Nutrition, Iron Deficiency Anemia, and the Demand for Iron Fortified Salt: Evidence from an Experiment in Rural Bihar

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Abstract

Iron Deficiency Anemia is frequent among the poor worldwide. While it can be prevented with the appropriate supplement or food fortification, these programs often do not reach the poorest. Further, little is known about the impact of treating iron deficiency anemia on productivity. This paper is the first of a larger project that investigates the feasibility and the impact of addressing IDA through partly subsidized double fortified salt (DFS) — salt fortified with iron and iodine — in rural Bihar. Analysis of a baseline survey in 400 villages suggests that anemia is prevalent (over 50% of adult women are anemic) and is correlated with lower physical and cognitive fitness at all ages. This is despite the fact that consumption per capita is not particularly low by the standards of rural India (INR 67 per capita and per day), and average BMI is not very low, indicating that the overall calories intake must be adequate. This suggest that micronutrient deficiency is likely playing a key role. Almost all households purchase salt, which makes DFS a promising channel to distribute supplemental iron. A randomized pricing experiment suggest that subsidizing DFS by about 55% led to a fairly large take up, even without detailed information campaign.

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1 Introduction

According to the WHO Global Anemia Database, 24.8% of the world's population is anemic (de Benoist et al., 2008). Iron deficiency is one of the leading causes of anemia, along with other nutritional deficiencies, disease (malaria), and infections (parasites). The consequences of iron deficiency anemia (IDA) depend on age. For children, IDA is associated with slower physical and cognitive development (Lozoff, 2007) with potentially long-lasting effects (Lozoff et al., 2006). For working age adults, productivity may be lowered by IDA, as feeling weak is the most common symptom of the disorder (Haas and Brownlie, 2001). Severe anemia during pregnancy can lead to low birth weight and child mortality (Stoltzfus, 2001). For older adults who have passed their most physically productive years, high rates of the anemia are observed generally, Lower hemoglobin levels in the elderly are associated with cognitive decline (Peters et al., 2008) and lower physical performance (Penninx et al., 2004).

Reduced productivity caused by IDA and its potential impact on earnings has become a focus area for health research in developing countries where large sections of the population provide physical labor in agriculture, construction and manufacturing. To address iron-deficiency anemia, health policies normally focus on providing mineral supplements or fortifying foods. Surprisingly, few evaluations have looked at the impact of treating IDA in any form on actual output. Basta et al. (1979) found a large effect of iron supplementation on sugar tree tappers in Indonesia (but the study suffered from attrition), Li et al. (1994) and Edgerton et al. (1979) found a much smaller effect on productivity. Thomas et al. (2003), which found a large effect of an iron supplementation program on the labor supply of males who were anemic at baseline, and an increase in earnings, but only for self-employed males.

Providing supplements to a large population, particularly pregnant women, is a standard policy in many countries.[1] However, it faces two problems. The first is that it relies on public health infrastructure and local providers, who the government struggles to monitor (Banerjee et al., 2004; Chaudhury et al., 2006). The second is that individuals often do not comply with

[1] Under the National Rural Health Mission in India, large iron supplements are to be provided to pregnant women and adolescent girls, at a cost of INR 105 per 1000 tablets. This is only about USD 2 for enough supplements for 10 women. When cases of severe anemia (a pregnant woman has a hemoglobin level of less than 8 g/dL) are identified they are addressed with iron sucrose given intravenously.

the protocol, perhaps because the gains are not easily measurable but potential side-effects (such as constipation) are evident (Allen et al., 2006). In our study area, which is covered by a supplementation policy aimed at pregnant women, we found 60% of pregnant females to be anemic using the standard 12 g/dL cutoff.

The second approach to prevent widespread anemia is to add iron to foods that are a regular part of the local diet. Fortification is a compelling solution in locations where households regularly purchase packaged foods that can be fortified centrally during mass production. For example, in the US, all enriched grain products are fortified with folic acid to help prevent neural tube defects in newborns, toothpaste is fortified with fluoride to prevent cavities, salt is fortified with iodine to prevent goiter, and milk is fortified with vitamin D to prevent rickets. Several states in India now have iron fortification subsidies for flour, which is then purchased on the open market.

These channels do not effectively reach low-income populations in remote locations, however, because they do not buy as much processed grains. Village-level fortification, which we studied in a prior study (Banerjee et al., 2011) had a very low rate of take-up which suggest that this is not a sustainable alternative. The study found no impact on anemia after one year as most households stopped fortifying after 6 months. This suggests that the need for continued household effort, in particular taking the grain to a mill that is equipped to fortify (and monitoring that the miller actually fortifies the food) , is a barrier to long-term take-up.

This project will study the feasibility and the impact of an an alternative approach, which is to fortify salt with iron. There are currently two accepted formula for double fortified salt in India, one produced by the National Institute of Nutrition (Hyderabad) and the other by the micronutrient initiative. There is evidence from clinical trials in several countries (including India) that iron-fortified salt has the potential to improve hemoglobin-status and reduce anemia among young adults and lactating women (Nadiger et al., 1980; Sivakumar et al., 2001) and children (Nair et al., 1998; Brahmam et al., 2000; Andersson et al., 2008).

These studies, however, involve very small samples in carefully controlled environments, often ensuring consumption by adding the salt to food consumed by the participants, or dis-

tributing it at home for free. There are thus so far no large-scale study of making DFS available, potentially at subsidized rate on usage, eventual health, let alone productivity. DFS is promising technology, for at least three reasons. First, it can be fortified centrally and stored for up to one year due to technology that slows iron and iodine degradation (Ranganathan and Sesikeran, 2008). Second, all local diets include salt, whereas some regions eat more rice than flour-based rotis. Third, even in remote villages, households purchase salt throughout the year rather than produce it. Unless we directly study take up and impact, however, one cannot assume that DFS will be part of the the answer to the anemia problem among the poorest. Furthermore, to the extent a government is willing to subsidize the fight against anemia, it can do so by subsidizing DFS. But without evidence on the willingness to pay for DFS at various prices, how should the subsidy level be set up?

This larger project fill this gap by implementing a large scale RCT in 400 villages in Bihar, including 200 where DFS produced by Tata salt will be made available at a subsidized price. In this paper, we report findings from the baseline survey, which strongly suggest the need for an intervention to fight anemia, and the potential role of DFS, as well as the result from a small-scale RCT we implemented to identify the level of subsidy needed to insure a sufficiently high take up. We also find 53% of women age 15-49 have hemoglobin levels under 12 g/dL and 21% of men have a hemoglobin level under 13, the rough cutoffs for anemia. A large majority of household (94%) purchase iodized salt, which makes an intervention to provide DFS potentially promising.

This paper also presents the results of a small-scale experiment to assess willingness-to-pay for Double Fortified Salt using randomly assigned discount vouchers. We find that the take up of DFS falls quickly with price. At a price point of 45% of the retail price of DFS sold in major Indian metros, the take up of DFS is 20%.[2] We also assess the impact of three separate information campaigns on purchase behavior: a basic campaign limited to written promotional materials; the basic campaign plus a street play; or all of the above plus a door-to-door public health campaign conducted by incentivized volunteers referred to as ASHAs (accredited social

[2] A rate of 20 to 30% of households purchasing DFS was estimated as the requirement to observe an average increase in hemoglobin of 0.7 g/dL, which is meaningful.

health workers). We find no differential impact of information campaign type among households who were given vouchers to purchase DFS.

2 Setting and Background on Double Fortified Salt

2.1 Setting for Baseline Survey and Pricing Experiment

Our pricing experiment and baseline survey for the larger impact assessment were conducted in the state of Bihar. With a population of 104 million (Registrar General of India, 2011), a state Human Development Indicator that puts it in 21st place out of 23 ranked states (Planning Commission and IAMR, 2011), and an underweight prevalence rate of 56.1% for children under age five (Menon et al., 2009), Bihar is large, poor, and undernourished. Anemia rates are also high in the state as 68% of ever-married women 15-49 years old and 88% of children under age three are anemic (International Institute for Population Sciences, 2007). Our study takes place in Bhojpur, a district with approximately 44 doctors for a population of 2.2 million (District Health Society Bhojpur, 2011). From our survey, we estimate there are 912 girls for every 1000 boys under the age of 5 in Bhojpur.

2.2 DFS Formulation and Evidence from Studies in Controlled Conditions

The DFS used in the pricing experiments reported here (and for the larger project this is part of) is manufactured by Tata Chemicals, Ltd., a leading private manufacturer of salt, based in Mumbai. TCL uses the National Institute of Nutrition formulation for DFS, which is fortified with 1 mg of iron and 40 g of iodine per gram of salt. When consumed regularly at 10 g/day (roughly the consumption of an adult), this formulation is estimated to provide 10mg of iron and 150 g of iodine (Ranganathan and Sesikeran, 2008), or 56-125% and 100% of the RDA in iron and iodine, respectively. This formulation has been endorsed by a committee set up by the Indian Council for Medical Research (ICMR). The maximum retail prices in major urban markets where DFS was introduced under the brand name "Tata Plus" is INR 20 per kg.[3]

[3] At the time of writing this version, the exchange rate is approximately 54 INR per USD.

3 Baseline Survey

3.1 Data Collection

The survey was conducted across the 14 blocks (sub-district administrative units) of Bhojpur District. We excluded villages with fewer than 50 households from the District Rural Development Agency (DRDA) household and village listing for Bhojpur, stratified by block, and randomly selected 28 or 29 villages from each block to include ub the study. In total, 400 villages are participating. We then randomly selected 15 households per village to participate in our surveys, which are led by Research Associates at J-PAL South Asia.

Our baseline survey collected information on households and each individual member. The household module collected information on the economic status of the household: consumption, savings, assets, etc. The background modules collected data on self-reported health, consumption, productivity, education and pregnancy. The health modules collected anthropometric measurements, hemoglobin counts, objective measures of physical fitness, and subjective measures of illness and general health. Finally, the cognition modules involved several tests assessing respondents memory, attention and mental awareness. The baseline survey began at the end of May 2011 and lasted for 10 months. In total, 6,002 households and 39,623 individuals were surveyed.

3.2 Education, Income Generation, Assets and Consumption

Table 2 presents a snapshot of the households interviewed for the baseline. There are slightly more women in the sample (20,330 females versus 19,276 males), reportedly due to seasonal migration of adult males for income generation. Households are also young with nearly 40% of the sample being under the age of 15 years. In this area, there is a fairly high percentage of families belonging to Scheduled Castes (19%) and other Backward castes (14%), but almost no Scheduled Tribes.

Literacy rates based on reading a paragraph presented by the surveyor are under 50% for women, and much lower for women over age 50 as predicted by historical schooling. Approximately 88% of girls under the age of 15 are enrolled in school presently. Literacy rates are

much higher for males in our sample, with 85% of males age 15 to 49 and 73% of males age 50 and above able to read a short paragraph we presented them easily or with some difficulties. For boys age 5 to 14 school enrollment is 91%.

Most women in our sample do not earn an income. Those that do are principally engaged in animal husbandry or agricultural fieldwork. For men, the most common income generating activities are also animal husbandry and agricultural fieldwork, followed by work in shops or in the mining sector.

We asked households a serious of questions about the assets they own, to approximate relative wealth levels (Table 3). More than half of households own a bicycle (63%) and 14% a motor cycle or a scooter. Mobile phones can be found in 77% of households. Only one-third have a kerosene stove, 25% own a radio, and 23% have a television.

Houses have approximately four rooms on average including the kitchen, with household size of six to seven persons on average. The average household owns about three animals, the most popular being goats and buffaloes.

We measure consumption with a series of questions about the amount consumed on various categories over the previous 30 days (food broken down into nine types, pawn/tobacco/alcohol, fuels, personal and house care, entertainment and media, gambling, travel, phones, other) or the previous year (clothing, shoes, schooling, festivals and ceremonies, healthcare, insurance, rent, and eight types of durable goods). These figures were then converted into an estimated monthly expenditure divided by the number of household members. Monthly per capita consumption is high at just over INR 1900 (Table 3) and it reflects the value of articles produced as well as purchased in the market.

We also asked individuals which types of foods anyone in the household consumed the day before the survey and counted the number of food groups eaten out of the 12 used to estimate dietary diversity.[4] Dietary diversity is a useful proxy for a diet associated with caloric and protein sufficiency, better birth weight, improved child anthropometric status and higher hemoglobin (Swindale and Bilinsky, 2006). As our measurement combines answers for foods consumed by anyone in the household about which the respondent knows, it may be an overestimation of

[4] We excluded responses for people who had attended a festival or other special event the previous day.

diversity for individual members. Nonetheless, the average household consumed 6.8 out of 12 food groups the previous day. Unsurprisingly, less than 2% of households consumed meat the previous day, about 4% consumed eggs and only about 6% consumed fish. Comparatively, Swindale and Bilinsky (2006) recommend setting Dietary Diversity targets in such a sample using the score for the highest income tercile or the highest diversity tercile in the population. For our sample, the Dietary Diversity Score for the highest diversity tercile is approximately 8.5.

Finally, we also asked about the type of salt that the household normally consumes. In our sample, 94% of households reported buying iodized salt the last time they purchased salt.

3.3 Health of Children

We turn next to the results of extensive health and physical measurements in our baseline survey. Our full sample of children age 14 and below includes 7,465 girls and 8,025 boys. Rates of anemia in young girls and boys are high at around 50% for "any" anemia (see Appendix Table A for thresholds) and around 25% for moderate or severe anemia in the age group of 6 months to under 5 years (see Table 4). The gender gap in anemia rates is evident in older children, with 40% of girls aged 5 to 14 years testing as having any anemia (22% are moderately or severely anemic) and 29% of boys measured as having any anemia (15% are moderately or severely anemic).

The vast majority of children eat at least three meals a day. For children there's no BMI-related standard of thinness, but in our villages the average BMI among children is around 14.6 to 15.1. According to Mid Upper Arm Circumference (MUAC) benchmarks about 8% of young girls and 4% of young boys are undernourished.

We also conduced four objective tests of physical fitness among children aged 10 and above. The QCT is a variation of the Harvard Step Test which has been previously been used on Indian populations to create a physical fitness index (Chatterjee et al., 2004, 2005). The QCT is performed using a 16.25 inch high step. All respondents are asked to follow the same protocol, which required them to step on and step off the step to the beat of an electric metronome. All male respondents were asked to follow a 96 beats per minute rhythm, while

women and children (10-14 years), were asked to follow 88 beats per minute, in accordance to the guidelines established by Chatterjee et al. (2004).

Of the 2,051 girls who attempted the QCST, 54% were able to complete it. Of the 2,263 boys who attempted it, 74% finished. If a respondent fell out of sync with the beat of the QCT for more than 15 seconds, he/she was asked to stop and perform the other basic fitness tests.

Second, for the Balance Tests, respondents were asked to stand in 3 positions for at least 10 seconds (feet side by side, semi-tandem, full tandem). For those who could not finish or would not attempt the QCT, 89% of girls finished all three Balance Tests and 94% of boys finished all three. For the Walk test, individuals were asked to walk a distance of 4 meters in a fast walking pace twice. On average, girls covered this distance in 3.2 seconds and boys covered it in 2.8 seconds. For the fourth test, subjects were asked to sit and stand from a stool five consecutive times. Girls did this in 8.9 seconds on average and boys finished in 9.0 seconds.

In addition to objective measures, we also asked about subjective health. The surveyors began by asking the respondents to rank their overall health on a scale from 1 (Very good) to 4 (Very bad). For very young children, a parent was asked the question about the child's health. Self-reported health is good or very good for the vast majority of all ages of children.

Next, respondents were asked to indicate the number of occurrences of short-term sicknesses in the last 30 days as well as of more severe disease symptoms in the last 6 months from two respective lists. Very few children (3% to 6%) report chronic illness over the past 30 days, though about 40% of girls and boys have missed school due to illness or excessive fatigue in the same time period. About one-quarter of the older children have also missed work for the same reasons. The most common sicknesses for children, adults as well as elderly are cold, fever, fatigue, and diarrhea.

Last, the survey also measured perceived mental health. Respondents were asked to indicate how frequently each mental state from the following list is experienced: (1) I felt sad, (2) I felt like crying, (3) I felt scared, (4) I felt lonely, like I did not have any friends, (5) I felt like people I know were not friendly or did not even want to be with me, (6) I did not feel like eating or was not hungry. For each mental state the respondent indicates how intensely/often

she or he felt that way in the last week: (1) Not at all, (2) a little, or (3) a lot.

Our depression index is formed simply by adding up the intensity values (1-3) for all six feelings. Someone who does not feel any of these negative states over the previous week will, therefore score a 6. This test is modeled after the CES-D depression index (Radloff, 1977).[5] Children scored very low on this index with no difference between girls (7.3) and boys (7.2), indicating on average they felt one of the negative states during the previous week.

3.4 Health of Adults

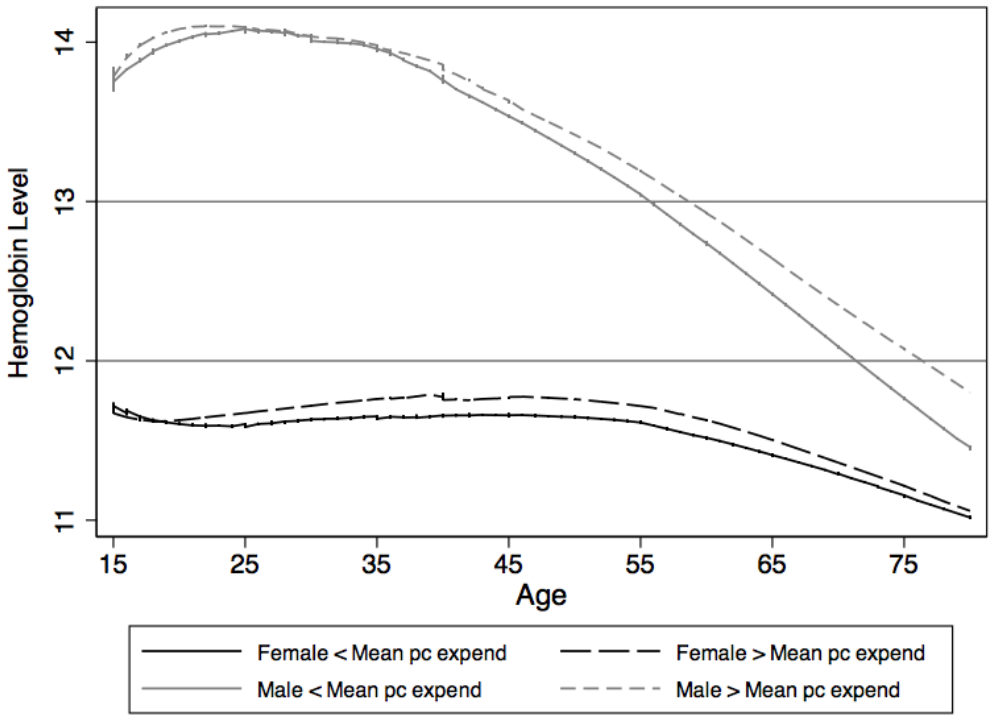
In order to assess the health of adults and older adults, we used a similar set of objective tests and self reports. They are reported in Table 5. In this sample, the average woman is anemic, with hemoglobin under 12 g/dL. Among adult women, 52% are anemic by all definitions. and 25% are moderately or severely anemic. These percentages increase with age and 68% of women aged 70 and above are anemic by all definitions, 39% moderately or severely. The situation is only relatively better for adult males for whom the rate of "any" anemia is 22% for the 15 to 49 age group. The gender gap in "any" anemia goes away in this sample as the proportion of anemic men increases to 55% for men in their sixties and to 67% for men over the age of 70. However, men do have lower rates of moderate and severe anemia in all age groups. Figure 1 illustrates the relationship between hemoglobin and age in our sample.

Many adult females and adult males eat fewer than three meals per day, but this is particularly high among men in their sixties (43%) and seventies (49%). Over 85% of women across all age groups never eat meals outside. For adult males under 50 this proportion is only 58%, but it rises to 82% for men in their seventies. Nonetheless, the percentage of meals taken outside is extremely low for all adults at 6% or less, indicating that iron-fortified salt will reach this group if it is in food cooked and consumed at home.

In terms of healthy weight-for-height, the average adult is within the healthy range for BMI. However, a fairly high proportion of adults have a BMI that would be classified as Moderate or Severe Thinness. This is true for 12% of women between the ages of 20 and 49, and increases to 29% for women in their seventies. Approximately 10% of men aged 20 to 49 are moderately

[5] The number of feelings and coding of answers of this survey differs from the standard 10-item CES-D index.

Figure 1: Lowess Graph of Hemoglobin Level by Sex and Consumption



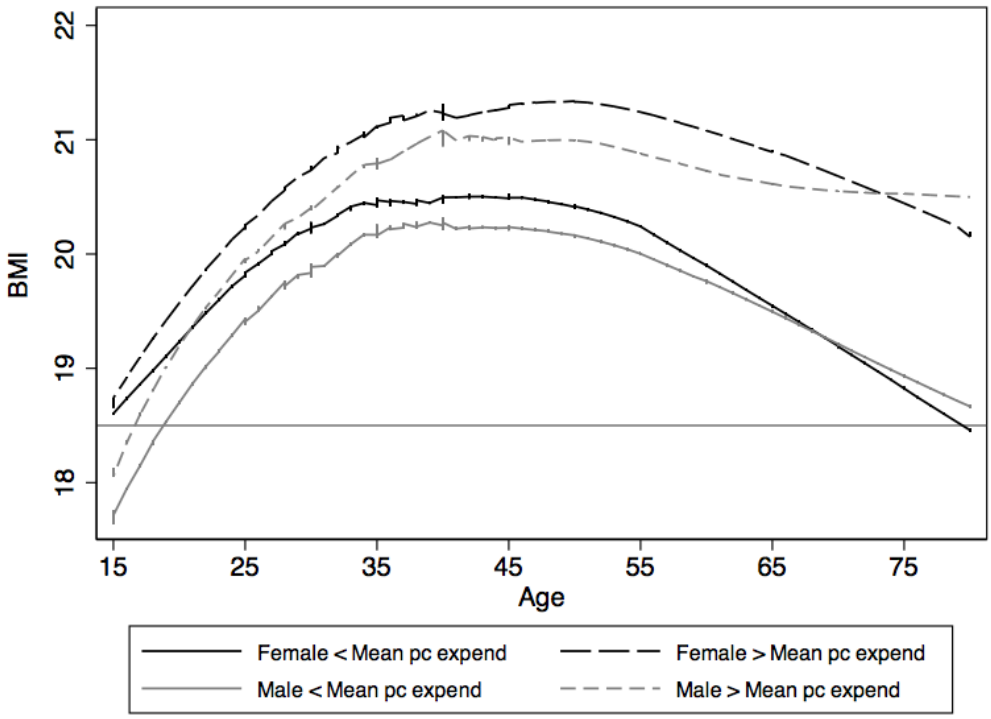
or severely thin, and this increased to 22% among men in their seventies. Figure 2 shows the relationship between BMI and age is strong and is not mediated by a measure of wealth. The dotted lines indicate individuals whose household consumption per person places them in the upper half of the consumption distribution.

Undernourishment among adults is corroborated using a conservative benchmark of a 20 cm MUAC for adults. By this measure, approximately 25 % of adults under the age of 50 are undernourished. MUAC is roughly stable until individuals reach their seventies.

For adults, the Queen's College Step Test was limited to people under age 50; 25% of women who attempted it could complete it and 73% of men could finish it. Most women under age 50 could, however, complete the three balance tests as could men of the same age. For both sexes, balance declines over the decades. Figure 3 highlights the decline, which is greater for women.

Time taken to walk four meters start at about 4 seconds for adult women and 3.3 seconds

Figure 2: Lowess Graph of Body Mass Index by Sex and Consumption

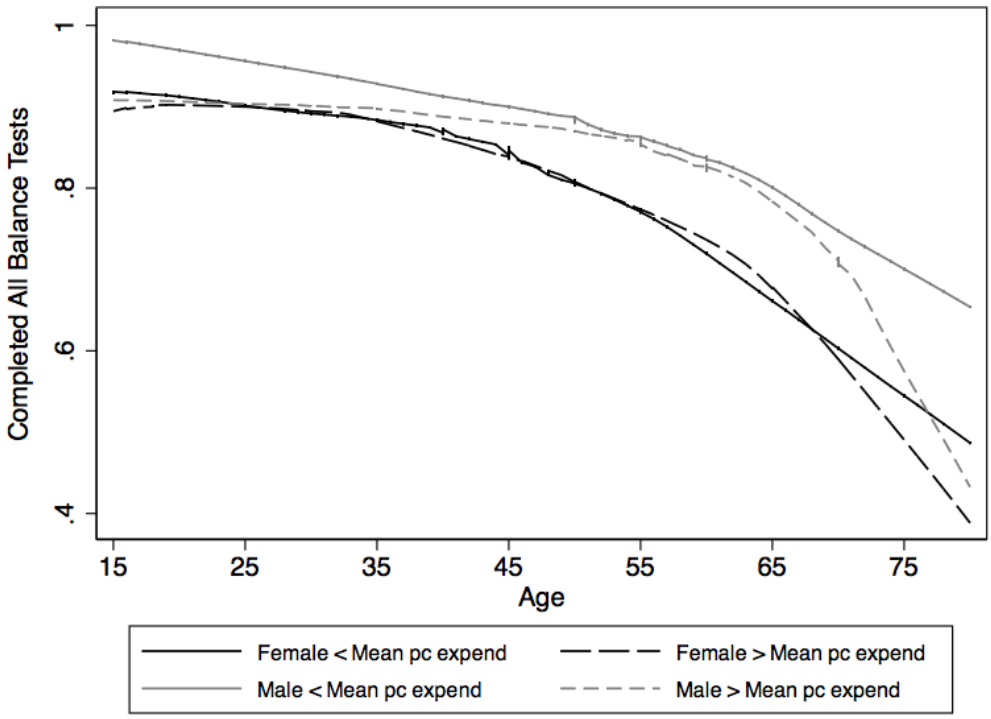


for adult men. Both sexes are slower at older ages, but the difference is greater for women. The average man over age 70 covers the distance as a woman in her sixties. Next, Table 5 shows us that the time taken to stand up and sit down five times is quite a bit longer for adults than for children. It takes adult women over 11 seconds and adult men need 15 over 10 seconds to complete the task. Men are faster than women on this test at all ages, but particularly when comparing women and men in their seventies.

A more direct way to capture physical health through self-reported information is to ask respondents about their ability to perform activities involving different degrees of physical stress. In the survey adult and elderly respondents were asked to report the level of difficulty they experience during the following seven common activities of daily living: stand up from sitting on the floor, fill a bucket with water, use a hand pump, walk 0.5 km, walk 5 km, carry 5 kg weight, and sow rice for 1 day.

For each activity the respondent indicated whether he or she: can do it easily, can do it

Figure 3: Lowess Graph of Balance Tests by Sex and Consumption



with some difficulty, finds it very difficult to do, or cannot perform the activity. We report the number of activities that can be done easily or with some difficulty as "can be done." The average working-age woman can complete 3.4 of these activities and the average male can complete 4.0. Older women can do fewer and women in their seventies on average can only compete one task while men in their seventies can complete two.

Next, we look at reports of subjective health. Nearly 80% of working age women and 90% of working age men report that their health is good or very good. With each decade of age, reports of good health are lower. But, remarkably, 56% of women and 67% of men in their seventies report that their health is good or very good. This, of course, could be the result of the sicker people dropping out of the population.

As in other surveys we find high rate of self reported diseases (an "ocean of diseases"). The number of illnesses reported over the past 30 days is higher for average adults of all ages than for children. This potentially reflects the relative difficulty parents had remembering children's

illnesses versus their own. Prime-age adult women report 2.95 symptoms of disease over the last 30 days, and 19% say they had an illness "all the time" over the last 30 days. This jumps to 3.47 diseases for women in their fifties, 30% of whom feel ill "all the time," and keeps increasing with age. The same pattern is present for men, though at all ages they report fewer illnesses. As in many other studies, we find higher self reported status among men and women, and self reported health status decline with age. Remarkably, 26% of prime age women, and 28% of the prime-age men report having missed some days of work due to illness or excessive fatigue over the last 30 days, which suggest that the poor health status may in fact have an impact on productivity.

Finally, we report the results for adults on the Depression Index in Table 5. Women under 50 score an average of 9.2 on the test while men score 8.1 This is slightly higher than for children (scoring just over 7). The score is higher with greater age; women in their seventies score 10.5 and men in the same age group scoring 9.0 on average.

3.5 Cognitive Health

An interesting feature of this survey is the combination of the rich demographic and economic data (and the experiment) with detailed cognitive assessment for both children and adults. The tests instruments are based on internationally or locally validated measures, and are described in details in the appendix. Cognitive health was measured by four age groupings: 0 to 30 months, 5 to 14 years, 15 to 49 years, and 50 years and above.

For infants, the Lucknow Development Screen (all cognitive tests are described in more detail in the Appendix) measures psycho-motor skills by asking parents if the infant can complete age-appropriate activities such as recognizing his or her mother, turning head toward a sound, and walking with help or alone (Bhave et al., 2010). The child receives a score equal to the percent of items he or she can do that 97% of children the same age can do. Children in our population score below the expected range of the test: approximately 47% of infants (both boys and girls) can accomplish all of the age-appropriate tasks. This is only slightly less than the Lucknow sample (142 children aged 6 to 24 months), where 49.3% of children could complete

all age-appropriate tasks. Further, Table 6 shows the average infant in our sample can complete 94% of the actions appropriate for his or her age. This thus suggests low levels of cognitive development among infants. The results are similar among boys and girls.

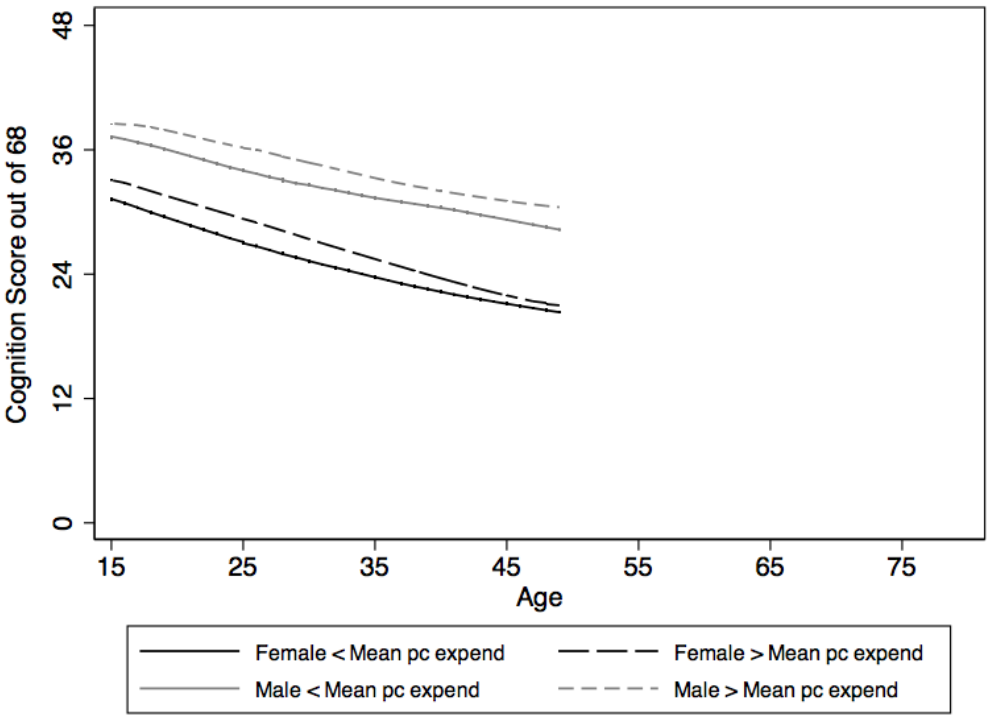
For children between the ages of 5 and 14, we used two tests. The Digital Span Test from the PGI Memory Scale (Pershad and Wig, 1988) asks the child to repeat four sequences of numbers, 3 to 8 numbers in length forward and 2 to 8 long backward. One point is awarded for each correct repetition out of a total of 26.

The first part of the block tapping test from the National Institute of Mental Health and Neurosciences (Kar et al., 2008) asks children to tap the top of four matchboxes in the same order they just saw a surveyor tap. In the second part, the child is asked to repeat the tap in reverse order. Each correct answer on five forward and five reverse tapping tests earns the child one point. The maximum possible is 10 points.

The average scores increases with age and is higher for boys than for girls. Strikingly, they are lower for girls than for boys, even among the youngest children. Boys performed better than girls by approximately 1.5 points (significant at 99%). At the age of 5 to 7 years the gap is 0.7 points, with girls earning a total of 3.9 points on average and boys earning 4.6. In the 8 to 10 year group, girls earned 7.8 points and boys 9.5 points. For the oldest children, aged 11 to 14, the gap is widest with girls earning 10.1 points while boys earned 12.7 on average.

For age adults (age 15 to 49), we again used sub-tests from the PGI Memory Scale. The first is identical to the children's Digital Span Test and is worth 26 points. The second test asks the individual to listen to a sequence of words read out slowly and then repeat it back after one minute; it is worth 10 points. The third test requires the subject to listen to sentences of increasing length and repeat back phrases from the sentences and can earn the individual 12 points. The final test asks the individual to listen to a sequence of pairs of words and then to complete the pair when the first word is repeated. The final test is worth 20 points making the possible total for all four tests 68. The average woman scores 26.8 on this battery of tests while the average male scores 34.3, meaning the gender gap observed among children persists into adulthood. Figure 4 show that scores are lower for older adults, even in the group under

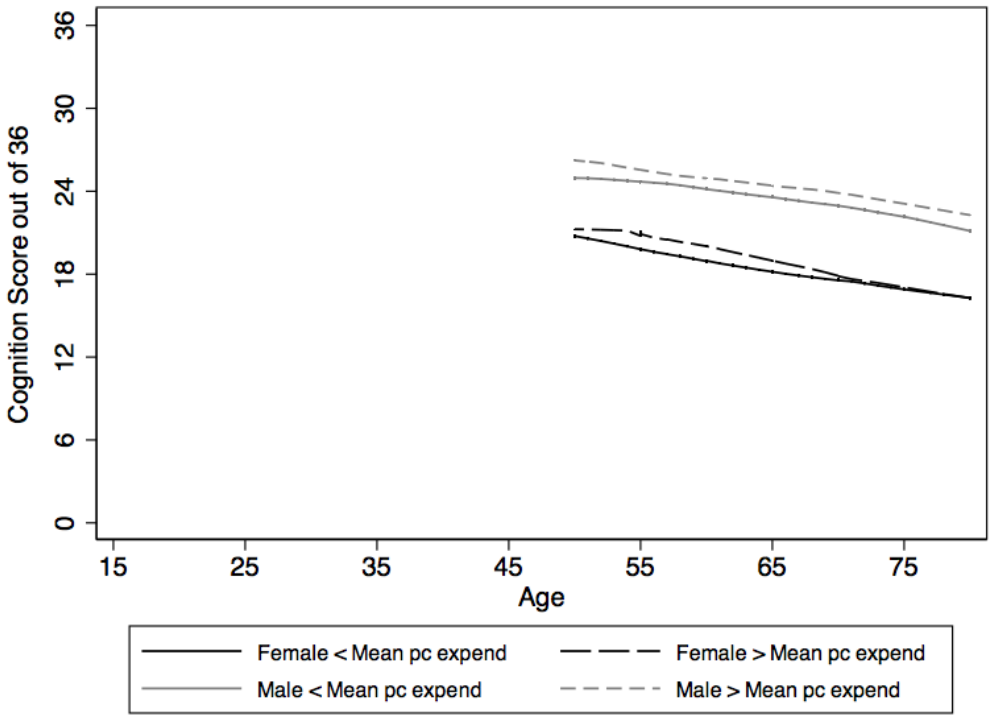
Figure 4: Lowess Graph of Adult Cognition by Sex and Consumption



age 50.

Finally, we measure cognition among adults age 50 and above using the Hindi Mental State Examination (Ganguli et al., 1995), which is based on the Mini Mental State Examination (MMSE) and validated in India populations. This exam contains 11 different sections involving orientation to time and location, repetition and recall, registration and recognition of objects, figure drawing, and addition (of sevens serially). The maximum score on this battery is 36. In the validation of the test in Ballabargh, a rural setting outside Delhi, with a population over 55 years old (mean age 70.7), the scores varied from 21 among those with no education to 26 among those with some education. Overall, women age 50 and older score 19.2 points and men score 24. Figure 5 shows the decline in women's and men's scores as they age. Table 6 shows that women's average scores decline from 20.6 for 50 to 59 year-olds to 19 for 60-69 year-olds and 16.9 for those age 70 and above. Men in their fifties score 25.4 points, men in their sixties score 24.1 points, and men age 70 and above score 22.3 points.

Figure 5: Lowess Graph of Older Adult Cognition by Sex and Consumption



3.6 Associations between Anemia and Health Characteristics

Without attempting to make any causal inference (since the causality is likely to run both ways), in Table 7 we present the associations between anemia and other characteristics separately for each sex. At the household level, there is a significant association between the percentage of the household that is moderately or severely anemic and measures of wealth. Households with more anemic members have slightly lower monthly per capita expenditure and own slightly fewer assets (Panel A). Anemia is also more prevalent in households that have a lower nutritional variety. This correlation persists (and remain significa) even after controlling for asset (which is strongly significant) and for per capita expenditure. This suggest that anemia may have something to do with the quality of nutrition, rather than the quantity.

We also observe many significant associations at between individual hemoglobin and other personal characteristics controlling for age, smoking status, and pregnancy in regressions with standard errors clustered at the village level. Hemoglobin is lower for males who never eat

meals outside (most adult males are in this category) and, higher among those who eat less than three meals daily (most individuals do eat three meals daily see Table 5). Interestingly, among females, anemia is not correlated with the number of meals missed.

We also observe a strong pattern of associations between hemoglobin and measures of physical fitness. Higher hemoglobin is associated with higher BMI, high completion rates for the Queens College Step Test and Balance Tests, faster time in walking four meters, faster times standing up and sitting down (for males only), and a higher number of activities of daily living that can be done.

Table 5 also shows that higher hemoglobin is associated with better self-reported health, fewer number of illnesses reported and having an illness "all the time" in the past 30 days. There is, however, no relationship between hemoglobin and the depression index (which was fairly uniformly low among males and females).

Finally, there are also strong associations between hemoglobin and cognition for all age groups. Higher hemoglobin is associated with slightly high LDS scores for female infants (the sign is the same, but not significant, for male infants). Higher hemoglobin is also associated with higher cognition for children age 5 and older and adults of all ages. Though the effect is significant for adults under age 50, the size is small (0.005 for female and 0.01 for male adults).

This may not indicate a correlation from anemia to poor physical fitness or nutrition, although the fact that it holds among both children and old people (who are presumably not earning money) indicate that it may not be entirely due the direct reverse causality (of higher cognition causing greater earnings and hence lower anemia).

To summarize, the baseline survey paints a picture similar other surveys of rural populations in India. Anemia is ubiquitous, particularly among women, as are various symptoms of poor health, frequent self-reported diseases, poor performance on physical fitness tests. What is striking, however is that this is a population that is neither particularly poor by the standard of rural India (the average per capita consumption is 67 rupees per day), and the overall level of nutrition seems to be satisfactory, judging by the BMI (though a substantial fraction of people do not eat 3 meals a day). There is no proof that anemia is associated with poor nutrition, but

it is strongly correlated with dietary diversity among both men and women. There is thus some indication from the baseline that it is related to micronutrient availability.

In turn, anemia is associated with poor health outcomes and poor cognition outcomes among people of all ages and all genders. Moreover, all the household buy salt, and they frequently buy iodized salt. This suggests that the introduction of salt that is fortified with iodine may be a promising way to fight anemia. In the second part of this paper, we report the results of a randomized control trials we conducted to determine what the take up of double fortified salt would be at various prices, and whether the way it is introduced to the villagers would affect this take up.

4 Pricing Experiment

4.1 Design of Experiment

DFS had not been marketed in rural Bihar before this trial. Our Pricing Experiment was designed to assess household willingness to pay for Double Fortified Salt, as a first stage in our larger research agenda. Working in one district of Bihar (Bhojpur), we randomly selected 45 villages in Behea block (administrative areas smaller than the district) and in cooperation with Tata, we stocked Tata Salt Plus in small private stores (hereafter called kirana shops) and Public Distribution System (PDS) shops. Within these 43 villages, we combined a randomization of information treatment at the village level and pricing/outlets at the household level. Each village was randomly assigned to receive one of three information campaigns:

1. A basic campaign consisting solely of printed materials displayed at the participating stores,

2. The full Tata campaign, which included street plays and group activities similar to those Tata conducts in other markets, in addition to the basic campaign, or

3. Household visits by the governments ASHA health workers, in addition to the basic campaign and the full Tata campaign.

Table 1: Pricing Experiment Vouchers

	Voucher Type	PDS Price	Kirana Price
Lower price only at PDS shops; MRP at kirana	1	8	
	2	9	
	3	10	17
	4	11	
	5	12	
Same price at kirana and PDS shops	6	8	8
	7	9	9
	8	10	10
	9	11	11
	10	12	12
No Discount	11	17	17

After the campaign was conducted, our team distributed vouchers for DFS purchase to 99 households in each village and conducted a short survey asking about previous salt usage, socioeconomic status, and knowledge of DFS. The net price after discount was INR 12, 11, 10, 9, or 8 per kilogram. Within each of the villages, anyone was free to purchase one kilogram packets of DFS at the kirana store for Rs. 17, the price without any subsidy. Coupons either showed consumers the full price at private stores (kiranas) and offered them a subsidized price at the government Price Distribution System (PDS) shop, or were valid at the same price (full or various levels of subsidy) at both the PDS shop and the selected kirana(s), in order to assess purchase habits and take-up in both distribution channels. In all, there were 11 types of vouchers (see Table 1) distributed and they were valid for four weeks.[6]

Our data collection activities included both household survey and administrative data. When the first vouchers were handed out, households were asked to complete a short survey including simple questions about use of PDS and kirana stores and the wealth of the household. The location of these households was also recorded with a handheld GPS device. In addition, data was collected on salt and DFS sales and voucher use from the PDS and kiranas, and DFS consumption and satisfaction, as well as possible resale, by households.

[6] We also distributed a second, exactly similar voucher to each household five weeks after the first distribution. This second round is not discussed separately here as the results are similar.

Appendix Table A presents the results of checks of the household level randomization. Each household characteristic listed was the dependent variable in an OLS regression with 10 binary variables indicating voucher type as independent variables along with a covariate for the village. We present the test statistics for the join test of significance for all of the voucher-type independent variables. This allows us to detect a correlation, if any, between voucher type assigned to the household and its characteristics. The hypothesis of joint significance can be rejected for all but one of the characteristics. Voucher types predict the number of Buffaloes a household own. But they can't predict other measures of economic wellbeing, such as ownership of land, asset ownership, better contraction materials, number goats owned, or total number of animals owned.

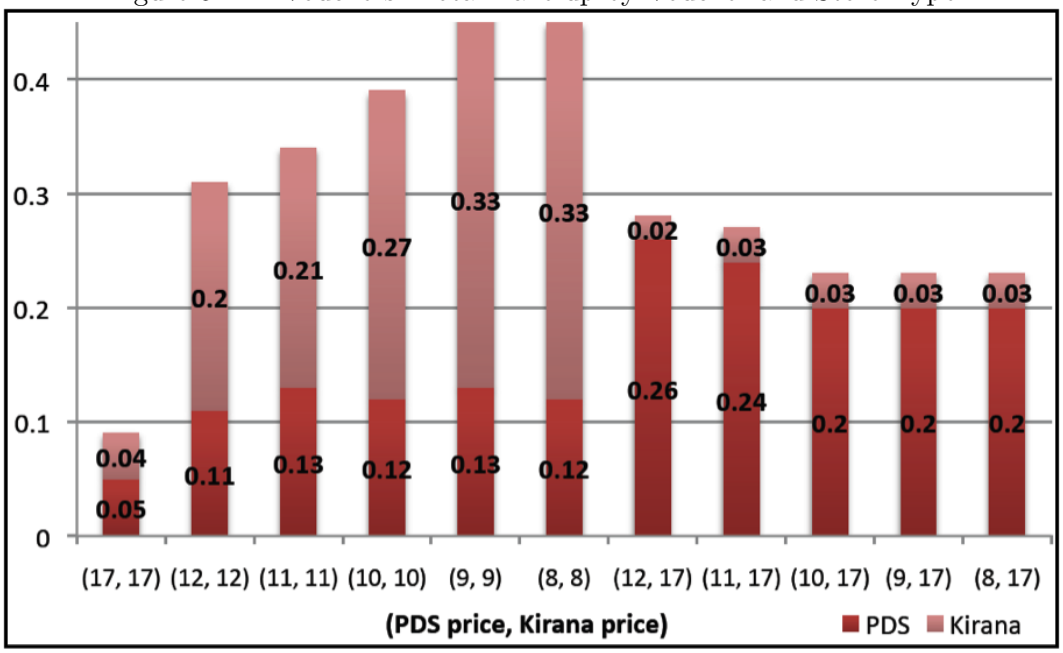
Appendix Table B presents the results of checks of the village-level randomization of the information campaigns. Again, each row presents the results from a separate regression in which the dependent variable is a household characteristic and the independent binary variables indicate the type of information campaign. Standard errors are clustered at the village level. The 15 villages that were given the Tata campaign have slightly fewer (-0.22) children per household, are less often constructed of bricks (rather than mud) and own 0.33 fewer animals than households in the 14 villages that received only the basic information campaign. While 97% of households report that they ever buy goods from the PDS, this proportion is 98% for households in the 14 villages that got all three information campaigns. Since the survey where people were asked about anemia was conducted after the information campaigns, the 5 pp increase in ever hearing about anemia in the Basic + Tata + ASHA group likely reflects the success of ASHAs in delivering the health message.

4.2 Results of Pricing Experiment

Overall, 4,179 vouchers were distributed, of which 1,237, or 30%, were redeemed. Total sales was 1,808, i.e., voucher sales comprised 68% of total sales, and there were 571 purchases of DFS without vouchers (32% of all sales).

Take-up for those given full-price vouchers was approximately 8%. Table 8 presents

Figure 6: All Vouchers: Total Take-up by Voucher and Store Type

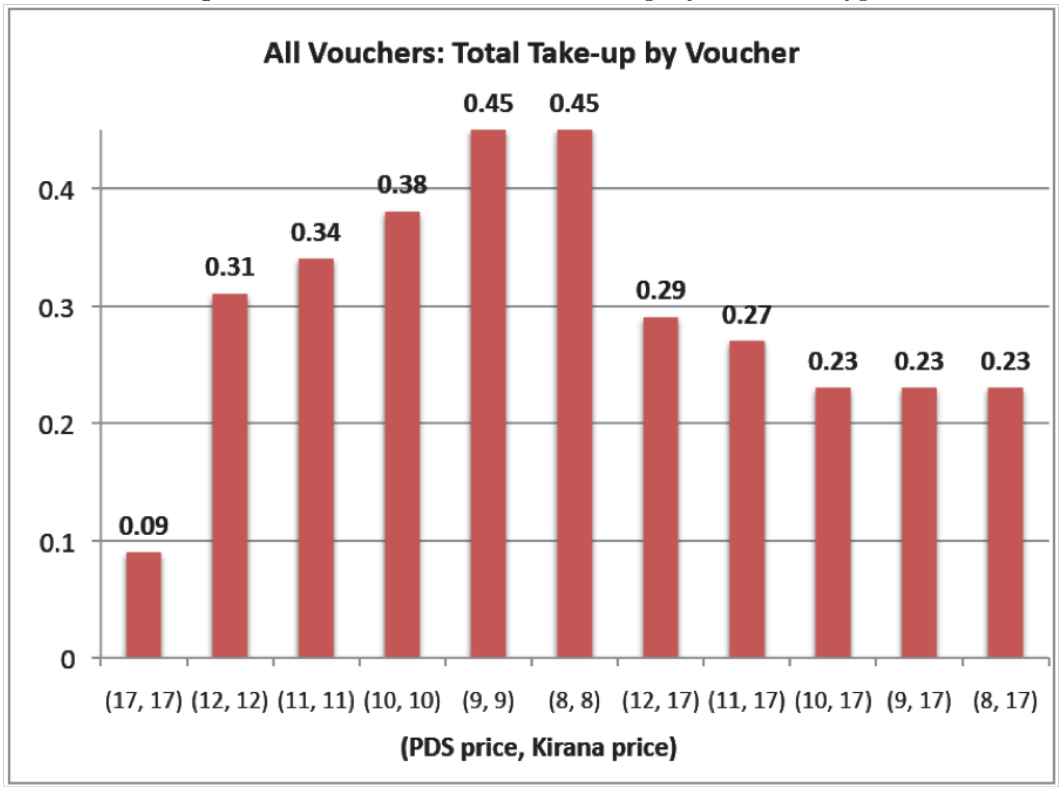


the results of the pricing experiment. Columns 1 through 5 estimate purchases in both types of stores combined when the amount of the discount offered was from 5 to 9 INR. At every discount level, total take-up is higher when the discount is available at both outlets than when it is only available at PDS. Offering a discount in the PDS increased total household purchases more than offering it in the private shops (19 pp vs. 13 pp). The impact of each Rupee discounted off the price in the PDS was to increase household purchases by approximate 2.7 pp while each Rupee discount in the private shops increased sales by 1.9 pp. This result is robust to the inclusion of the information campaign in the regressions (column 5). Column 3 suggests the impact of the discount is linear over the discount amounts we tested.

The final two columns measure take up by store type, PDS (Column 6) or Kirana (Column 7). These models show that discounting sales in both store types increased sales more in private shops than in the PDS shops. When looking at the subset of vouchers that offered the same discount in both PDS and private shops, we can see in Figure 6 that vouchers are more than twice as likely to be used in the private shops.

Comparing Figure 6 and Figure 7 also allows us to see purchase responses at the intensive

Figure 7: All Vouchers: Total Take-up by Voucher Type



margin. For example, when a discounted price of Rs.8 is available at both types of stores, total take-up is 45%; when the same discount is available at only PDS, total take-up falls to 23%. At any discount level, the shift from kirana to PDS is incomplete when the discount is constrained to the PDS. Although people are sensitive to price and shift to PDS when the discount is constrained, not all do so. Many households simply do not purchase DFS at all. This is reminiscent of the results in Rajasthan, where households were not willing to switch miller to take advantage of the opportunity. Sales appear to be quite sensitive to price, particularly when it falls form 10 rupees to 9. The significance of this result is that this is the price at which regular iodized salt is often sold. When DFS is priced just below the price of regular iodized salt, it is probably seen as a cheaper way to buy iodized salt.

4.3 Results of Information Campaign Experiment

The last row in Table 8 shows the impact of the adding a more involved information campaign (led by Tata) and a door-to-door campaigning by ASHA workers on take up. There seems to be no effect whatsoever. The estimates are not very precise due to the low sample size at the village level, but the point estimates indicate fairly low impact. We also tested whether information affect price elasticity (results not reported) but found no evidence for this.

Additional evidence we collected strengthen these findings. For example, in the ASHA group, only 1% of households had heard of DFS through an ASHA. In our first survey, shortly after the information campaigns, 21% of the households had heard about Tata salt. They were more likely to have heard about it through a play in the villages were a play was performed, but it seems that information that the product actually existed was not a constraint, at least among surveyed households. Among people who had heard about the salt in the first survey, 35% knew it was "healthy," 31% knew that it contains iron, and 25% knew that it contains iodine. However, only 6% reported that it helps fight anemia, and 4% that it may help fight common diseases. By the end of the experiment, 68% of households knew about DFS, though most still did not know what it stood for or how it differed from regular salt. By and large, it seems that households appear less interested in the specific impact of Tata salt than in the fact

that it gives them access to a brand name product at a price which they consider affordable.

5 Conclusions

The baseline survey indicated that anemia is prevalent, and may be both caused by and a cause of poverty: households with low expenditure per capita and with low diversity in their diet are more likely to have anemic member. Anemic individuals are less strong, sicker, and perform less well on cognitive tests than non-anemic individuals. Finding a way to solve this issue on a large scale is important for policy, and would also give us an opportunity for the first time, to get a reliable measure of the impact of a plausible instrument to fight IDA on health and economic outcomes.

Double Fortified Salt, if priced sufficiently low, seems to have some promise. At a subsidy of 55%, it appears that take up of DFS was reasonably high, even though households did not quite understand why Tata Plus was more desirable than any other type of salt.

A caveat is that there may have been a Hawthorne effect, since the very fact of distributing a voucher (even for the full price) may have made households aware of the product, and may have given them a motive to try it out. Moreover, the sensitivity to a reduction in price through a voucher may be larger than that of a low price offered in the shop, if households have the feeling of having gotten a bargain. In the full scale experiment, salt was made available at INR 9 per kg, the price that was likely to maximize take up according to the price experiment. An information campaign similar to the basic campaign was run in every village by a group subcontracted by Tata salt. We are monitoring take up, and so far (on a relative small sample) the take up is only about 10% on average, much lower than in the price experiment. This may come from teething problems at the beginning of the program (it took a while to supply all the shops, and to renew their stocks when they run low), as well as from poor implementation of the information campaign at this large scale. Tata also reported to us that a take up of 10% is standard for a new product (although this one is subsidized).

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Table 2: Demographics of Baseline Survey Sample

Households (number)	5970
Scheduled Caste (% of household head)	0.19
Scheduled Tribe (% of household head)	0.004
Other Backward Caste (% of household head)	0.14
General Category (% of household head)	0.67

	Age 0-4	Age 5-14	Age 15-49	Age 50+	Total
Females					
Number	2462	5003	9387	3478	20,330
Can read paragraph easily or with difficulties (%)	-	0.47	0.49	0.17	
Enrolled in School (%)	-	.88	.13	-	
Number who are working	-	-	3651	1703	
Primary income generating activity is agricultural fieldwork (%)	-	-	0.26	0.23	
Primary income generating activity is animal husbandry	-	-	0.60	0.68	
Primary income generating activity is textiles & handicrafts	-	-	0.04	0.01	
Primary income generating activity is shop, business, etc.	-	-	0.03	0.04	
Primary income generating activity is other	-	-	0.08	0.05	
Males					
Number	2557	5468	7658	3593	19,276
Can read paragraph easily or with difficulties (%)	-	0.55	0.85	0.73	
Enrolled in School (%)	-	0.91	0.24	-	
Number who are working	-	-	5826	2796	
Primary income generating activity is agricultural fieldwork (%)	-	-	0.30	0.35	
Primary income generating activity is animal husbandry	-	-	0.37	0.48	
Primary income generating activity is mining, construction, physical work	-	-	0.11	0.05	
Primary income generating activity is shop, business, etc.	-	-	0.13	0.07	
Primary income generating activity is other	-	-	0.09	0.04	

Table 3: Household Assets and Consumption (Baseline Survey)

Bicycle (% owning)	0.63
Motor Cycle or Scooter	0.14
Kerosene stove	0.34
Mobile phone	0.77
CD/DVD player or Radio	0.25
Television	0.23
Number rooms in house (excluding bathroom)	4.1
Number cows	0.7
Number buffaloes	0.9
Number goats	1.7
Number chickens	0.5
Number pigs	0.03
Total animals	2.7
Monthly per capita consumption (INR)	1913
Household Dietary Diversity Score (out of 12)	6.8
Last salt purchased was iodized (% yes)	0.94

HDDS is the number of food types out of 12 consumed on the previous day.
It is a composite measure of food access and socio-economic status.
N= 5970 households

Table 4: Individual Nutrition and Health - CHILDREN (Baseline Survey)

	Girls		Boys	
AGE:	0-4 years	5-14 years	0-4 years	5-14 years
Number	2462	5003	2557	5468
Hemoglobin (g/dL)	10.70	11.78	10.81	12.18
Anemic (% yes)	0.54	0.40	0.49	0.29
Moderately or Severely Anemic (% yes)	0.27	0.22	0.23	0.15
Eats less than 3 meals daily	0.01	0.02	0.02	0.03
BMI	14.63	15.05	15.07	14.86
Mid Upper Arm Circumference (cms)	14.07	18.02	14.30	17.50
Mid Upper Arm Circumference indicates Undernourished (% yes)	0.08	-	0.04	-
Completed Queens College Step Test (%)	-	0.54	-	0.74
Completed all 3 Balance Tests (%)	-	0.89	-	0.92
Seconds taken to Walk 4 Meters	-	3.18	-	2.82
Seconds taken to Stand Up & Sit 5 times	-	8.89	-	7.95
Reported Health is Good or Very Good (%)	0.89	0.94	0.87	0.95
Number Illnesses over last 30 days (out of 10 asked)	2.12	1.79	2.26	1.80
Had any illness "all the time" over the last 30 days (%)	0.05	0.04	0.06	0.03
Missed school in last 30 days due to illness or excessive fatigue (%)	-	0.40	-	0.40
Missed work in last 30 days due to illness or excessive fatigue (%)	-	0.26	-	0.24
Depression Index (6-18, higher more depressed)	-	7.27	-	7.21

Hemoglobin and anemia are only for children above the age of 6 months. N=1803 girls and 1907 boys 6 months to 5 years old.
There is no established MUAC cutoff for people aged 5 to 19.
Physical tests were administered to individuals aged 10 and above. N= 1785 girls and 1851 boys.
Balance, walk and sit/stand only tested if QCST couldn't be attempted.
Disease Symptoms asked about were: Blood loss, Bad Sight, Night Blindness, Tuberculosis, Malaria, Pain in Joints, Worms, Bloody Stool/ Urine
The Adapted CES-D Depression Index in this sample has a mean of 8.6 with an SD of 2.73. The median is 8.

Table 5: Individual Nutrition and Health - ADULTS (Baseline Survey)

	Female				Male			
AGE:	15-49	50-59	60-69	70+	15-49	50-59	60-69	70+
Number	9387	1424	1241	813	7657	1123	1408	1062
Hemoglobin (g/dL)	11.7	11.7	11.5	11.2	14.0	13.3	12.6	11.9
Anemic (% yes)	0.52	0.55	0.59	0.68	0.22	0.39	0.55	0.67
Moderately or Severely Anemic (% yes)	0.25	0.25	0.30	0.39	0.03	0.09	0.16	0.28
Eats less than 3 meals daily	0.19	0.35	0.38	0.39	0.20	0.36	0.43	0.49
Never eats meals outside home (% yes)	0.87	0.89	0.87	0.90	0.58	0.64	0.70	0.82
Share of meals taken outside	0.01	0.01	0.01	0.01	0.06	0.04	0.03	0.02
BMI (kg / squared meters)	20.34	20.75	20.52	19.39	20.01	20.73	20.04	19.48
BMI indicates Moderate or Severe Thinness (over age 20)	0.12	0.17	0.21	0.29	0.10	0.11	0.17	0.22
Mid Upper Arm Circumference (cms)	24.65	24.98	24.39	23.19	25.65	26.18	25.25	24.16
Mid Upper Arm Circumference indicates Undernourished (% yes)	0.17	0.19	0.25	0.41	0.10	0.12	0.22	0.35
Completed Queens College Step Test	0.25	-	-	-	0.73	-	-	-
Completed all 3 Balance Tests (%)	0.88	0.81	0.71	0.53	0.90	0.88	0.82	0.65
Seconds taken to Walk 4 Meters	3.98	4.03	4.45	5.68	3.26	3.48	3.50	4.30
Seconds taken to Stand Up & Sit 5 times	11.44	12.75	13.66	15.49	10.36	10.86	11.77	13.68
Number of ADL that Can be done (out of 6)	3.40	2.57	2.01	1.14	3.95	3.69	3.22	2.20
Self-reported Health is Good or Very Good (%)	0.79	0.65	0.6	0.56	0.90	0.82	0.75	0.67
Number Illnesses over last 30 days (out of 10 asked)	2.95	3.47	3.57	3.75	2.08	2.45	2.62	2.91
Had any Illness "all the time" over the last 30 days	0.19	0.30	0.38	0.46	0.10	0.17	0.27	0.41
Missed school in last 30 days due to illness or excessive fatigue	0.31	-	-	-	0.24	-	-	-
Missed work in last 30 days due to illness or excessive fatigue	0.26	0.32	0.33	0.29	0.28	0.31	0.31	0.28
Depression Index (6-18, higher more depressed)	9.15	10.09	10.29	10.53	8.11	8.51	8.78	8.98

Anemia thresholds are adjusted for pregnancy and smoking. Thinness thresholds adjusted for pregnancy.
MUAC cutoff for undernourishment for adults is 20. This is a conservative estimate.
The QC Step Test was administered to individuals between the ages of 10 and 49.
Activities of Daily Living (ADL) asked about were: Standing up, Filling a bucket, Walking 0.5 kilometers, Walking 5 kilometers, Carry 5 kg, and Sow rice for 1 day. "Can Do" ADL includes Can Easily Do and Can Do with Some Difficulty.
Disease Symptoms asked about were: Blood loss, Bad Sight, Night Blindness, Tuberculosis, Malaria, Pain in Joints, Worms, Bloody Stool/ Urine.

Table 6: Cognitive Capacity (Baseline Survey)

Panel A: Infants 0 - 30 months

	Female	Male
Lucknow Development Screen (% tasks completed)	93.7	93.8
N	952	1083

The Lucknow Development Screen shows the percentage of age-appropriate actions that the infant can do. Age appropriate actions can be done by 97% of children at a given age.

Panel B: Children

	Female			Male		
AGE:	5-7 yrs	8-10 yrs	11-14 yrs	5-7 yrs	8-10 yrs	11-14 yrs
PGIMS Digital Span Test (out of 26)	1.91	4.02	5.65	2.27	4.95	6.94
NIMHANS Visuospatial Working Memory (out of 10)	1.97	3.79	4.48	2.29	4.57	5.74
Total Cognition (out of 36)	3.91	7.83	10.12	4.59	9.53	12.69
N	1342	1454	1623	1560	1648	1685

There are no validated cognitive texts for 30 months to 59 months.

Panel C: Adults 15 - 49 years old

	Female	Male
Digital Span Test (out of 26)	4.10	6.56
Word Recall (out of 10)	6.29	7.04
Sentence Reproduction (out of 12)	7.89	8.66
Word Pairs (out of 20)	8.46	11.99
Overall Cognition (out of 68)	26.80	34.29
N	8041	6319

Panel D: 50 years old and above

	Female			Male		
AGE:	50-59	60-69	70+	50-59	60-69	70+
Overall Cognition (out of 36)	20.63	19.04	16.86	25.35	24.13	22.29
N	1290	1102	666	1017	1284	942

Elderly cognition is the sum of 11 individual tests.

Table 7: Associations between Hemoglobin and Personal Characteristics (Baseline Survey)

Panel A: Household Level

Association between variable and anemia	Coefficient	SE	N
Monthly per capita consumption (INR 000s)	-0.001***	0.002	5475
Number assets reported owned (0 to 8)	-0.018***	0.002	5880
Household Dietary Diversity Score (0 to 12)	-0.013***	0.002	5200

Anemia is defined as percentage of people in the household being moderately or severely anemic. 60% of households have >0 moderately or severely anemic members.

Panel B: Individual level

Association between variable and hemoglobin level	Female			Male		
	Coefficient	SE	N	Coefficient	SE	N
Never eats meals outside home (% yes)	-0.02	(0.05)	9282	-0.22***	(0.04)	9555
Eats less than 3 meals daily	0.01	(0.04)	15651	0.25***	(0.05)	16527
BMI	0.03***	(0.00)	15282	0.17***	(0.01)	16170
Completed Queens College Step Test	0.20***	(0.05)	5072	0.38***	(0.04)	7598
Completed all 3 Balance Tests (%)	0.15**	(0.05)	5984	0.47***	(0.09)	4102
Time taken to Walk 4 Meters (seconds)	-0.07***	(0.02)	6545	-0.11***	(0.03)	4379
Time taken to Sit & Stand Up 5 times (seconds)	-0.01	(0.01)	6379	-0.04***	(0.01)	4287
Number of ADL that Can be done (out of 6)	0.05**	(0.02)	9136	0.18***	(0.02)	9518
Self-reported Health is Good or Very Good (%)	0.19***	(0.03)	15551	0.60***	(0.06)	16377
Number Illnesses over last 30 days (out of 10 asked)	-0.04***	(0.01)	15585	-0.13***	(0.01)	16420
Had any Illness "all the time" over the last 30 days	-0.17***	(0.04)	15590	-0.52***	(0.06)	16411
Depression Index (6-18, higher more depressed)	-0.01	(0.01)	11387	-0.01	(0.01)	11846
Lucknow Development Screen - Infants	0.03**	(0.01)	704	0.01	(0.01)	813
Total Cognition - Children 5+	1.25***	(0.16)	4290	0.85***	(0.14)	4764
Total Cognition - Adults	0.005***	(0.00)	5902	0.01***	(0.00)	6123
Total Cognition - Adults 50+	1.48***	(0.20)	2964	2.14***	(0.30)	3139

Coefficients reported are from regressions where the outcome variable is hemoglobin level (g/dL) and controls include: age, smoker, pregnant. SEs clustered by village.

Table 8: Impact of Price and Information Campaign on Take-Up (Price Experiment)

VARIABLES	(1) Purchased Anywhere	(2) Purchased Anywhere	(3) Purchased Anywhere	(4) Purchased Anywhere	(5) Purchased Anywhere	(6) Purchased at PDS	(7) Purchased at Kirana
Discount given at PDS (any)	0.194***						
	(0.03)						
Discount given at Kirana (any)	0.132***						
	(0.02)						
PDS Discount Amount (INR 5 to 9)		0.027***	0.050***		0.027***	0.023***	-0.005**
		(0.00)	(0.02)		(0.00)	(0.00)	(0.00)
Kirana Discount Amount (INR 5 to 9)		0.019***	0.021		0.019***	-0.013***	0.030***
		(0.00)	(0.01)		(0.00)	(0.00)	(0.00)
PDS Discount Amount Squared			-0.002				
			(0.00)				
Kirana Discount Amount Squared			0				
			(0.00)				
Information Campaign: Basic + Tata				-0.002	-0.003	-0.012	0.008
				(0.05)	(0.05)	(0.05)	(0.02)
Information Campaign: Basic + Tata & ASHA				0.021	0.02	0.018	0.001
				(0.06)	(0.07)	(0.05)	(0.03)
Sales at full Price (Mean)	0.084					0.047	0.037
	[0.28]					[0.21]	[0.19]
Observations	4,179	4,179	4,179	4,179	4,179	4,179	4,179
Pseudo R-squared	0.04	0.04	0.04	0.00	0.04	0.03	0.16

Table reports marginal effects from Probit regressions, in which purchase is the outcome variable.
Robust standard errors in parentheses, clustered at the village level.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$*
Omitted information campaign category is Basic Campaign.

Appendices

Appendix Table A. Thresholds for Determining "Any" Anemia

Age or Gender Group	Hemoglobin Threshold (g/dL)	Smokers (g/dL)
Children (0-4 years)	11.0	–
Children (5-11 years)	11.5	–
Children (12-14 years)	12.0	12.3
Pregnant Females	11.0	11.3
Non Pregnant Females (15 years & above)	12.0	12.3
Adult Males	13.0	13.3

- Mild anemia refers to hemoglobin between 10 and 11 g/dL for young children and between 11 and 12 g/dL for everyone else.
- Moderate anemia is defined as hemoglobin between 7 and 10 g/dL for young children and between 8 and 11 for older children and adults.
- Severe anemia is 7 g/dL and below for children and 8 g/dL for older children and adults.
- All of these benchmarks are adjusted for smoking and pregnancy (as reflected in the table above) when determining if an individual's hemoglobin measurement reflects mild, moderate, or severe anemia.

Appendix Table B. Household-Level Balance Checks by Voucher Type Assigned

Dependent Variable	N	Test: Voucher Dummies are Jointly Significant	
Number Adults in Household	4178	2.51	F-stat
		(0.12)	P-value
Number Children in Household	4178	0.86	
		(0.57)	
Children enrolled in School (%)	4178	0.84	
		(0.59)	
Household has a Below Poverty Line card (any type)	4178	0.75	
		(0.68)	
Ever Shops at Public Distribution System Shop	4179	0.54	
		(0.86)	
Household Owns Other Land	4151	1.02	
		(0.42)	
Number Assets owned (out of 8 asked about)	4178	0.73	
		(0.70)	
House Construction includes Bricks (not only mud)	4178	0.76	
		(0.67)	
Number Buffaloes owned	4155	3.41	
		(0.00)	
Number Goats owned	4135	1.29	
		(0.23)	
Total Number Animals owned	4179	1.41	
		(0.17)	
Ever heard of Anemia	4178	0.21	
		(1.00)	

Table reports F-statistics and P-values for a test of joint significance of voucher type dummies after OLS Regressions in which the voucher assignment is used to predict the characteristic on the left.
P-values in (). The regressions also include a covariate for the village, as voucher assignment was done within the village.
Households were asked if they owned these assets: TV, motorcycle, music player, gas/kerosene stove, mobile phone, bicycle, chair, cots/beds.
Total Animals includes: cows, buffalos, goats, chickens, and pigs.
Standard deviation of mean in [] and Standard Error of Difference in ().
** p<0.10, ** p<0.05, *** p<0.01*

Appendix Table C. Village-Level Balance Checks by Information Campaign

	Basic Campaign (mean)	Basic+Tata (diff. from Basic)	Basic+Tata+ASHA (diff. from Basic)	Test: Basic = (B+T)+(B+T+A)
Villages in sample	14	15	14	
Households in sample	1356	1455	1368	
Average Village Population (Administrative Data)	1945	-441	-53	0.32
	[1349]	(465)	(537)	(0.58)
Number Adults in Household	4.77	-0.25	-0.09	1.69
	[3.06]	(0.16)	(0.16)	(0.20)
Number Children in Household	3.5	-0.22*	-0.16	3.99
	[2.66]	(0.13)	(0.10)	(0.05)
Children enrolled in School (%)	0.62	-0.01	0.00	0.01
	[0.39]	(0.03)	(0.02)	(0.94)
Household has a Below Poverty Line card (any type)	0.56	0.06	0.06	2.35
	[0.50]	(0.05)	(0.05)	(0.13)
Ever Shops at Public Distribution System Shop	0.97	0.01	0.01*	3.56
	[0.16]	(0.01)	(0.01)	(0.07)
Household Owns Other Land	0.61	-0.04	-0.07	1.13
	[0.49]	(0.07)	(0.06)	(0.29)
Number Assets owned (out of 8 asked about)	3.59	-0.31	0.01	1.14
	[2.10]	(0.19)	(0.15)	(0.29)
House Construction includes Bricks (not only mud)	0.77	-0.08**	-0.02	2.51
	[0.42]	(0.04)	(0.04)	(0.12)
Number Animals owned	2	-0.33**	-0.12	3.19
	[4.69]	(0.14)	(0.15)	(0.08)
Ever heard of Anemia	0.09	0.02	0.05**	3.75
	[0.28]	(0.02)	(0.02)	(0.06)

Differences shown are the coefficient on "Basic + Tata" or "Basic + Tata + ASHA" from separate OLS regressions using household-level data and Standard Errors clustered at the village level.

Final column shows F-statistic and p-value for test of joint significance following the regression. Households were asked if they owned these assets: TV, motorcycle, music player, gas/kerosene stove, mobile phone, bicycle, chair, cots/beds.

Total Animals includes: cows, buffalos, goats, chickens, and pigs.

Sample size same as Appendix Table A. Standard deviation of mean in [] and Standard Error of Difference in ().

** p<0.10, ** p<0.05, *** p<0.01*

Description of Cognitive Tests

The cognition modules drew from a series of tests validated on Indian population, to assess a respondents cognitive ability and awareness. Four different tests were used to assess these characteristics among respondents of different age groups: infants (1-30 months), children (5-14 years), adults (15-49 years) and elderly (50 years and above). All cognition tests were conducted in isolation with the respondent, or in an isolated area overseen by a guardian, in order to maximize concentration. These tests were also conducted in the local language, Bhojpuri, to facilitate a clear understanding of the exercise.

Infants (1-30 months)

The Infant Cognition module is entirely based on the Lucknow Development Screen (LDS), a screening tool validated to assess the psychomotor skills of infants. The LDS was adapted from the Bailey Scales for an Indian population in Lucknow, Uttar Pradesh, by Professors Bhave, Bhargava and Kumar from the CSM Medical University (Bhave et al., 2010). In this test, the mother of the child is asked about the infants ability to perform a set of tasks (from the infants capacity to thrust his/her arms and legs forward in play while lying to the infants ability to walk upstairs and downstairs with help), the number of tasks asked about depending on the age of the child. Therefore, this test requires having accurate information on the age of the infant (in months).

The LDS used for the baseline followed the 97% screen i.e. it only enquired about tasks that can be expected to be performed by 97% of infants of that age group. All the tasks in the LDS and the age up to which this task is applicable for the 97% screening are listed below.

Appendix Table D. Lucknow Development Screen

Task	Screening Age (in months)
Arms & legs thrust in play	1
Lateral head movement	1
Follows moving person	1
Social smile	3
Holds head steady	4
Recognizes mother	4
Laughs aloud	5
Reaches for dangling ring	5
Turns head to sound	6
Turns supine to prone	8
Sits alone steadily	8
Retains two things in two hands	9
Raises self to sitting	10
Playful response to mirror image	10
Says da-da ma-ma	10
Waves ta-ta	11
Picks up small things	11
Stands by leaning on furniture	11
Inhibits on command	13
Walks with help	13
Stands alone	16
Speaks two words with meaning	18
Stands up	18
Walks alone	18
Gestures for wants	19
Speaks sentences of two words	25
Walks up & downstairs with help	25

Children (5-14 years)

The Child Cognition module is based on tests taken from two different batteries. First, it uses the digit span tests from the PGI Memory Scale (PGIMS), a memory scale developed for the Indian population by Professors Dwarka Pershad and N.N. Wig from the Post Graduate Institute of Medical Education and Research, Chandigarh. The digit span test involves a respondent repeating a sequence of numbers articulated by the surveyor. The reverse sequence questions expect the respondent to repeat the numbers articulated in reverse order. The forward sequence begins with a sequence of 3 numbers and goes up to a sequence of 8 numbers. The reverse

sequence begins with a sequence of 2 numbers and proceeds up to a sequence of 8. There are two sets of questions for both forward and reverse sequences where each correct answer scores one point. Therefore the maximum number of points in the digit span test is 26.

The second test in this module is the taken from the Visuospatial Working Memory Span Task (block tapping test) from the NIMHANS child neuropsychology tests. This battery of tests was developed by Professors Kar, Rao, Chandramouli and Thennarau from the National Institute of Mental Health and Neurosciences (NIMHANS) in Bangalore. The box tapping test involves the surveyor tapping a set of four match boxes in a particular order that the respondent is expected to replicate. In the reverse tapping test, the respondent is expected to tap the boxes in the reverse order. Each correctly executed tapping sequence scores one point, making the maximum possible points 10.

Adults (15-49 years)

The Adult Cognition was based on four sub-tests taken from the PGIMS module. The first subtest is the digit span test which is identical to the one used for the child cognition module. The second is a word recall test which involves two sets of five words each. Each set of words is recited slowly, and the respondent is asked to remember as many words as possible after a one minute interval. Each correctly remembered word is given one point. The third is a sentence recall test, where three sentences of increasing length are used. Each phrase correctly recalled from a sentence scores one point. Unlike the word test, there is no interval for recalling the sentence. The last subtest involves the use of related and unrelated word pairs. The respondent is verbally told a list of word pairs at the start of the test. The respondent is then expected to recall the pair of each word recited thereafter. Each correctly recalled pair scores a point. These tests and their maximum scores are listed below.

Older Adults (50 years and above)

The Older Adult Cognition module is based entirely on the Hindi Mental State Examination (HMSE), a version of the Mini Mental State Examination that has been modified for Indian

Appendix Table E. Adult Cognition Sub-tests and Scoring

Test	Maximum Points
Number Sequence (Digit Span)	26
Word Recall	10
Sentence Reproduction	12
Word Pairs	20
Total Points	68

Appendix Table F. Older Adult Cognition Sub-tests and Scoring

Question Type	Maximum Score
Orientation to Time	5
Orientation to Location	5
Registration of three Objects	3
Days of the Week (in reverse order)	5
Recall	3
Ability to Recognize Objects	2
Sentence Repetition	1
Following Command	1
Three Step Command	3
Figure Drawing	3
Attention and Calculation (Serial Sevens)	5
Total Score	36

populations. The HMSE was developed by Professors Ganguli and Ratcliffe from the University of Pittsburgh, in collaboration with the Centre of Ageing Research in New Delhi, India. The HMSE is made up of several different sub-tests. All the subtests check for basic cognitive awareness and alertness. The scoring for these sections is as shown in the table.