School Meals and Classroom Attention: Evidence from India

Farzana Afridi[*] Bidisha Barooah [†]
Rohini Somanathan[‡]
(PRELIMINARY DRAFT. Please do not cite)

September 15, 2014

Abstract

We study the effect of the national school meal program in India on students' attention in class. We use a panel of scores in tests of attention of over 400 students from 16 poor-performing public schools in the capital, Delhi. Using the performance of students in solving maze puzzles, we find that school meals led to a improvement in attention and students were able to solve 0.34 additional maze puzzles. The effect was mostly seen in the more difficult mazes and in schools where students were likely to miss bringing packed lunch from home.

1 Introduction

Learning outcomes in India remain poor in spite of increased school access and high enrolment rates. Although enrolments have reached over 90% and there has been a six-fold increase in schools over the past five decades, a nationwide survey of rural schools found that only 64%

[*]Planning Unit, Indian Statistical Institute, 7 S.J.S. Sansanwal Marg, New Delhi - 110016,(fafridi@isid.ac.in)
[†]Delhi School of Economics (bidisha@econdse.org)
[‡]Delhi School of Economics

of children in grades 3 to 5 could read and 56% could solve arithmetic operations meant for first graders (Pratham 2009). Poor learning outcomes in India have been attributed to several factors such as inferior school infrastructure, poor teacher quality and lack of accountability[1].The problem is compounded by low attendance, poor health of children and high prevalence of hunger which have been found to impair learning (Galal et al. 2005). Unannounced visits to a nationally representative sample found that only 68% of enrolled students actually attended school on an average school day. With about half of children below age five being malnourished, India's hunger ranking is rated 'alarming' in the Global Hunger Index[2] .

One of the measures adopted to improve learning by addressing school participation and health of students is the provision of on-site cooked school meals in public schools in India. This program, known as National Program of Nutritional Support to Primary Education, was launched in August 1995 but only became effective from 2002. Popularly called the mid-day meal scheme, it is one of the largest education support programs in the world covering all public schools with around 110 million beneficiaries and a budgetary outlay that was half of the total allocation for education in 2009-10.

Initially targeted at children enrolled in primary level (grades 1 to 5), the coverage of this program was extended to include students in grades 6 to 8 in 2007[3]. The national capital of Delhi implemented this extension in September 2009 although the program had been in place for primary grades in all public schools since 2003. I study the impact of this extension on the performance of students in academic and non-academic classroom tasks. To measure performance, I use the scores of over 400 grade 7 students from 16 randomly selected public schools in solving curriculum-based math and language questions and maze puzzles respectively. The quality of these schools was poor with students being able to solve less than half of the math and language questions.

The scores were collected over two rounds of school visits. We started the first round of tests from August 2009. The extension was brought in unannounced halfway through our first survey.

[1]Muralidharan and Kremer (2006) find that test scores in Indian public schools are much lower than private schools. This persists even after controlling for similar observables. They find the private schools have lower teacher absenteeism and higher observed effort. Private schools are likely to have lower class size and multi-grade teaching. Pritchett and Pande (2006) provide a model where centralized management of schools and teacher pays makes public school teachers less accountable for the quality they deliver.

[2]Attendance figures are from a report by Educational Consultants India Limited (2007) for the Sarva Shiksha Abhiyan. Malnutrition data is from International Institute of Population Sciences (2007).India's hunger ranking is from International Food Policy Research Institute (2009).

[3]Available in the program website mdm.nic.in

We re-visited the sampled schools after 4 months and administered the same tests. In the first round, 10 of the 16 schools were observed when meals for upper grades had not started while 6 were observed after. In the second round, all schools had implemented meals for upper grades. We use this difference in the provision of meals to upper grades to identify treatment effects. Our strategy is to compare the change in scores of grade 7 students in schools that had meals only in the second round to those in schools that had meals in both rounds. In a difference-in-difference framework, the former form the treatment group and the latter the control.

Our definition of the control group is different from usual as these schools are not observed at a time when meals for upper grades had not started. One concern is that we do not know the grade 7 score trends of treatment and control schools in the absence of meals. We use the scores of grade 5 students to check if the score trends were comparable across the two groups. Grade 5 students were entitled for school meals since their enrolment. We do not expect their scores to vary as a result of the extension of the program to upper grades[4]. We use grade 5 as a placebo group and test for the equivalence of trends across the two groups to validate our results for grade 7.

In our sample, school meals are typically served in the middle of the school day during meal break. We gave students two set of tests in each visit- one each before and after the meal break. This enables us to study two possible effects of meals on students' performance. School meals could lead to improvements in students' performance by improving in their cognition and health or/and by alleviation of hunger. The former would manifest in the longer term while the latter would be the more immediate effect. By comparing the change in scores in sessions before students had eaten their meals on the day of survey, we are able to isolate the impact through the health-cognition channel from the hunger-alleviation channel. Any gains observed in sessions after the meal break can be attributed to the *combined* effect of the long and short-term factors. We find that students in treatment schools improved maze scores by 0.42 points in the second round. Since each maze carried 1 point, this can be interpreted as being able to solve 0.42 additional mazes. This improvement was seen only in sessions held after the meal break.

We find no corresponding improvement in BMIs of students. These results need to be interpreted in the context that ,on average, students in our sample were adequately nourished. School quality also seemed to matter and gains in maze scores were higher in schools that has higher

[4]There could be some externalities such as a change in the meal distribution process that could effect primary grades. However, we find no evidence of this. Primary grades are often located away from upper grades and the distribution of meals in these grades is done separately.

high-school graduation rate. We do not find evidence that school meals led to an improvement in scores in academic tests. This is similar to findings from other studies such as Vermeersch and Kremer (2005) and Kazianga et al. (2012) that do not find any improvement in test scores even though school meals improved health and participation because the quality of schools was poor.

There are a number of studies that evaluate the Indian meals program and find positive effects on participation and health outcomes. Jayaraman and Simroth (2011) make use of the district-wise staggered implementation of the program and find that school meals led to an increase in enrollments. Afridi (2011) found that the provision of on-site cooked meals improved average attendance of grade 1 students, particularly girls, in one of the poorest districts of Madhya Pradesh. Singh et al. (2012) use longitudinal data of child anthropometric measures from Andhra Pradesh to show that school meals led to an improvement of nutritional status of children who had suffered from droughts. This program has also been found to increase calorie intake (Afridi 2010) and reduce classroom hunger (Dreze and Goyal 2003). Our study contributes to the literature on school meals by studying its effect on attention to classroom task. The unanticipated implementation of the program in Delhi provides a natural experiment setting from which we can draw causal interpretation. The panel of individual scores of students enables us to control for time-invariant student characteristics that could influence performance in classroom tasks.

The remainder of the paper is organized as follows -Section 2 provides the background, describes the data and methodology while Sections 3 and 4 discuss the results.

2 Data and Methodology

A. Data

Public schools in Delhi are managed by local municipalities and the directorate of education of the Government of Delhi (DoE). The majority of middle, secondary and senior secondary schools are administered by the DoE. The DoE also runs composite schools that integrate all schooling levels from grades 1 to 12 into one known as Sarvodaya Vidyalayas. The Government of Delhi extended the school meal program to upper primary grades from 29th September, 2009. Cooked meals are provided to students in school premises for around 180-200 days in a year. The calorific value of a mid-day meal is stipulated to be a minimum of 300 calories and 8-12 grams of protein per child per day for primary grade students and 700 calories and 20 grams of protein for upper primary grades.The food-items ,selected on the basis of acceptability and nutritive content, that can be served under this scheme are rice or bread with pulses or vegetables and one sweet. The provision of meals to schools is contracted to NGOs. In 2009-10, the Delhi MDM scheme covered approximately 2.5 million students of primary and upper-primary grades.

The data used in this study come from 16 Sarvodaya schools out of 185 in all. Delhi has 8 districts and Sarvodaya schools are spread across all of these. We were in communication with the DoE about the possibility of introduction of meals in upper grades and there was no expectation of this happening until the end of the year. Our initial strategy was to compare the performance of grade 5 students who were getting meals using upper grades as control and then follow up with a survey after the program was started in upper grades. In order to do this, we sampled 4 schools from each district making our total sample 32. We visited these schools to administer the tests from August 2009. Halfway through our survey, the meals were extended to upper grades. This meant that we could not apply our earlier strategy of using upper grades as controls. We decided to use this shock to identify causality in upper grades. We re-visited the schools for a second round of tests from February 2010. We had 2 months, February and April, to complete our second survey before summer holidays started[5]. Since, we knew we could not cover all schools in this time, we drew a sample of 16 from the 32 schools. This is the sample we use for this study.

We chose Sarvodaya schools for three reasons: first, these schools allow us to compare the effect of the cooked meals on students in primary and upper primary grades holding the characteristics of the school constant. Second, admission into Sarvodaya schools in any grade is free of cost and no screening is conducted for admission into these schools. This ensures that our sample of students is comparable to the average public school student in Delhi in terms of ability. Third, these schools are spread across all municipality zones of Delhi which makes the sample of students more representative.

The test instruments we use were designed to measure attention in classroom tasks and math and language skills. While the math and language tests were multiple choice questions selected from grade 5 text books, the tests of attention required students to solve maze puzzles. Puzzles, such as mazes, have been used extensively to study effort as performance in these is not conditional on reading, writing or math skills. Rather they require concentration and non-cognitive skills such as perseverance and patience (Niederle and Vesterlund, 2007; Hoff and Pandey, 2006; Gneezy,

[5]We could not visit schools in March because this is when exams are held. Summer holidays are in May and June.

Niederle, and Rustichini, 2003). The test was to find a path through a field from one side to the other of a maze without crossing the solid lines. These mazes were from Yahoo! Games suitable for children of age 10 (or fifth-graders). Most studies measure attention using tests that measure short-term memory, concentration and attention span such as Letter Cancellation Tests, Knox Cube Tests and Digit Span tests. These are difficult to implement in situations where class size is large (over 30 students) and teaching time limited[6] which is why we chose the maze puzzles.

The tests were conducted in the classroom during regular school hours. We conducted two sessions per round-before the lunch break (session 1) and after the lunch break (session 2). School meals are served before or during the lunch break. The average time between sessions was around 2 hours. Two female experimenters were assigned to one randomly selected section each in grade 5 and 7. Test booklets, with a pencil and an eraser, were distributed to all students present in the classroom. The test booklet consisted of five maze puzzles. Before conducting the test the experimenter demonstrated how to solve maze 1 to students. Students were then given 8 minutes to solve all five mazes[7]. The first two mazes were of the lowest difficulty level while the next three mazes were increasing in difficulty. The difficulty levels of the first two mazes were kept the same so that the first maze could be treated as a practice maze. The set of puzzles differed between sessions but not rounds. Each maze carried 1 point. Thus, the minimum a student could score in one session is 0 and the maximum score in 4. The test booklets were identical for both grades which suggests that the mazes may have been easier for students of grade 7.

After 8 minutes, students were asked to stop solving mazes and move to the next section which had the math and language questions. In the test booklet, each question included an example that showed how to solve it. The instructors explained these examples to students. In round 1, there were 4 text book questions- one Hindi, one English, two counting and addition problems and one logical reasoning question. Students were given 12 minutes to solve these questions. In round 2, 3 additional language and arithmatic questions in exactly the same pattern were added and students were given 15 minutes to solve this section. Each question carried one point. Data on socio-economic characteristics, food-intake by students on the day of the survey, their heights and weights were also collected after the tests in both rounds. In the second round 10 students in each grade were randomly chosen to be interviewed for additional details of students' socio-economic characteristics such as parents' occupation, number of siblings and type of residence.

[6] Classes are held for approximately 50 mins per period

[7] In our pilot study we found that students needed 6 minutes on average to solve 5 mazes. We added 2 minutes over this in the final experiment

Table 1 summarizes the timeline of this study.

Table 2 shows some individual-level baseline summary statistics. 560 grade 7 and 618 grade 5 students took the test in Round 1. As expected, grade 7 students could solve more mazes and questions than grade 5 students. However, on average, the quality of schools was poor. Students could solve less than half of the academic question. There were more girls than boys in grade 7 compared to grade 5. This could be because there are more girls' schools in the sample and schools are segregated by gender only in upper grades. The nutritional status of students is adequate as seen from the mean height-for-age[8]. The uptake of the meal was not universal and about 50% of grade 5 students who were entitled to meals in round 1 ate school meals on the day of survey. From the students' interview, however, we find no systematic difference in socio-economic status of grade 7 and 5 students which suggests that grade 5 students are an acceptable placebo group.

Of the 560 grade 7 students, 117 (21%) did not appear for the test in round 2. We cannot be sure if these students had left the school or were simply absent on the day of the test. However, since the school visits were unannounced we do not expect selection by students to take the test. Columns 1 and 2 of table 3 compare the individual observable characteristics of students who dropped out of the sample in round 2 to those that were present in both rounds. We find that there are no systematic differences on observables of grade 7 students who stayed in the sample and those that dropped out. Table 1 in the Appendix describes the pattern of attrition in the grade 5. Students who were not found in the second round were clearly the better students. Since potential gains in scores of the students who were present in both rounds is higher, the placebo effect is likely to be the upper-bound.

B. Methodology

We use a Difference-in-Difference (DID) strategy to estimate the effect of school meals. The outcomes of interest are scores in mazes and questions of grade 7 students. We identify the treatment and control schools on the basis of whether they changed their meal provision status for grades 6 to 8 between rounds or not. This makes schools which were administered round 1 tests before 29th September, 2009 the treatment group while schools visited after this date are the control schools. The treatment schools had meals for upper grades in round 2 but not round 1 while the control schools had meals in both rounds. The control schools were already receiving meals for at least 2 weeks by the time of the first visit. This is long enough for the impact of of school meals on concentration through channels such as hunger alleviation and

[8]The cut-off for malnutrition is less than -2SD

short-term memory to manifest in control schools.

The date of visit to a school was randomly selected and the date of expansion of the program was unanticipated. The timing of the policy change and the date of school survey exogenously determine whether a school falls in the treatment or control group. Here, treatment status is determined at the school-level and not by whether the students ate meals on the day of visit. This enables us to use the Intention-to-Treat estimator. The ITT estimator is appropriate in this context for two reasons- First, given the non-universal uptake of the meal program, whether a child eats school meals on the day of survey could be endogenous to what is being served that day, whether the child had meals at home and other characteristics. A student may not consume school meals on all days. Using ITT enables me to capture the average effect of school meals for a child irrespective of whether she took school meals on the day of tests. Second, ITT estimators are suitable to capture possible peer-effects of school meals. For example, even if a child does not eat school meals, her concentration at work might improve if her disadvantaged classmates ate the meals and were less distracted.

We compare the gain in scores in the same session between rounds to identify treatment effects. The advantages of this are that- (a) We are comparing sessions that were held during the same time of a school day. Students' attention could vary by time of the day. For example, by the end of the school day students may be tired and their attention levels could see a natural decrease. (b) We are comparing scores in the same tests as the booklets differed in sessions and not in the rounds. (c) Estimating the treatment effect separately for each session, further, enables us to identify the long-term impact on health and cognition and the more immediate effect of reducing hunger of school meals. Comparing gains in session 1, when students had not eaten school meals, gives us the impact due to improvement in children's health and nutritional status. Changes in scores in session 2, held after meal distribution, can be interpreted as the combined effect of health and the short-term factors such as memory and hunger alleviation.

Table 4 compares the changes in the mean maze scores between rounds for control and treatment students using the individual balanced panel of 442 grade 7 students. Panel A shows the scores in session 1 and Panel B shows the scores in session 2. In Panel A, we see that the mean baseline score of control schools (which already had meals for at least 2 weeks) is higher than treatment. There was an improvement in maze scores over rounds for students of both treatment and control schools. This could be due to a learning effect as well as the impact on attention due to extension of the meal program between the two rounds. While the learning effect would be valid for students in the control and treatment school the latter effect would exist only for the treatment group. The difference in gain in scores between treatment and control schools could then be attributed to the school meal program. The gain made by treatment schools in round 2 was higher than control schools (by 0.09). Thus, treatment schools got 0.09 more mazes correct in round 2 compared to control schools. This improvement can be interpreted as the effect of the meal program, other things remaining constant. Our assumption here is that the learning effect of control and treatment schools would be the equivalent if all schools had meals. Panel B shows that the effect of school meals was positive although insignificant in the post-lunch break session. Students in treatment schools improved scores in these mazes by 0.16 mazes compared to control schools. In fact, there was a reversal of trends after the school meals and the scores of treatment schools were higher than control schools.

Table 5 compares the baseline school and student characteristics of grade 7 students. Panel I shows the school-level differences between treatment and control schools. Control schools scored better in tests of math and language suggesting that these schools had better academic performance that treatment schools. It is hard to say if this is the result of getting the meals in round 1 or some exogenous school quality. Panel II shows the student-level differences between treatment and control schools. Students in control schools were older which can be explained by the difference in the timing of the first visit. There were significantly fewer girls in the treatment schools. But there does not appear to be any difference on socio-economic characteristics for the sub-sample of students who were selected for a household interview which suggests that the difference in academic scores may be influenced more by school than student characteristics.

Apart from the observable differences in child-characteristics, there are others such as micro-nutrient deficiencies and conditions at home that could influence the impact of school meals . These are not adequately measured by our data. We, therefore, use child-fixed effects to control for all time-invariant omitted child variables that could influence attention. The specification we use is:

$$S_{ijsr} = \alpha_0 + \alpha_1 Round_r + \alpha_2 Treat_j * Round_r + \gamma Age_{ir} + \mathbf{M}_{jr} + \mu_i + \epsilon_{ijsr} \qquad (1)$$

This equation estimates the treatment effect for grade 7 students. In this equation, S_{ijsr} is the score of student i of grade 7 in school j in session s in round r. $Round_r$ takes value 1 if the score is recorded for round 2 and 0 if round 1. The variable $Treat_j$ takes value 1 if school j started cooked meals for grade 7 in the round 2 but not round 1 and 0 if it was started in round 1. Age_{ir} is age of the child in round r. This controls for the change in difficulty level of the mazes for the the same students over rounds. $\mathbf{M}_{jr}$ is a vector of dummies for the menu served in control schools and day of the week. Three of the six control schools provided a different menu in each round. The meal menu is fixed by day of the week and the same item cannot be provided on two consecutive days which makes it easy for students to predict what they would receive. This could lead to selective attendance and variation in uptake of the meal that could confound the treatment effect. The menu dummies allow control schools that changed menu to have a separate trend. μ_i is the child-fixed effects and ϵ_{ijsr} is the error term. Here, the coefficient on $Round_r$ is the learning effect between rounds. We are interested in the coefficient of $Treat_j * Round_r$ (α_2) which can be interpreted as the additional gain in test scores of session s made by treatment schools between rounds 1 and 2. This is the DID- ITT estimator.

The DID estimator would unbiased if pre-program trends in test scores are comparable between treatment and control schools. However, since control schools are observed only after the meals, we cannot test for this. Instead, we do a placebo test using grade 5 of the same schools. Students in grade 5 have been receiving school meals since they were enrolled. If there are no systematic differences at the school-level between treatment and control schools, the change in scores for grade 5 students in treatment schools should be comparable control schools. This would at least enable us to validate that at the *school-level*, treatment and control schools are not systematically different. To do this, we estimate equation (1) for students of grade 5 of the same schools and test for the significance of α_2. If insignificant, this would suggest that when grades did not change their meal implementation status the trend in test scores between treatment and control schools would be parallel.

To test the heterogenous effect of school meals, I use the following equation:

$$S_{ijsr} = \alpha_0+\alpha_1 Round_r+\alpha_2 Treat_j * Round_r+\alpha_3 Treat_j * \delta * Round_r+\alpha_4 \delta * Round_r+\gamma Age_{ir}+\mathbf{M}_{jr}+\mu_i+\epsilon_{ijsr} \quad (2)$$

Here δ takes value 1 if a particular characteristic is satisfied and 0 if not. α_2 is the treatment effect when δ is 0 and $\alpha_2+\ \alpha_3$ the effect when it equals 1. The significance of α_3 indicates if the two effects are statistically different.

3 Results

Figure 1 is describes the results in pictures. There does not seem to be any difference in the change in the average session 1 maze score of grade 7 students between rounds 1 and 2 across treatment and control schools. The trend of the score for grade 5, however, appears divergent. The average score in session 2 is a different picture. The score of treatment schools is lower scores in round 1, but by round 2 this was higher than control schools. This might lead to the question that maybe this is driven by some school differences that the data does not take into account. We do not know what the score of control school before the introduction of meals. However, looking at the score of grade 5 of the same schools, we find that there was no difference between the trend of treatment and control schools. This gives us some confidence that the schools were not systematically different, keeping the meal status unchanged. There still might be differences at the individual-level. However, the data does not allow to us to control for this. We now report the results of estimating equation (1).

Table 6 shows the overall effect of school meals on maze scores. Columns 1 to 3 estimate equation (1) with school-fixed effects and some basic controls of child characteristics. Columns 4 to 6 show the estimates from equation (1). Column 1 shows the effect on the total scores(summed over sessions) for grade 7. The coefficient on *Treat*Round 2* is 0.34 but this is insignificant. Columns 2 and 3 separate this effect by sessions. I find that the effect on scores in the session 1 is insignificant while that in session 2 is 0.42 (significant at 10%). This can be interpreted as improvement in maze scores by 0.42 mazes. This is significantly greater than the effect in session 1 as shown by the chi-square test statistic. The results follow the same pattern when estimated with child-fixed effects. I find no difference in test scores of the placebo group- grade 5 students of the same schools.

Table 7 shows the the differential effect by the difficulty level of mazes. The total score in the more difficult mazes (level 4 and 5) increased significantly due to school meals and this improvement was due to increase in scores in session 2.

Heterogenous Effect on Maze Scores

Table 8 shows the effect by gender. There was no effect of school meals on total and session 1 scores of students of either gender. However, the meals improved the score of boys by 0.69. The effect on girls' scores was 0.37 but this difference does not seem to be statistically significant. This suggests that boys and girls gained equally from meals.

Table 9 shows the results by school quality. We measure school quality by percentage of students who passed the centralised examination in grade 12, averaged for previous 2 years. Schools that had higher graduation rate than the sample median are called *Good* schools. We see that the treatment effect was concentrated entirely on good schools.

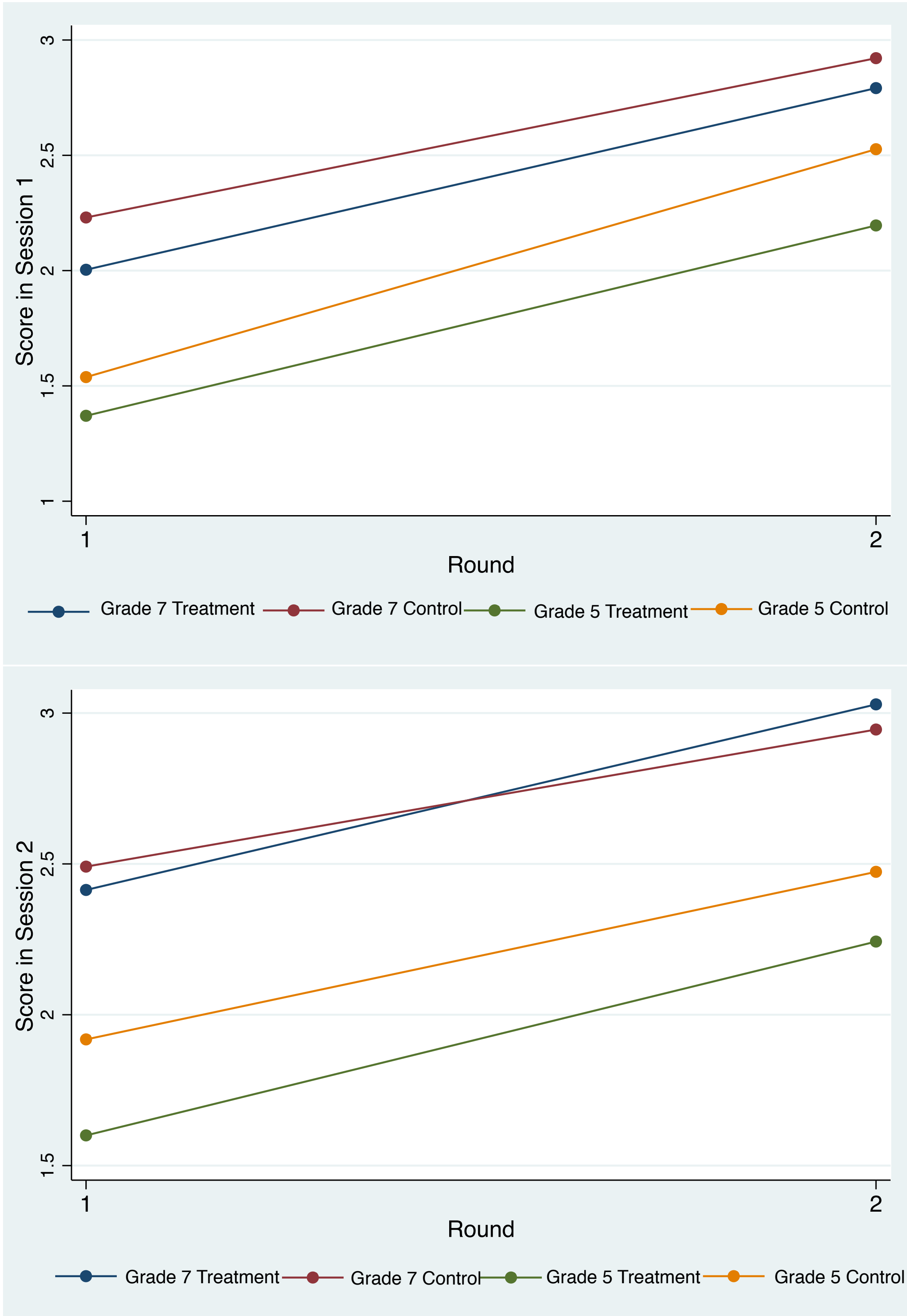

Figure 1: Average Score in Mazes

School meals may have replaced meals brought from home. Table 10 shows the probit estimates of bringing meals from home after the introduction of school meals. We find that school meals led to a decline in the probability of grade 7 students bringing home meals. We find no such effect on grade 5. We next test if there was any differential impact of school meals by the prevalence of home meals. For treatment school, where school meals may have displaced home meal, we use the proportion of grade 7 students who ate home meals in round 2 as a measure of extent of home meals. For control schools, we use the average proportion of grade 7 students who ate home meals in both rounds. We, then, categorise a school as "Less Home Meals" if the proportion of students who ate home meals was less than the sample median and estimate equation (2). The results are shown in table 11. We find that almost all gains of school meals was concentrated in these schools where relatively fewer students eat home meals.

Table 12 shows the effect of estimating equation (1) with school-fixed effects and keeping all students who were present in round1. The pattern of effects remains the same as the student panel with insignificant improvement in session 1 scores. The effect on session 2 scores is 0.49 , higher than what we find in the student panel. The total effect is insignificant. This suggests that estimates from the student panel are likely to be underestimates.

Effect on Scores in Math and Language Tests and BMI

Table 13 shows the results of estimating equation (1) for scores in the math and language test. I find a positive effect on session 1 scores but it is not possible to attribute this to school meals as grade 5 of treatment schools showed a similar improvement. There could be some unobservable changes at the school level which may have led to improvements in overall test scores.

We analyze if the effect on attention was associated with a corresponding improvement in health status of students in Table 14. This table shows the impact of the school meals on BMI-for-age of children. We chose BMI-for-age as an indicator of health as this appropriately measures short-term improvement in nutrition. We find the school meals did not lead to any significant gains in BMI. Of course, there could be other health improvements by reduction of deficiencies but this is beyond the scope of these data.

4 Discussion of Results

We find that school meals had a positive effect on classroom attention of student. The scores of grade 7 students in mazes improved as a result of the meals. This improvement was significant in sessions held after meals had been distributed on the day of school visit. Students were, moreover, able to solve the more difficult mazes. The effect of school meals was more pronounced in schools where relatively fewer students ate packed meals from home. We also find that school quality mattered and the effect was higher in academically better performing schools. This may seem to be contradictory as one would expect that academically better schools are likely to have a less deprived students who would bring packed lunch. However, the correlation between these two measures is insignificant (correlation coeffient= -0.02).

References

Afridi, Farzana (2010) 'Child welfare programs and child nutrition: Evidence from a mandated school meal program in india.' *Journal of Development Economics* 92(2), 152–165

_ (2011) 'The impact of school meals on school participation: evidence from rural india.' *Journal of Development Studies* 47(11), 1636–1656

Dreze, Jean, and Aparajita Goyal (2003) 'Future of mid-day meals.' *Economic and Political Weekly* pp. 4673–4683

Educational Consultants India Limited (2007) 'Study of student's attendance in primary and upper primary schools.' Technical Report, Research, Evaluation and Studies Unit

Galal, Osman M, Charlotte G Neumann, and Judie Hulett (2005) 'Preface.' *Food & Nutrition Bulletin* 26(Supplement 2), 127–130

International Food Policy Research Institute (2009) 'Global hunger index.' Technical Report

International Institute of Population Sciences (2007) 'National family health survey-3, 2005-2006'

Jayaraman, Rajshri, and Dora Simroth (2011) 'the impact of school lunches on primary school enrollment: evidence from india's midday meal scheme.' CESifo Working Paper No. 3679

Kazianga, Harounan, Damien de Walque, and Harold Alderman (2012) ‘Educational and child labour impacts of two food-for-education schemes: evidence from a randomised trial in rural burkina faso.’ *Journal of African Economies* 21(5), 723–760

Muralidharan, Karthik, and Michael Kremer (2006) ‘Public and private schools in rural india.’ *Harvard University, Department of Economics, Cambridge, MA*

Pratham (2009) ‘Annual status of education report (rural).’ Technical Report

Pritchett, Lant, and Varad Pande (2006) ‘Making primary education work for india’s rural poor: A proposal for effective decentralization.’ *New Delhi: World Bank*

Singh, Abhijeet, Albert Park, and Stefan Dercon (2012) ‘School meals as a safety net: An evaluation of the mid-day meal in india.’ *Economic Development and Cultural Change*

Vermeersch, Christel, and Michael Kremer (2005) *School meals, educational achievement, and school competition: evidence from a randomized evaluation,* vol. 3523 (World Bank Publications)

Table 1: Timeline of study

Date	**Activity**
1st August- 8th September 2009	Baseline in10 schools (Round 1). No Meals for upper grades.
September 29th 2009	Meals introduced in upper grades of all schools
8th October- 3rd November, 2009	Baseline in 8 schools (Round 1).
1st February- 31st April, 2010	Follow-up in all schools (Round 2). Household questionnaire

Table 2: Baseline Individual Summary Statistics

	Grade 5	Grade 7	Difference
Number of students	*618*	*560*	
Age (in Years)	9.36	11.85	2.48***
	0.029	0.048	
Score Mazes Session 1 (0-4)	1.52	2.10	0.58***
	0.050	0.055	
Score Mazes Session 2 (0-4)	1.85	2.46	0.62***
	0.058	0.057	
Score Questions Session 1 (0-4)	1.37	1.51	0.13***
	0.038	0.041	
Score Questions Session 1 (0-4)	1.37	1.84	0.47***
	0.038	0.041	
Ate school meals	0.24	0.51	0.27***
	(0.020)	(0.020)	
Height-for-Age	-1.28	-1.18	0.10
	0.044	0.052	
Girls	0.60	0.65	0.05*
	0.020	0.020	
Student Characteristics			
Number of students	*123*	*121*	
(i) Father's Occupation			
Regular Salaried	0.32	0.26	-0.05
	0.042	0.040	
Mechanics	0.29	0.22	-0.07
	0.041	0.038	
Other skilled workers	0.11	0.15	0.04
	0.028	0.032	
Small business	0.11	0.16	0.05
	0.028	0.033	
Unskilled	0.10	0.11	0.01
	0.027	0.028	
(ii) Working Mother	0.23	0.24	0.01
	0.038	0.039	
(iii) Owner-occupied home	0.72	0.69	-0.04
	0.040	0.042	
(iv) Tapped water at home	0.92	0.85	-0.07
	0.025	0.032	
(v) Electricity connection	0.99	0.97	-0.02
	0.008	0.016	

Standard errors in parenthesis. Significance level *** 1% ** 5% *10%

Table 3: Attrition in Grade 7

Students present	Round 1	Round 1 and 2
Number of students	*118*	*442*
	(1)	(2)
Score Mazes Session 1	2.13	2.09
	(0.12)	(0.06)
Score Mazes Session 2	2.55	2.44
	(0.13)	(0.06)
Score Questions Session 1	1.48	1.51
	(0.09)	(0.05)
Score Questions Session 2	1.88	1.83
	(0.10)	(0.05)
Score Logic Puzzles (0-2)	0.59	0.67
	(0.06)	(0.03)
Age in Years	11.81	11.86
	(0.10)	(0.06)
Height for age	-1.06	-1.21
	(0.11)	(0.06)
Girls	0.60	0.66
	(0.05)	(0.02)

Table 4: Mean Scores- Grade 7

Panel A			
Session 1	Round1	Round 2	Difference
Control (N=164)	2.23	2.92	0.69
	(0.097)	(0.094)	(0.100)
Treatment (N=278)	2.00	2.79	0.78
	(0.077)	(0.083)	(0.084)
Difference	-0.23*	-0.13	0.09
	(0.125)	(0.126)	(0.131)
Panel B			
Session 2	Round1	Round 2	Difference
Control (N=164)	2.49	2.94	0.45
	(0.103)	(0.102)	(0.108)
Treatment (N=278)	2.41	3.028	0.62
	(0.080)	(0.077)	(0.080)
Difference	-0.077	0.083	0.16
	(0.135)	(0.130)	(0.133)

Table 5: School and Individual Characteristics by Treatment Status

	Control	Treatment	Difference
Panel I: School Characteristics	(N=6)	(N=10)	
Class size	101.83	83.50	-18.33
	(16.02)	(6.50)	(14.80)
Average Score in Math and Language	3.33	2.79	-0.54 **
	(0.12)	(0.17)	(0.24)
Panel II: Student Characteristics	(N=165)	(N=278)	
Age in Years	12.09	11.72	-0.37 ***
	(0.10)	(0.07)	(0.11)
Height-for-age	-1.31	-1.18	0.13
	(0.11)	(0.08)	(0.13)
Girls	0.72	0.63	-0.09 ***
	(0.04)	(0.03)	(0.05)
Solved IQ question in Session 1	0.18	0.24	0.06
	(0.03)	(0.03)	(0.04)
Solved IQ question in Session 2	0.46	0.44	-0.02
	(0.04)	(0.03)	(0.05)
Panel III: Socio-Economic Characteristics (Student Sub-sample)	(N=45)	(N=76)	
Father's Occupation			
Regular Salaried	0.29	0.22	-0.06
	(0.06)	(0.05)	(0.08)
Mechanic	0.17	0.26	0.09
	(0.05)	(0.05)	(0.08)
Other Skilled Worker	0.12	0.16	0.04
	(0.04)	(0.04)	(0.06)
Business	0.21	0.13	-0.08
	(0.06)	(0.04)	(0.07)
Unskilled Daily Wage Earner	0.10	0.13	0.04
	(0.04)	(0.04)	(0.06)
Working Mother	0.24	0.21	-0.02
	(0.06)	(0.05)	(0.08)
Owner-Occupied Home	0.71	0.67	-0.04
	(0.06)	(0.05)	(0.08)
Water Connection at Home	0.83	0.88	0.05
	(0.05)	(0.04)	(0.06)
Electricity Connection at Home	0.98	0.96	-0.02
	(0.02)	(0.02)	(0.03)

Table 6: Meal Effect on Maze Scores

	Total	Session1	Session2	Total	Session1	Session2	Total	Session1	Session2
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treat*Round2	0.338	-0.077	0.416*	0.304	-0.103	0.408*	-0.155	-0.177	0.022
	(0.314)	(0.156)	(0.212)	(0.321)	(0.154)	(0.218)	(0.329)	(0.181)	(0.199)
Round2	1.114***	0.899***	0.215	1.000***	0.811***	0.189	1.443***	0.968***	0.474**
	(0.244)	(0.093)	(0.196)	(0.207)	(0.071)	(0.173)	(0.287)	(0.124)	(0.184)
Age in Years	-0.084	-0.055	-0.029	0.175	0.144	0.030	0.286	0.049	0.237
	(0.093)	(0.043)	(0.053)	(0.212)	(0.133)	(0.121)	(0.173)	(0.118)	(0.137)
	(0.047)	(0.044)	(0.053)	(0.112)	(0.131)	(0.133)	(0.084)	(0.110)	(0.142)
Girl	-0.357***	-0.345***	-0.368**						
	(0.085)	(0.058)	(0.138)						
Girl	-0.712***	-0.345***	-0.368**						
	(0.168)	(0.058)	(0.138)						
Baseline HFA	0.137	0.071	0.066						
	(0.086)	(0.046)	(0.046)						
Score in Logic Puzzle	0.382*	0.173	0.209**						
	(0.182)	(0.108)	(0.082)						
Constant	5.987***	2.809***	3.177***	2.547	0.256	2.291	0.502	0.988	-0.486
	(1.055)	(0.462)	(0.618)	(2.596)	(1.612)	(1.479)	(1.623)	(1.110)	(1.285)
Grade	7	7	7	7	7	7	5	5	5
Fixed effect	School	School	School	Child	Child	Child	Child	Child	Child
Menu dummies	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Observations	442	442	442	442	442	442	404	404	404
R^2	0.293	0.294	0.213	0.298	0.272	0.175	0.371	0.343	0.190

Chi-square statistic of H0: Effect is equal for session 1 and 2 is 12.69***. Menu dummies not included for grade 5. Only 4 schools did not change menu between rounds- 3 in control and 1 in treatment. Estimating this equation for grade 5 with menu dummies does not change results. Standard error clustered at school level. Significance level ***1% ** 5% * 10%

Table 7: Effect on Maze Scores by Difficulty Level-School Fixed Effects

	Total		Level 2-3		Level 4-5	
	Level 2-3	Level 4-5	Session1	Session2	Session1	Session2
	(1)	(2)	(3)	(4)	(5)	(6)
Treat*Round2	0.161	0.242*	-0.005	0.166	-0.072	0.249*
	(0.160)	(0.135)	(0.065)	(0.108)	(0.112)	(0.124)
Round2	0.378***	0.396***	0.348***	0.031	0.552***	0.184
	(0.127)	(0.119)	(0.041)	(0.090)	(0.064)	(0.107)
Age in Years	-0.116**	-0.004	-0.069**	-0.048*	0.014	0.019
	(0.048)	(0.048)	(0.025)	(0.025)	(0.026)	(0.034)
Girl	-0.305***	-0.172	-0.142***	-0.163**	-0.202***	-0.205*
	(0.093)	(0.133)	(0.042)	(0.065)	(0.054)	(0.108)
Baseline HFA	0.050	0.097	0.036*	0.014	0.036	0.052**
	(0.041)	(0.061)	(0.019)	(0.027)	(0.033)	(0.023)
Score in Logic Puzzle	0.122	0.247**	0.057	0.064	0.116**	0.145**
	(0.101)	(0.105)	(0.063)	(0.042)	(0.049)	(0.056)
Constant	4.529***	2.057***	2.235***	2.294***	0.574**	0.883**
	(0.573)	(0.521)	(0.291)	(0.305)	(0.257)	(0.377)
Observations	442	442	442	442	442	442
R^2	0.223	0.269	0.237	0.131	0.240	0.204
χ^2Treat*Round2	Column (1)=(2) 0.64		Column (3)=(4) 4.39**		Column (5)=(6) 13.82***	

Chi Square statistic for H0: Treatment effect is equal across two samples. Results do not change with child-fixed effects. Menu dummies for control schools included. Standard errors clustered at school level. Significance level ***1% ** 5% * 10%

Table 8: Effect on Maze Scores by Gender

	Total	Session1	Session2
	(1)	(2)	(3)
Treat*Round2	0.517	-0.176	0.693***
	(0.362)	(0.252)	(0.152)
Girl*Treat* Round2	-0.167	0.158	-0.325
	(0.450)	(0.312)	(0.203)
Round2	0.442*	0.668***	-0.226**
	(0.243)	(0.170)	(0.087)
Girl*Round2	0.699**	0.179	0.520***
	(0.259)	(0.212)	(0.117)
Age in Years	0.190	0.149	0.041
	(0.202)	(0.125)	(0.122)
Constant	2.365	0.199	2.166
	(2.446)	(1.505)	(1.485)
Observations	442	442	442
R^2	0.320	0.286	0.193

Child-Fixed Effects. Menu dummies for control schools included. Standard error clustered at school level. Significance level ***1% ** 5% * 10%

Table 9: Effect on Maze Scores by School Quality

	(1) Total	(2) Session1	(3) Session2
Treat*Round2	0.174	-0.066	0.280
	(0.138)	(0.191)	(0.215)
Good School* Treat* Round2	0.241	0.007	0.450*
	(0.183)	(0.239)	(0.246)
Good School* Round2	-0.313**	-0.284***	-0.570***
	(0.114)	(0.069)	(0.169)
Round2	0.488***	0.896***	0.361**
	(0.104)	(0.077)	(0.138)
Age in Years	0.013	0.156	0.050
	(0.086)	(0.132)	(0.128)
Constant	1.853*	0.174	2.174
	(1.023)	(1.580)	(1.521)
Observations	442	442	442
R^2	0.296	0.274	0.184

Good school=1 if average percentage of students who passed grade 12 exam in 2006-07 and 2007-08 is greater than the sample median,0 if not. Child-Fixed Effects. Menu dummies for control schools included. Standard errors clustered at school level. Significance level ***1% ** 5% * 10%

Table 10: Change in Home Meals (Probit estimates with School Fixed Effects)

	(1)	(2)
	Grade 7	Grade 5
Treat*Round2	-0.292*	-0.074
	(0.173)	(0.323)
Round2	-0.241***	0.138
	(0.070)	(0.315)
Age in Years	-0.040	0.040
	(0.062)	(0.074)
Girl	0.438**	0.053
	(0.203)	(0.143)
Baseline HFA	0.069**	0.034
	(0.028)	(0.075)
Score in Logic Puzzles	0.008	0.030
	(0.092)	(0.072)
Constant	-0.610	-0.135
	(0.749)	(0.613)
Number of schools	15	15
Observations	406	382

Excludes 1 school for which lunch status in Round 1 is missing. Menu dummies for control schools included. Standard errors clustered at school level. Significance level ***1% ** 5% * 10%

Table 11: Effect on Maze Scores by the Proportion of Students who do not eat Home Lunch

	Total	Session1	Session2
	(1)	(2)	(3)
Treat*Round2	-0.180	-0.368**	0.188
	(0.240)	(0.146)	(0.201)
Less Home Lunch* Treat* Round 2	1.254***	0.615**	0.639**
	(0.392)	(0.242)	(0.245)
Round2	1.245***	0.886***	0.359**
	(0.111)	(0.077)	(0.137)
Less Home Lunch* Round 2	-0.859***	-0.288***	-0.570***
	(0.108)	(0.068)	(0.169)
Age in Years	0.236	0.181	0.055
	(0.214)	(0.136)	(0.124)
Constant	1.813	-0.187	2.000
	(2.563)	(1.620)	(1.497)
Number of schools	15	15	15
Observations	406	406	406
R^2	0.315	0.284	0.187

Less Home Lunch=1 if proportion of grade 7 students who ate lunch ,averaged over rounds for control schools and only in round 2 for treatment schools, is less than median proportion, 0 if not. Excludes 1 school for which lunch status in Round 1 is missing. Child-Fixed Effects. Menu dummies for control schools included. All standard error clustered at school level. Significance level ***1% ** 5% * 10%

Table 12: Effect on Maze Scores -School Fixed Effects

	(1) Total	(2) Session1	(3) Session2
Treat*Round2	0.496	0.013	0.484*
	(0.358)	(0.160)	(0.234)
Round2	0.975***	0.820***	0.154
	(0.297)	(0.106)	(0.216)
Age in Years	-0.047	-0.046	-0.001
	(0.092)	(0.043)	(0.052)
Girl	-0.778***	-0.381***	-0.397***
	(0.122)	(0.068)	(0.096)
Baseline HFA	0.126	0.060	0.066
	(0.078)	(0.043)	(0.041)
Score in Logic Puzzle	0.333**	0.145	0.188**
	(0.142)	(0.084)	(0.068)
Both Rounds	-0.064	0.015	-0.079
	(0.267)	(0.152)	(0.141)
Constant	5.731***	2.757***	2.974***
	(1.221)	(0.571)	(0.689)
Observations	553	553	553
R^2	0.260	0.265	0.184

Table 13: Meal Effect on Math and Language Test Scores

	Session1	Session2	Session1	Session2
	(1)	(2)	(3)	(4)
Treat*Round2	0.696***	0.131	0.411*	0.379**
	(0.203)	(0.184)	(0.195)	(0.163)
Round2	2.387***	2.340***	1.918***	1.847***
	(0.185)	(0.174)	(0.173)	(0.138)
Age in Years	0.081	-0.117	0.201	0.073
	(0.184)	(0.157)	(0.190)	(0.161)
Constant	0.488	3.201*	-0.611	0.640
	(2.181)	(1.868)	(1.779)	(1.511)
Grade	7	7	5	5
Menu Dummies	Yes	Yes	No	No
Observations	884	884	808	808
R^2	0.713	0.676	0.596	0.632

Child-Fixed Effects. Standard error clustered at school level. Significance level ***1% ** 5% * 10%

Table 14: Meal Effect on BMI

	(1)	(2)	(3)	(4)
	Grade 7	Grade 5	Grade 7- Boys	Grade 7-Girls
Treat*Round2	0.082	0.066	0.022	0.120
	(0.057)	(0.062)	(0.066)	(0.077)
Round2	0.011	0.014	0.024	0.006
	(0.047)	(0.049)	(0.044)	(0.063)
Constant	-1.063***	-1.129***	-1.010***	-1.092***
	(0.013)	(0.015)	(0.018)	(0.017)
Observations	391	388	142	249
R^2	0.020	0.011	0.008	0.028

Weights missing for some students in round 2. All standard error clustered at student level. Significance level ***1% ** 5% * 10%

Appendix :Attrition in Grade 5

Students present	Round 1	Round 1 and 2
Number of students	*214*	*404*
	(1)	(2))
Score Mazes Session 1	1.67	1.44***
	(0.090	(0.06)
Score Mazes Session 2	2.06	1.73***
	(0.10)	(0.07)
Score Questions Session 1	1.56	1.28***
	(0.07)	(0.05)
Score Questions Session 2	1.48	1.32***
	(0.06)	(0.05)
Score Logic Puzzles (0-2)	0.18	0.19
	(0.03)	(0.02)
Age in Years	9.37	9.36
	(0.05)	(0.04)
Height for age	-1.33	-1.27
	(0.09)	(0.05)
Girls	0.53	0.63***
	(0.03)	(0.02)