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School Meals and Educational Outcomes in Rural Ethiopia

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ABSTRACT

We investigate the relationship between providing school meals program and educational outcomes in Ethiopia. Using data from school catchment areas across rural Ethiopia, the paper focuses on the role played by the modalities and the implementation of the program. The results indicate that supplementing on-site school meals with take-home rations can be beneficial for concentration, reading, writing and arithmetic skills. The timing of the distribution of school meals is also found to play an important role.

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1. INTRODUCTION

Chronic food shortage remains a serious obstacle to children's physical and cognitive development in many poor countries. Hunger diminishes children's ability to concentrate and to retain what they learn at school. School meals attempt to improve poor and credit-constrained households' investments in education by subsidizing the cost of schooling, by reducing short-term hunger and improving nutrition. In poor countries, where school enrollment is low, school meals can provide a strong incentive to poor households to send their children to school and to support their education continually.[1] School meals appear to be attractive as they may not only increase school participation and reduce dropout, but they may also improve learning and cognitive development.

The educational benefits of a school meals programs depend on the targeting, modality and implementation of the program. In most developing countries, school meals programs target areas with high food insecurity, low enrollment or high gender disparity. School meals programs can be implemented in different ways or modalities, which could substantially affect their impacts. Two basic modalities comprehend (i) providing school meals on-site or (ii) as take-home rations, both of which may be combined with micronutrient supplementation (Adelman et al., 2008). While on-site meals (breakfast, lunch or snacks) are usually provided to all students, take-home rations are often given only to girls, conditional on school attendance exceeding some threshold. School meals may also involve local (community or household) contributions. Children are often involved in the acquisition of the material contributions (such as firewood) that their households are required/expected to make available as part of the preparation of school meals. This has a potentially detrimental effect on the learning achievement of children.

Further, food distribution can be subject to disruption or may divert class and teacher time away from learning depending on how well the program is implemented.

This paper examines the link between a school meals program (SMP) in Ethiopia and educational outcomes. It contributes to the literature by investigating the relationship between the modalities and implementation of the school meals program (SMP) on the one hand and educational outcomes on the other. Whereas several studies have investigated the effects of school meals per se, much less is known about how school meals should be implemented and how differences in implementation affect their outcomes. In this paper, we examine variations in the implementation of SMP and how this is related to children's outcomes. While we acknowledge that the non-experimental and cross-sectional nature of the data does not allow us to fully address the problem of endogeneity, we use a unique dataset with a broad geographical coverage within Ethiopia that is likely to allow investigating the link between the SMP and educational outcomes. Other studies, e.g. Alderman et al. (2012), attain stronger internal validity but are more local in scale. Hence, while our results should not be interpreted as strong evidence of causal effects, they provide important indications about how modalities of the implementation of SMP is related with children's educational outcomes, which, as a minimum, can guide further studies and projects towards finding the optimal design of school meals programs. A main finding is that supplementing on-site meals with take-home rations is positively associated with concentration, reading, writing and arithmetic skills. These results also suggest that not only targeted girls, but also boys benefited. Moreover, the timing of the distribution of school meals is also found to play a role. Specifically, our results suggest that school meals are less effective if they are served at the end of classes, which appears to be especially important for girls.

2. REVIEW OF RELATED LITERATURE

Food deprivation remains a serious obstacle to children's physical and cognitive development in many developing countries. For example, the United Nations World Food Programme (WFP) provided school meals to around 22 million children in 70 countries in 2008 (Bundy et al., 2009). SMPs are generally thought to help tackle the problem of chronic food shortages for school age children. In the short-run, school meals are expected to alleviate hunger in the classroom and help the child to concentrate better and learn more. In the long-run, improved nutrition is expected to increase children's physiological capacity for learning and to reduce morbidity by strengthening the immune system, thereby reducing missed school days due to sickness. In addition, school meals make going to school more attractive. The impact of on-site school meals on learning is expected to operate through an increase in school attendance and through improvement in learning efficiency while in school, because in the absence of hunger children are able to concentrate better and because (micronutrient-fortified) school meals may also improve cognitive functions. School meals can also subsidize the cost of school attendance by providing food with the potential of improving learning and nutrition (Adelman et al., 2008). If beneficiary households respond to school meals by reducing their food expenditures, more resources will be available, which may increase expenditures on education or other activities.

A number of studies found school meals to raise enrollment and attendance (Ahmed, 2004; Alderman et al., 2012; Buttenheim et al., 2011; Dreze and Goyal, 2003; Kazianga et al., 2012, Tan et al., 1999; Vermeersch and Kremer, 2005) where school participation has initially been low. However, effects on learning achievement and cognitive development are less clear.[2] Filmer and Schady (2009) argue that students may not learn

much due to overcrowding as a consequence of school meals attracting new students, who are often poorer. Poor marginal students may do worse in terms of learning if schools cater to elites (Duflo et al., 2008). If poor, credit-constrained households send their most promising children to school first, then the marginal students will have less favorable characteristics, e.g. in terms of ability (Card, 1999). Furthermore, on-site school meals may adversely affect the effectiveness of the educational process, if, for example, food distribution disrupts learning when school children spend time collecting firewood. In some cases the total amount of hours devoted to teaching is found to decrease by 15 percent (Vermeersch and Kremer, 2005). The environment in which school meals take place also plays an important role. If a program increases enrollment and attendance, while teaching quality is low or teachers' absenteeism high, it is unlikely to induce better learning achievement. For example, Vermeersch and Kremer (2005) found no impact of school meals on cognitive skills; better test scores were primarily associated with greater teachers' experience. Kazianga et al. (2012) found that school meals increase enrollment but fail to improve academic performance. Finally, the school meal program might even fail to increase nutrition if parents change their behavior in that they provide less food at home if they know that food is provided in school, e.g. they knowing that meals are given in school they might not provide breakfast or dinner. Such substitution could possibly even lead to worse nutrition outcomes.

The evidence on the link between school meals and educational outcomes is mixed for the most part, as the review in the preceding paragraphs indicated. This has also been highlighted in a major recent review paper examining the link between school resources and educational outcome in Developing countries covering a 20 year period (Glewwe *et al*. 2011), which concludes that the impact of school meals on student educational outcomes is inconclusive. There is also a dearth of evidence on the role played by

program implementation; and how different program modalities may influence expected outcomes. This paper aims to contribute to the literature by providing additional evidence on the link between SMP and educational outcomes generally, and the role program modalities and their implementation play.

3. DATA AND SCHOOL MEALS

3.1 THE ETHIOPIAN SCHOOL MEALS PROGRAM

The Government of Ethiopia (GoE) adopted an Education and Training Policy in 1994 with a view to achieving the educational MDGs by the year 2015. To that end, the GoE has implemented three phases of multi-year Education Sector Development Programmes (ESDP). One of the main components of the ESDP has been the SMP, which the GoE has undertaken in partnership with the United Nations World Food Programme (WFP).

The 3rd phase of the ESDP expanded school meals to schools in food insecure and vulnerable areas in Ethiopia. In particular, the program targeted pastoralist areas and chronically food deficit highland districts in the country with the aim of: attracting children to school in chronically food insecure areas, increasing enrollment, stabilizing attendance and reducing dropout. The program also pays special attention to increasing girls' enrollment in program areas with a view to bringing about gender parity in school enrollment.

WFP sponsored school meals started in Ethiopia in 1994 with an initial pilot project in war-affected zones in Tigray region. It has since provided school meals in chronically food insecure districts in six of the country's nine regional states (Afar, Amhara, Oromia, SNNPR, Somali and Tigray) with a particular focus on districts with lower enrollment and higher gender disparity. In 2008, WFP provided food for 915 schools

with 482,000 children benefiting from school meals. The per child food ration consists of 150 gm of corn-soya blend (CSB), 6 gm of fortified vegetable oil and 3 gm of iodized salt, provided as a cooked meal on every school day.

In addition to the main program, the WFP launched 'the Girls' Initiative' intervention in 2002 in food insecure pastoralist areas of four regional states (Afar, Somali, Oromia and SNNPR). The initiative has the objective of encouraging girls' education and narrowing the gender gap in pastoralist communities. The program provides 8 liters of vegetable oil per semester ('take-home rations') conditional on 80 percent girl's attendance in addition to on-site school meals. In the first semester of 2010, 81,000 girls received take-home rations. The estimated cost of take-home rations is USD 8.1 per beneficiary girl (during the first semester of 2010).

In about 300 communities, WFP's school meals program is supported by Children in Local Development (CHILD), a community-led planning tool initiated by the WFP and the Ministry of Education. CHILD is primarily intended to increase the sustainability and impact of school meals; and mainly involves capacity building for local government partners and beneficiary communities to assist communities to plan for a child-friendly school environment in order to improve the learning atmosphere.

School meals may involve local contribution, which is usually in kind, with the exception of cooks' remuneration. Sometimes communities are expected to contribute labor e.g. to build canteens and storage rooms. Additionally, parents may be required to contribute firewood and water to support the preparation of meals or cash to cover payments for cooks.

3.2 DESCRIPTIVE ANALYSIS

The data used in this paper come from a household survey conducted in 2010 by the World Food Programme Country Office Ethiopia in partnership with the University of Mannheim covering school catchment areas in food-insecure districts in four of the major regions of Ethiopia (Amhara, Oromia, SNNPR and Tigray).[3] Employing a two-stage stratified sampling design, the survey sampled 200 school catchment areas in the four regions stratified by highland and pastoral areas. The survey covered the school catchment areas of program schools and non-program schools.[4] The first-stage sampling was conducted using program districts as the sampling frame for non-program school catchment areas. This type of program/non-program school catchment area matching procedure was chosen in order to attain comparable school catchment areas. The second-stage sampling involved randomly sampling ten children aged 7 to 13 years per school catchment area using household lists irrespective of whether the children were enrolled in school at the time of the survey.[5] This design feature of the survey permits a richer analysis than school based surveys since it allows investigating relationships within the school service area, thus circumventing potential selection problems stemming from focusing only on children already enrolled in schools. Only students enrolled in grades 2 to 4 were included if they were enrolled in school. In sum, the survey was restricted to (i) children aged between 7 and 13 years old and (ii) children enrolled in grades 2-4 if they were students. If a child was not enrolled, then the grade restriction did not apply, only the age restriction was effective. The survey provides information on health, education, learning, and child and household characteristics for nearly 2000 children. We dropped schools where food had not yet been distributed at the time of the survey (3 schools). The fact that these schools were still without food although the school year had already started is unlikely to be attributable to pure chance only. Rather, these schools might be different along unobserved characteristics. In addition, as we are interested in

current school meals on current outcomes, including children in schools where food had not been distributed yet might understate the results. Table 1 shows the distribution of schools across regions and livelihood (highland vs. pastoralist) in the sample.

[Table 1 here]

To measure scholastic performance, we tested children on their reading, writing and arithmetic skills.[6] Children were tested regardless of whether they were enrolled in school or not. For reading, children were asked to read pre-prepared letters, words and sentences. In the writing test, children were asked to write down pre-prepared sentences that the interviewers read aloud. Children were also tested on their arithmetic skills using up to three different arithmetic questions. In all three cases, two different versions of the tests were administered depending on the age of the children involved – one set for children between the ages of 7 and 10 years and a more difficult set for children between the ages of 11 and 13 years.

To test children's cognitive development we use the Raven's Standard Progressive Matrices (SPM) test. The major benefit of this test is that no formal schooling is required to solve the questions. The nonverbal aspect of the test reduces the impact of cultural or language bias. We use a modified version of the d2 Test of Attention (Brickenkamp and Zillmer, 1998) to test children's concentration and attention.[7]

Table 2 reports child, household and school characteristics in program and non-program school service areas. The children's mean age is close to ten years with 68 percent of children aged 10 years or less. (10 years is the cutoff above which children were given the more difficult set of tests). Slightly more boys than girls are included in our sample. If children were enrolled, their mean grade was grade 3. Around 20 percent of children were not enrolled in school at the time of the survey. Households in program school

service areas have slightly more children on average, have a higher share of either parents without education and are more often headed by a male household head. They also have a higher livestock index.[8] Children residing in program school catchment areas have access to better school facilities as measured by our school equipment index.[9]

[Table 2 here]

As discussed before, while there were no school meals in the non-program schools, in the program schools the implementation of the school feeding was not uniform. It varied in several dimensions, which we label modalities of implementation in the following. Table 3 shows some statistics on these implementation modalities. Around a quarter of schools have the additional program component: *take-home rations*. Almost 50 percent of the schools have implemented the community-led planning tool (CHILD). Schools usually establish food management committees as part of the program to oversee delivery, storage and distribution of food. In 59 percent of cases the food management committee has been trained to enable members to more effectively assume their responsibilities. In 43 percent of cases cooks have been trained. On the other hand, 88 percent of schools reported that they experienced disruptions in the distribution of food and water. 16 percent reported that cooks' absenteeism was the main reason for the disruption. In the majority of schools, food is distributed half-way through the school day, and only 25 percent of the schools use a special eating place within the school compound. Most schools use a traditional three-stone fire place for cooking and reported inadequate storage facilities. The mean program duration at the time of data collection is 8.43 years.

[Table 3 here]

Table 4 reports households' contributions to the program. 6 percent of beneficiary households are member of a food management committee. Their most important contribution to school meals is firewood, followed by cash and water contribution. Only 2 percent of beneficiary households report no contribution at all.

[Table 4 here]

4. EMPIRICAL ANALYSIS

4.1 EMPIRICAL SPECIFICATIONS

The paper examines the link between, on the one hand, school meals, its modalities of program implementation and, on the other, cognitive skills, concentration/attention span, reading, writing, arithmetic and children's activities as outcomes. These outcomes are correlated with school, teacher, household or child characteristics, many of which are not observed. The empirical analysis is split into two parts: In Section 4.2 we compare program versus non-program school catchment areas, controlling for other covariates **X**. Here, school meals status is considered as binary and we thus compare SMP versus non-SMP. Thereafter in Section 4.3 we examine the effects of the different modalities of implementation, controlling for the same covariates **X**. In those analyses only the subsample of program school catchment areas is used, i.e. the subsample of the non-program school catchment areas is dropped. In both sections we use a linear regression model:

$$(1) y_{ts} = \boldsymbol{X'}_{is}\alpha + \boldsymbol{D'}_{s}\delta + \epsilon_{is}.$$

where *i* and *s* denote a child and school service area, *y* represents the outcome of interest and **X** is a vector of child, household, and school service area characteristics, and ϵ denotes the error term.[10]

In Section 4.2, the variable **D** is a binary variable for program status, i.e. SMP school or non-SMP school. In Section 4.3, on the other hand, **D** is a vector that captures the characteristics and modalities of the program implementation.

In Section 4.2 we report results using OLS and propensity score matching in order to analyze sensitivity to functional form and estimation approach. In Section 4.3 we will use only OLS, because there **D** represents a non-binary vector of program modalities, which themselves are correlated and thus require joint estimation of their effects. (In an earlier version of the paper we had also estimated random-effects models where random school service area effects were included in the linear model. Overall, the main results were similar with, as expected, somewhat larger precision. Due to space constraints, these estimates are not reported here.)

In all empirical analyses, the vector **X** always includes the following control variables: the child's age, a dummy for the child being aged between 7 and 10 years,[11] the child's gender, a dichotomous variable whether the head of household is male, the number of children in the household, a dichotomous variable whether both parents are uneducated, the logarithm of total household expenditures, the school equipment index, a dichotomous variable whether the district of the school catchment area is characterized by pastoralism, and controls for the region (Amhara, Oromia, SNNPR and Tigray). (Obviously, control variables without variation were dropped in the respective analyses; e.g. in the subgroup analysis for girls or boys we did not include child gender in **X**.)

4.2 EMPIRICAL RESULTS FOR PROGRAM VERSUS NON-PROGRAM SCHOOLS

In this subsection, we compare program to non-program schools and we therefore use the full sample that includes both program and non-program (comparison) school catchment areas. In Table 5, we report OLS and Propensity Score Matching (PSM) regressions of various outcome variables on the binary school meal indicator (SMP yes or no) and control variables. For OLS we use cluster robust standard errors throughout. For propensity score matching, we examined various estimation routines. In the table, we report results using *psmatch2* (Leuven and Sianesi 2010) with normal kernel, logit specification of the propensity score and the inbuilt bandwidth-choice algorithm and report the Average Treatment Effect on the Treated (ATT) with bootstrapped standard errors clustered at the primary sampling unit: School catchment areas. Results were robust to alternative bandwidth choices. We also examined direct matching using the *nplate* command (Frölich 2007), which overall delivered similar results.

In Table 5 we report the estimated school meal effects on educational outcomes (reading, writing, math, concentration), separately for the subsamples of boys and girls. In the appendix in Tables A.2 to A.5 we show further estimates for various other outcome variables: Table A.2 gives estimates stratified by age group. Table A.3 provides estimates on child labor activities, and Tables A.4 and A.5 show estimates on child labor separately for low-asset and high-asset households. Most of the estimates in these tables are statistically insignificant. Overall, the OLS and PSM estimates usually go in the same direction and are never statistically different of each other, but are mostly also not statistically significantly different from zero, such that no strong conclusions can be drawn. The most stable estimates are found in Tables A.4 and A.5 with respect to child labor activities. In the subsample of low-asset households, we find that school meals are associated with higher child labor, i.e. more domestic tasks and some evidence (in Table A.3) for more work in the family business for boys, while on the other hand paid work

seems to be lower for the younger age cohorts). On the other hand, no such association is found for the high-asset households in Table A.5. Regarding cognitive outcomes, in Table 5 and A.2 most estimates are negative but not significantly different from zero. Only the estimates for concentration seem to be negatively associated with school meals, although not in every specification significantly so. Overall, the estimated associations between school meals and child outcomes tend to be negative (more labor, less concentration skills), but, as mentioned before, we would rather abstain from interpreting these estimates as causal effects because of concerns in differences in unobservables since the actual selection process into the school meals program might also have depended on factors that are not fully captured in our control variables.

[Table 5 here]

In the following tables, on the other hand, we estimate the effects of school modalities and there we are more confident that endogeneity may be of lesser concern.

4.3 MODALITIES OF PROGRAM IMPLEMENTATION

In this subsection, we will examine the implementation modalities of the school meals program. In these analyses, we basically compare within the SMP schools and do not include the control schools anymore. That means, in contrast to the previous subsection where we had been comparing control versus treatment schools and were concerned about unobservables having affected the school selection process, in the following tables we only compare within treatment schools and thus compare schools with the same feeding treatment but different implementations of it. Here we feel that selection issues might be less of a concern. In other words, whether school meals are served in the

morning or during lunch of whether cooks have been trained or not might depend less on unobservables than whether a school was selected for SMP or not at all. Of course, we cannot exclude the possibility that systematic differences in unobservables might have determined the implementation modalities, but believe that unsystematic variations in unobservables might have generated most of the variation in modalities. Hence, we consider the evidence in these tables as stronger as in the previous subsection.

In contrast to the previous subsection, in the following analyses we use the subsample that only includes program school catchment areas, i.e. the non-program schools are dropped. The implementation characteristics **D** included in the regressions are: whether CHILD is implemented, take-home rations are distributed, the food management committee is trained, the cooks are trained, the school had at least one day of food not being distributed, whether food is served half-way through classes, whether food is served at the end of classes (serving food at the beginning of classes is the reference category), the duration of the program, whether households contribute to the program with cash, and whether households contribute with material (defined as labor, water or firewood contributions), the reference category being no contribution. We use means at the school catchment area level for the contribution-related variables to reduce potential measurement errors at the household level and to avoid potential confounding with individual household income. The modality and implementation variables are included simultaneously in the estimations.

Because the way the school feeding is implemented is characterized by many variables, which we all need to include in the same regression as they are also correlated, we only show OLS results. In other words, the implementation modality is a type of treatment

vector and no longer a binary indicator. In addition, some variables are also continuous, e.g. School meal program duration, such that a binary propensity score would no longer be applicable. We also examined PSM for some subvector of implementation modalities, e.g. the combination of several modalities. These results were mostly confirmative of the OLS findings but usually rather noisy because the number of observations was very small in each cell of the combined treatment modalities.

The estimation results are reported in Table 6, separately by gender, and Table 7 for the two age groups. We discuss the results for each modality and implementation characteristics across the two tables.

(i) Children in Local Development (CHILD): For the CHILD component we do not find significant results for boys, but for girls a positive association is found for cognitive skills as we find a positive effect of about 1.4 points (s.e. = 0.51).[13] We also find that girls are 11.6 percentage points (s.e.= 5.7%), or a quarter of a standard deviation, more likely to be able to read a sentence if the CHILD component is in place.

[Table 6 and Table 7 here]

(ii) Take-home rations: We find take-home rations to improve girls' concentration score by 78.1 points (s.e.= 23.8), or by about 1.4 standard deviations. This effect is particularly large in terms of economic significance. Take-home rations supplement on-site school meals in pastoralist and semi pastoralist areas. They are aimed at improving girls' attendance in areas that have lower girls' school attendance rates. We also find take-home rations to have a large effect on reading as we find girls to be 21.9 percentage points (s.e.= 9.7%) more likely to be able to read a sentence, as well as on writing, as we find girls to be 47.5 percentage points (s.e.= 17.6%) more likely to be able to write, an improvement by about 1 standard deviation.

We also find take-home rations to be positively associated with reading skills for boys, both in terms of being able to read a word and a sentence. This finding is quite remarkable as take-home rations are conditional on girls' attendance. Nevertheless, boys may also be benefiting from take-home rations as, due to the value transfer to the household, boys' attendance may improve as well as their nutritional status. We also find take-home rations to be positively associated with writing and arithmetic skills for boys. We also find take-home rations to be positively associated with concentration for younger children as well as to improve reading skills for older children and writing for younger and older children. Overall, of all modality and implementation characteristics, take-home rations appear to have the largest and most stable positive effect.

(iii) Food management committee trained: No significant effects of training of the food management committee are found neither for boys nor for girls. For older children some positive association is found for cognitive skills and math.

(iv) Cooks trained: While many of the estimates are insignificant, they are positive throughout. Some significant effects on cognitive skills and concentration are found for boys and girls and for the younger age cohort.

(v) Disruption in food distribution: Most of the estimates are insignificant, whereas the significant ones are inconclusive, partly negative partly positive. {Note that no effects for concentration are reported because the regressor *Disruption in food distribution* dropped from the regression. This happened because, for budget reasons, the concentration test had been collected only in a subset of school service areas and it had happened that in this subset of schools, disruptions had always occurred. Hence, this regressor had no variation in the subset of schools where the concentration outcome had been collected.}

(vi) Timing of serving food: In terms of the timing of the food distribution, serving food half-way or at the end of the school day is found to be less favorable than serving food at the beginning of the school day (which is the reference category) for girls. Particularly for *serving food at the end of the school day*, as opposed to serving food in the morning, negative estimates are found for cognitive development, reading skills, both in terms of being able to read a word and a sentence, and arithmetic skills. These results appear to be the strongest and most stable across all variables in Table 6, next to the take home rations. These findings underline the importance of serving food at the beginning of the school day, as school meals, through hunger alleviation during school hours, are expected to improve children's concentration. In addition, serving food at the end of classes may crowd out food served at home. Serving food later in the school day, as opposed to in the morning, also tends to have negative effects for boys and the various age groups, although most are insignificant and smaller.

(vii) Program duration: We find a longer program duration to be positively associated with concentration for boys, an additional year increases the concentration score by 6 points (s.e.= 1.9).[14] We also find a longer program duration to be positively correlated with cognitive development for girls, an additional year increases the Raven's test score by 0.1 points (s.e.= 0.06). These findings are in line with a school meals program to function better, the longer it has been implemented. On the other hand, most other estimates are insignificant and small; so no strong conclusion should be drawn.

(viii) Household contributions: We include firewood, water and labor in the materials category. Cash is usually contributed towards the cooks' remuneration. The reference category is no contribution at all. We use means at school catchment area level because of potential measurement errors at the household level and to avoid potential

confounding with individual household income. Generally, household contributions can be detrimental to schooling outcomes particularly if the burden falls on children to acquire the materials. Of course, household contributions may also improve the availability of resources that are complementary to the distribution of food, thereby reinforcing any beneficial effects of school meals. Making any kind of contribution (cash or material), as opposed to no contribution, is found to be negatively associated with writing skills for boys. In addition, cash contributions, as opposed to no contribution at all, appear to improve reading skills for girls. Cash contributions are also found to be positively associated with concentration for younger children but to be negatively associated with writing skills. On the other hand, they appear to positively affect reading and arithmetic skills for older children. Overall, the estimates thus appear inconclusive such that no strong conclusions should be drawn.

5. CONCLUSION

The effectiveness of school meal programs depends on how well these programs are designed in terms of modality as well as how well they are implemented. However, little is known about the role of school meals program modalities and their implementation on generating learning achievement and enhancing cognitive development. This paper investigated the role of the Ethiopian school meals program, its modalities and implementation on learning achievement, cognitive development and concentration/attention span in rural areas of the country.

Two main results stand out: First, most of the implementation characteristics do not appear to matter so much. This is not to say that their effects are zero, but they do not seem to be strong and systematic enough in order to produce coherent patterns in the estimates on several outcome variables and in the gender and age subgroups. On the

other hand, two characteristics stand out: Take-home rations and serving food early in the morning appear to be important and show the most systematic patterns across all estimates.

Supplementing on-site meals with take-home rations is positively associated with concentration, reading, writing and arithmetic skills. We interpret the results on take-home rations as evidence that not only targeted girls benefit, but possibly all children within households receiving take-home rations. This finding is in line with Kazianga et al. (2014) and Fafchamps et al. (2008). Although take-home rations are conditional on girls' attendance, all children within a household may well be benefiting from take-home rations as, due to the value transfer to the household, children's attendance may improve as well as their nutritional status.

Our results also suggest that school meals are less effective if they are served at the end of classes, which appears to be especially important for girls. School meals should be served in the morning in order to alleviate hunger and thus improve children's concentration. In addition, serving food at the end of classes may crowd out food served at home.

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NOTES

[1]Other interventions to attract children to school that have been found to increase school enrollment and attendance include deworming (Miguel and Kremer, 2004), provision of additional teachers (Duflo et al., 2008) and conditional cash transfers (Behrman et al., 2009).

[2]A body of literature investigates the impact of school meals on (short-term) cognitive development, focusing on the specific micronutrient content of school meals. Although the empirical evidence is mixed, there appears to be a consensus on the importance of animal source food. For example, Whaley et al. (2003) explore the effect of three different diets (meat, milk, and energy), suggesting that animal source food has greater impact on cognitive function. Similarly, Gewa et al. (2009) investigate the effect of different school meals comprised of exclusively vegetarian meals, milk, or supplemented with meat; results show that the meat variant is relatively more important in terms of improving cognitive function among school-age children. However, most of these studies are conducted in a laboratory setting, which limits their external validity.

[3]The Afar and Somali regional states were not included in the surveys due to security and logistical challenges at the time.

[4]In Tigray and Amhara WFP's school meals program is operational in highland areas only. Additionally, there was a smaller subsample of phased-out program school areas, i.e. of schools which had received meals only in the past but not now. These schools are not included in the analyses of this paper since the information on the timing and modalities of the school meals program was rather scarce. Furthermore, in this paper we focus on the link between current school meals and learning outcomes. For phased-out schools the treatment status is imprecise since some children might have received some

meals in the past but there is no precise measurement of such partial treatment status and its timing.

[5]For a more detailed description of the survey design see Haile et al. (2011).

[6]The survey adapted tests on reading, writing and arithmetic skills from the Young Lives project, a longitudinal study conducted in four countries (Peru, Ethiopia, India and Vietnam). http://www.younglives.org.uk.

[7]For a description of the test design see Poppe (2014).

[8]The livestock index is a weighted index using tropical livestock units (TLU) as weights as follows: cattle are weighted by 0.7 TLU, donkeys or horses are weighted by 0.3 TLU, goats or sheep are weighted by 0.15 TLU and poultry are weighted by 0.05 TLU.

[9]This index is defined as the sum (range 0-4) of whether sanitation facilities are available, school buildings are in a good condition, the school compound is fenced and classrooms have glass windows.

[10]Robust standard errors are used to adjust for school catchment area cluster.

[11]In the regressions, we control for whether a child is aged between 7 and 10 years because the survey administered different tests for younger and older children – except for the Raven's test and the concentration test which were administered irrespective of age – as in small samples the distribution of younger children might be unequal across program status.

[12] We also used the random-effects model. Because the random-effects model produces similar results, only results from OLS and PSM are presented.

[13]In the sample of program school catchment area girls, the score has a mean of 12.8 and a standard deviation of 3.5. See Table 10 in the Appendix.

[14]In the sample of program school catchment area boys, the score has a mean of 136.7 and a standard deviation of 56.6. See Table 10 in the Appendix.

Table 1: Distribution of schools, by region and livelihood

	Program schools	Non-program	Total
Amhara highland	14	17	31
Oromia highland	14	14	28
Oromia pastoralist	12	13	25
Tigray highland	14	16	30
SNNPR highland	10	12	22
SNNPR pastoralist	5	5	10
Subtotal highland	52	59	111
Subtotal pastoralist	17	18	35
Total	69	77	146

Notes: SNNPR refers to Southern Nations, Nationalities and Peoples' Region.

Table 2: Summary statistics (means) of selected characteristics of children, households, and schools

Variable Names	Program	Non-program	p-value
Child characteristics			
Age	9.96	9.91	.66
Children aged ≤ 10	.68	.68	.9
Male	.56	.52	.19
Grade	2.98	3	.64
Enrolled in school	.79	.8	.45
Household characteristics			
Number of children	4.08	3.85	.01
Total expenditures (log)	5.82	5.82	.93
Neither parent attended school	.68	.58	.0
Male headed household	.89	.83	.0
Livestock index	3.89	3.08	.01
School characteristics			
School equipment index	2.43	2.13	.0
Highland area	.75	.76	.61

Notes: The p-value stems from a means comparing t-test. The livestock index is a weighted index using tropical livestock units (TLU) as weights as follows: cattle are weighted by 0.7 TLU, donkeys or horses are weighted by 0.3 TLU, goats or sheep are weighted by 0.15 TLU and poultry are weighted by 0.05 TLU. The school equipment index is defined as the sum (range 0-4) of whether sanitation facilities are available, school buildings are in a good condition, the school compound is fenced and classrooms have glass windows.

Table 3: Summary statistics on school meals program modality and implementation

Variable Names	Mean
Modality of school meal program	
Take-home rations given	.26
Children in Local Development (CHILD)	.48
Timing of food distribution:	
Given at beginning of school day	.34
Half-way through	.62
Given at end of school day	.04
Implementation of school meals	
Food management committee trained	.59
Cooks trained	.43
Disruption in food distribution (yes=1)	.88
Reasons for days without food	
No food	.25
No water	.28
No fuel	.03
Cooks were absent	.16
Other reason	.28
Facilities	
Three-stone fire place	.85
Improved stove	.15
Storage facility adequate/safe	.87
Special eating place in school	.25
Program duration (years)	8.43
Number of observations (schools)	69

Table 4: Summary statistics on households' involvement and contribution

Variable Names	Mean
Households' involvement	
Member of food management committee	.06
Households' contribution	
No contribution	.02
Cash	.35
Firewood	.49
Labor	.03
Water	.09
Firewood, labor, or water	.61
Number of observations (households)	688

Table 5: Cognitive skills, concentration and learning achievement – by gender

	(1) Raven's test	(2) Concen-tration	(3) Reads words	(4) Reads sentences	(5) Writes	(6) Math
Boys						
OLS						
Coefficient	-0.324	-13.507*	-0.02	-0.007	-0.016	-0.052
Std. error	(0.351)	(7.914)	(0.039)	(0.038)	(0.037)	(0.035)
Observations	689	300	725	725	725	723
Matching						
ATT	-0.374	-16.536*	-0.029	-0.013	-0.028	-0.040
Std. error	(0.360)	(8.760)	(0.047)	(0.046)	(0.044)	(0.042)
Observations	689	300	725	725	725	723
Girls						
OLS						
Coefficient	0.005	-12.911	-0.048	-0.05	-0.071*	-0.034
Std. error	(0.372)	(8.559)	(0.038)	(0.035)	(0.041)	(0.041)
Observations	588	264	635	635	635	635
Matching						
ATT	-0.031	-12.188	-0.079	-0.073	-0.089	-0.043
Std. error	(0.424)	(10.209)	(0.049)	(0.049)	(0.054)	(0.048)
Observations	588	264	635	635	635	635

Table 6: School meals program's modalities and implementation, by gender

	(1) Raven's test	(2) Concen-tration	(3) Reads words	(4) Reads sentences	(5) Writes	(6) Math
Boys						
CHILD component	-0.150	-32.664	-0.104	-0.071	-0.010	-0.042
	(0.585)	(25.422)	(0.081)	(0.072)	(0.083)	(0.073)
Take-home rations	-1.307	-5.979	0.201*	0.517***	0.520***	0.318**
	(1.028)	(20.553)	(0.114)	(0.112)	(0.130)	(0.121)
Food management committee trained	0.465	-8.824	0.010	-0.080	0.021	-0.013
	(0.534)	(10.362)	(0.055)	(0.060)	(0.065)	(0.061)
Cooks trained	0.897	19.078*	0.012	0.059	0.089	0.062
	(0.547)	(10.505)	(0.054)	(0.057)	(0.064)	(0.052)
Disruption in food distribution	0.952	-	0.026	0.055	-0.021	0.050
	(0.797)	-	(0.080)	(0.073)	(0.084)	(0.103)
Meals served at half-way	-0.406	4.401	-0.044	-0.046	-0.049	0.020
	(0.473)	(15.498)	(0.073)	(0.060)	(0.083)	(0.065)
Meals served at end of school day	-0.645	-15.491	0.005	-0.064	-0.234	-0.117
	(0.707)	(24.253)	(0.178)	(0.190)	(0.205)	(0.161)
School meals program duration	0.024	6.021***	-0.004	-0.001	0.002	-0.005
	(0.074)	(1.945)	(0.008)	(0.008)	(0.009)	(0.008)
Cash contribution	3.258	82.131	0.717	-0.086	-1.224***	-0.151
	(4.280)	(67.714)	(0.572)	(0.557)	(0.424)	(0.420)
Material contribution	-0.678	74.192	0.422	-0.403	-1.202***	-0.300
	(4.360)	(70.951)	(0.585)	(0.567)	(0.405)	(0.428)
N	322	148	333	333	333	332
Girls						
CHILD component	1.410***	15.441	0.048	0.116**	0.126	0.012
	(0.511)	(26.170)	(0.063)	(0.057)	(0.084)	(0.081)
Take-home rations	-0.600	78.105***	-0.053	0.219**	0.475***	-0.033
	(0.968)	(22.553)	(0.134)	(0.097)	(0.176)	(0.119)
Food management committee trained	-0.211	-1.751	-0.061	-0.065	0.026	-0.074
	(0.461)	(17.023)	(0.062)	(0.054)	(0.064)	(0.062)
Cooks trained	1.026**	23.146	0.074	-0.034	-0.017	0.086
	(0.462)	(13.961)	(0.063)	(0.054)	(0.072)	(0.060)
Disruption in food distribution	1.716**	-	-0.094	-0.077	-0.175	-0.144
	(0.720)	-	(0.094)	(0.088)	(0.125)	(0.095)
Meals served at half-way	-1.049**	14.116	-0.041	-0.027	-0.062	-0.084
	(0.508)	(25.317)	(0.059)	(0.048)	(0.065)	(0.085)
Meals served at end of school day	-1.904**	-47.849	-0.211**	-0.188***	-0.086	-0.289**
	(0.902)	(31.584)	(0.082)	(0.069)	(0.184)	(0.118)
School meals program duration	0.118*	4.347	-0.005	0.002	-0.007	0.008
	(0.063)	(2.747)	(0.008)	(0.006)	(0.009)	(0.010)
Cash contribution	-0.103	48.843	0.635*	-0.031	-0.393	-0.148
	(3.554)	(63.155)	(0.350)	(0.193)	(0.407)	(0.275)
Material contribution	-4.756	25.264	0.379	-0.343	-0.267	-0.302
	(3.610)	(79.721)	(0.381)	(0.236)	(0.414)	(0.326)
N	252	112	277	277	277	277

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parentheses. In specification (2) the regressor *Disruption in food distribution* has been omitted because the concentration measure had been collected only for a subset of school catchment areas and it turned out that in this subset disruptions had occurred in all schools such that the regressor is without variation.

Table 7: School meals program's modalities and implementation, by age (7-10 vs 11-13)

	(1) Raven's test	(2) Concen-tration	(3) Reads words	(4) Reads sentences	(5) Writes	(6) Math
Age 7 to 10 years old						
CHILD component	0.332	-21.786	-0.088	-0.043	-0.055	-0.038
	(0.482)	(21.774)	(0.058)	(0.048)	(0.053)	(0.077)
Take-home rations	-1.500	38.100*	-0.107	0.143	0.409***	0.114
	(0.972)	(19.688)	(0.121)	(0.109)	(0.096)	(0.135)
Food management committee trained	-0.139	-12.056	-0.072	-0.100*	0.003	-0.076
	(0.472)	(10.876)	(0.051)	(0.053)	(0.049)	(0.060)
Cooks trained	1.105**	29.992***	0.019	0.005	-0.049	0.068
	(0.458)	(10.443)	(0.054)	(0.057)	(0.049)	(0.055)
Disruption in food distribution	1.129	-	0.015	0.062	-0.143**	-0.099
	(0.699)	-	(0.063)	(0.063)	(0.067)	(0.103)
Meals served at half-way	-0.907*	-8.197	-0.063	-0.068	-0.069	-0.089
	(0.460)	(18.730)	(0.056)	(0.045)	(0.051)	(0.071)
Meals served at end of school day	-0.962	-41.136	-0.045	-0.043	-0.143	-0.287*
	(0.760)	(32.419)	(0.134)	(0.122)	(0.117)	(0.161)
School meals program duration	0.080	5.672**	0.002	0.008	-0.001	0.003
	(0.063)	(2.280)	(0.007)	(0.006)	(0.006)	(0.008)
Cash contribution	3.615	129.451*	0.551	-0.012	-1.015***	-0.625
	(2.728)	(65.650)	(0.361)	(0.362)	(0.325)	(0.521)
Material contribution	-1.539	87.279	0.297	-0.354	-0.968***	-0.877*
	(2.811)	(72.500)	(0.391)	(0.404)	(0.345)	(0.526)
N	382	166	419	419	420	420
Age 11 to 13 years old						
CHILD component	0.827	-30.038	0.104	0.111	0.172**	-0.043
	(0.893)	(18.698)	(0.098)	(0.106)	(0.073)	(0.070)
Take-home rations	-1.001	57.426	0.387***	0.669***	0.641***	-0.087
	(1.148)	(42.981)	(0.129)	(0.124)	(0.140)	(0.098)
Food management committee trained	1.120*	2.501	0.108	0.021	0.060	0.146***
	(0.561)	(19.321)	(0.073)	(0.072)	(0.069)	(0.053)
Cooks trained	0.647	18.671	0.102	0.041	0.189***	0.074
	(0.589)	(25.084)	(0.074)	(0.069)	(0.066)	(0.054)
Disruption in food distribution	1.159	-	-0.135	-0.165	-0.109	-0.012
	(0.893)	-	(0.115)	(0.117)	(0.102)	(0.107)
Meals served at half-way	-0.379	30.229	-0.004	0.042	-0.037	0.026
	(0.735)	(23.543)	(0.094)	(0.094)	(0.072)	(0.074)
Meals served at end of school day	-0.673	4.152	-0.084	-0.144	-0.049	0.030
	(1.086)	(31.833)	(0.148)	(0.133)	(0.119)	(0.082)
School meals program duration	0.024	6.701	-0.014	-0.018	-0.009	-0.002
	(0.111)	(5.200)	(0.011)	(0.012)	(0.010)	(0.008)
Cash contribution	0.971	57.505	1.033*	0.157	-0.262	0.929***
	(4.787)	(72.934)	(0.574)	(0.413)	(0.394)	(0.236)
Material contribution	-1.333	97.236	0.816	0.008	0.019	0.835***
	(5.273)	(83.181)	(0.597)	(0.477)	(0.412)	(0.260)
N	183	93	188	188	190	189

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parentheses. In specification (2) the regressor *Disruption in food distribution* has been omitted because the concentration measure had been collected only for a subset of school catchment areas and it turned out that in this subset disruptions had occurred in all schools such that the regressor is without variation.