (fetal origins, early-life, school-age (nutritional intervention)- Maluccio et al, Hoddinott et al., Alderman et al.).
- Early-life malnutrition affects cognitive development, educational attainment, and labor market outcomes.

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Motivation

- This paper
  - particular form of micronutrient deficiency- lack of iron in the body
  - results into iron-deficient anemia (IDA)
  - The basic symptoms of IDA are fatigue, weakness, lethargy, shortness of breath and decreased concentration.
- Prevalence
  - IDA among children below the age of five (58 percent) and women (53 percent)-NFHS-4.
  - 11% of the YLD are due to anemia in India.

IDA has remained the top cause of disability in India (GBD study).

Disability Due To Anaemia, By Country

Years lived with disability (of total YLD's, in %)   Disability adjusted life years (of total DALY's, in %)

Country	YLD's (%)	DALY's (%)
India	10.56	3.18
Russia	5.64	1.76
Brazil	4.87	1.92
South Africa	4.29	1
China	3.52	1.39

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- IDA and Children Cognition
    - affects cognitive performance, language skills, motor skills.
    - affects immune system and increases chance of inflammatory diseases.
    - deficit of 5-10 points in IQ
- Younger and school-age children are most vulnerable population.

- Types of programs and delivery channel
  - Micronutrient supplementation programs (supply of iron-pills)
  - Food fortification (wheat flour, biscuit etc.)
  - Supply of double fortified salt (iodine plus iron)
- Delivery channels
  - Retail shops, Public distributions system (sold at subsidized price)
  - Public institutions (schools, hospitals)
- What is the most cost-effective combination of products and delivery channel?

- Research Question
  - What are the impacts of usage of iron-fortified salt in school lunches on
    - Hemoglobin level
    - Incidence of anemia
    - educational and learning outcomes in rural Bihar
  - Test the effectiveness of non-market institutions as delivery channel for the fortified products
  - Is there an evidence of heterogeneity in the impacts?

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Contribution

- add to the growing literature on early-childhood interventions
- contribute to the effectiveness of school-based interventions
- intervention reduces the issue of crowding out of existing school activities.

Previous evidence

- Previous evidence
  - Banerjee et al (2018) - No effect (DFS sold through village retail shops or PDS)
  - Berry et al. (2018) - No effect (impact of micronutrient mixed school lunch on child health)
  - Thomas et al. (2006) - positive impacts of iron supplementation in Indonesia.
  - Chong et al. (2016) -significant reduction in anemia by 34 % among anemic students in Peru.
- Mixed evidence: impacts vary by amount of iron dosage, compliance rate, treatment duration, sample size etc

- Setting
    - Two blocks in Jehanabad district, Bihar, India
        - Sample is universe of primary schools in these two blocks
        - 54 schools were randomly selected as Treatment group and 54 schools as control
        - On average, 20 children were surveyed from 2nd grade in each school
        - Treatment: Study team sold Iron-fortified salt to the treated schools at subsidized price
        - Control: continue to use iodized salt

Treatment

- Provision of iron-fortified salt to schools at discounted price
- Monthly supply, bought from private company by the study team
- One year of treatment

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GlobalFood

Distribution of DFS

GlobalFood Symposium 2017

- Data and timeline of intervention
    - Nov 2014–Jan 2015: Baseline survey
    - Aug 2015: Treatment started
    - Aug 2016-Oct 2016: Endline survey

Estimation Strategy: Double Difference

$$Y_{ist} = \alpha + \beta_1 * Post_t + \beta_2 * Treat_s * Post_t + \delta * X_{it} + \eta S_{st} + \gamma_{ist} \quad (1)$$

where $Y_i st$ is the outcomes for child i at school s at time t
Post: after-treatment period indicator
Treat: treatment assignment indicator
S: time-variant school control variables
X: time-variant child and household control variables
β_2: ITT effect

Table 1: Baseline summary statistics (Balance checks)

	Estimation sample for health outcomes				Baseline sample (without attrition)			
	N	Control mean (SD)	Treatment mean (SD)	p- values	N	Control mean (SD)	Treatment mean (SD)	p-values
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Child level outcome variables								
Anemia								
Hemoglobin (g/dL)	1,406	11.62 (1.11)	11.44 (1.07)	0.008***	1,789	11.59 (1.10)	11.45 (1.10)	0.02**
Any anemia	1,406	0.41 (0.49)	0.50 (0.50)	0.002***	1,789	0.42 (0.49)	0.49 (0.50)	0.02**
Mild anemia	1,406	0.16 (0.37)	0.22 (0.42)	0.003***	1,789	0.18 (0.38)	0.21 (0.41)	0.08*
Moderate/severe anemia	1,406	0.25 (0.43)	0.27 (0.45)	0.32	1,789	0.25 (0.43)	0.28 (0.45)	0.20
Cognitive test outcomes								
Block design	1,375	3.53 (2.22)	3.69 (2.19)	0.45	1,732	3.69 (2.26)	3.79 (2.19)	0.61
Digit span forward	1,377	4.03 (1.01)	4.07 (1.00)	0.61	1,734	4.06 (1.02)	4.10 (1.00)	0.58
Digit span backward	1,377	1.07 (1.27)	1.16 (1.30)	0.46	1,734	1.09 (1.29)	1.15 (1.30)	0.57
Progressive matrices	1,376	4.76 (1.64)	4.67 (1.69)	0.49	1,732	4.82 (1.66)	4.71 (1.71)	0.42
Day and night	1,375	5.25 (3.49)	5.19 (3.40)	0.81	1,731	5.40 (3.48)	5.27 (3.38)	0.65
Cognitive score index	1,372	-0.007 (1.01)	-0.03 (1.00)	0.73	1,727	0.00 (1.02)	0.00 (0.98)	0.91

Educational outcomes

Math score	1,377	4.66	4.53	0.77	1,734	4.90	4.74	0.68
		(3.85)	(3.77)			(3.87)	(3.81)	
Reading score	1,376	0.87	0.85	0.89	1,733	0.94	0.87	0.48
		(1.12)	(1.10)			(1.15)	(1.10)	
School attendance	1,338	0.80	0.79	0.44	1,692	0.79	0.78	0.64
		(0.15)	(0.16)			(0.16)	(0.17)	

Panel B: Demographics and socioeconomic variables

Muslim	1,406	0.02	0.03	0.89	1,789	0.03	0.03	0.90
		(0.15)	(0.16)			(0.16)	(0.16)	
SC/ST	1,406	0.25	0.34	0.12	1,789	0.25	0.32	0.16
		(0.44)	(0.48)			(0.43)	(0.47)	
Block	1,406	0.71	0.62	0.38	1,789	0.71	0.62	0.40
		(0.46)	(0.49)			(0.45)	(0.48)	*contd.*

Rural	1,406	0.97 (0.16)	0.98 (0.13)	0.59	1,789	0.97 (0.16)	0.99 (0.12)	0.42
Family size	1,406	7.85 (3.47)	7.62 (3.29)	0.31	1,789	7.85 (3.53)	7.66 (3.35)	0.39
Father's years of schooling	1,406	5.48 (4.76)	5.29 (4.81)	0.63	1,789	5.43 (4.85)	5.56 (4.89)	0.73
Mother's years of schooling	1,406	1.70 (3.15)	1.58 (2.94)	0.60	1,789	1.81 (3.27)	1.80 (3.22)	0.96
Asset index	1,406	0.01 (0.95)	-0.01 (1.04)	0.82	1,789	-0.03 (0.95)	-0.02 (1.00)	0.92
Gender of the child	1,406	0.44 (0.50)	0.46 (0.50)	0.43	1,789	0.45 (0.50)	0.47 (0.50)	0.39
Health care								
Institutional delivery	1,406	0.40 (0.49)	0.37 (0.48)	0.42	1,789	0.39 (0.49)	0.38 (0.49)	0.64
Health insurance	1,406	0.40 (0.49)	0.37 (0.48)	0.54	1,789	0.40 (0.49)	0.38 (0.49)	0.69
Diarrhea	1,406	0.04 (0.20)	0.03 (0.16)	0.30	1,789	0.03 (0.18)	0.03 (0.17)	0.57
Improved sanitation	1,406	0.07 (0.25)	0.08 (0.27)	0.56	1,789	0.08 (0.27)	0.09 (0.29)	0.53

Nutrition

	N	Mean	Mean	p-value	N	Mean	Mean	p-value
Diet diversity score	1,406	3.90 (1.18)	3.83 (1.15)	0.45	1,789	3.90 (1.19)	3.86 (1.14)	0.66
Number of meals/day	1,406	3.04 (1.06)	3.07 (1.01)	0.77	1,789	3.01 (1.07)	3.04 (1.03)	0.65
Food scarcity	1,406	0.82 (0.39)	0.81 (0.39)	0.74	1,789	0.80 (0.40)	0.80 (0.40)	0.81
Maternal health knowledge	1,406	0.35 (0.48)	0.38 (0.49)	0.42	1,789	0.36 (0.48)	0.40 (0.49)	0.19
Child eats meat products	1,406	0.55 (0.50)	0.52 (0.50)	0.45	1,789	0.53 (0.50)	0.53 (0.50)	0.87
Child received iron supplements	1,406	0.16 (0.37)	0.17 (0.38)	0.63	1,789	0.17 (0.38)	0.17 (0.37)	0.92
Panel C: School level covariates								
Calories of MDM per child	107	69.57 (21.45)	68.04 (25.62)	0.74	107	69.57 (21.45)	68.04 (25.62)	0.74
Amount of iron in MDM per child (mg)	107	0.84 (0.41)	0.75 (0.28)	0.19	107	0.84 (0.41)	0.75 (0.28)	0.19

Notes: This tables presents summary statistics as well as p-values for difference in the means t-tests between children in the treatment and the control schools. All variables shown are child level variables from the baseline except for panel C, which shows school level variables. SD: Standard deviation, MDM: Mid-day meal; SC/ST: Scheduled caste/scheduled tribe are the social and economically disadvantaged groups; N: Number of observations.

Table 2: ITT effects of the DFS treatment on hemoglobin level and anemia

	Hemoglobin	Any anemia	Mild anemia	Moderate or severe anemia
	(1)	(2)	(3)	(4)
Treatment	0.136*	-0.093***	-0.060**	-0.034
	(0.076)	(0.033)	(0.027)	(0.031)
Mean of dependent variable	11.529	0.452	0.193	0.260
Child fixed effects	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	2,812	2,812	2,812	2,812

Notes: Estimated coefficients are based on a DID model estimated separately in each column. Any anemia is defined as a hemoglobin value < 11.5 g/dl, mild anemia is defined as a hemoglobin value ≥ 11 & < 11.5 g/dl, moderate/severe anemia is defined as a hemoglobin value < 11 g/dl. *, **, *** denote significance at the 10%, 5% and 1% levels, respectively. Standard errors, clustered at the school level, are reported in parentheses.

Table 3: ITT effects of the DFS treatment on cognition and education

	Block design	Digit span forward	Digit span backward	Progressive matrices	Day and night	Cognitive Index
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A						
Treatment	0.012	-0.105	0.009	0.070	0.116	0.028
	(0.082)	(0.074)	(0.084)	(0.095)	(0.098)	(0.080)
Mean of dependent variable	0.048	0.030	0.033	-0.020	0.000	-0.038
Child fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,790	2,790	2,790	2,790	2,790	2,790

	Math	Reading	School attendance
	(1)	(2)	(3)
Panel B			
Treatment	0.129	0.104	-0.005
	(0.090)	(0.081)	(0.022)
Mean of dependent variable	-0.007	-0.019	0.798
Child fixed-effects	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Observations	2,790	2,790	2,715

Notes: Estimated coefficients are based on a DID model estimated separately in each column. All outcomes, except school attendance, are normalized with reference to the baseline mean in the control group. *, **, *** denote significance at the 10%, 5% and 1% levels, respectively. Standard errors, clustered at the school level, are reported in parentheses.

Table 4: Heterogeneous treatment effects on hemoglobin and anemia by school attendance rate

	Hemoglobin	Any anemia	Mild anemia	Moderate or severe anemia
	(1)	(2)	(3)	(4)
Treat (70% attendance)	0.138*	-0.089***	-0.060**	-0.029
	(0.075)	(0.032)	(0.027)	(0.031)
Treat (80% attendance)	0.144	-0.093**	-0.058*	-0.036
	(0.089)	(0.039)	(0.030)	(0.034)
Treat (90% attendance)	0.151	-0.098*	-0.056	-0.042
	(0.113)	(0.051)	(0.039)	(0.042)
Mean of dependent variable	11.530	0.451	0.191	0.260
Child fixed-effects	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations	2,780	2,780	2,780	2,780

Notes: Standard errors, clustered at the school level, are reported in parentheses. All coefficients are from a separate regression, except for the last coefficients that are from one regression where treatment and attendance are interacted. Any anemia is defined as a hemoglobin value < 11.5 g/dl, mild anemia is defined as a hemoglobin value ≥ 11 & < 11.5 g/dl, moderate/severe anemia is defined as a hemoglobin value < 11 g/dl. *, **, *** denote significance at the 10%, 5% and 1% level, respectively.

Table 5: Heterogeneous treatment effects on cognition and education by school attendance rate

	Block design	Digit span forward	Digit span backward	Progressive matrices	Day and night	Cognitive Index	Math test score	Reading test score
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treat (70% attendance)	0.005	-0.117	0.001	0.065	0.109	0.017	0.124	0.096
	(0.081)	(0.073)	(0.090)	(0.099)	(0.100)	(0.083)	(0.088)	(0.081)
Treat (80% attendance)	0.025	-0.128	-0.011	0.089	0.160	0.038	0.161*	0.139
	(0.086)	(0.081)	(0.084)	(0.097)	(0.102)	(0.084)	(0.092)	(0.087)
Treat (90% attendance)	0.045	-0.139	-0.023	0.112	0.210	0.058	0.197*	0.182*
	(0.104)	(0.099)	(0.095)	(0.110)	(0.114)	(0.096)	(0.105)	(0.104)
Mean of dependent variable	0.049	0.035	0.036	-0.023	-0.002	-0.039	-0.008	-0.019
Child fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,766	2,766	2,766	2,766	2,766	2,766	2,766	2,766

Notes: All coefficients are from separate regression, except for the last coefficients that are from one regression where treatment and attendance are interacted. All outcomes are normalized with reference to the baseline mean in the control group. *, **, *** denote significance at the 10%, 5% and 1% level, respectively. Standard errors, clustered at the school level, are reported in parentheses.

Summary

- The usage of DFS in the MDM resulted in a reduction of the prevalence of any form of anemia by about 20% and of mild anemia by about 30%.

- No statistically significant effect on cognitive ability.

- Despite a relatively short treatment period of one year, there is weak evidence that with 80% or 90% school attendance math and reading scores were higher.

- Weak evidence that SC/ST benefited slightly more with respect to anemia.

- Intervention is very cost effective: $5 - $50 per DALY adverted (Deworming $5, Vitamin A supplementation $9).

Thank You