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Promoting School Readiness through a Preschool Feeding Program

**A Nutritional Nudge to Improve at-Risk Preschooler's Cognitive Development
in Armenia**

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Abstract

Many school feeding programs target child hunger, nutritional deficiencies, attendance, and education outcomes but often do not examine their effects on cognitive development. In this cluster-randomized controlled trial, we tested the effects of adding a morning snack to a school lunch program on the fluid intelligence of 951 children ages 4 to 6 years. While there were no significant effects on development overall, the morning snack improved short-term memory (STM) and total score on the Wechsler Preschool and Primary Scale of Intelligence, Fourth Edition (WPPSI-IV) among children from the lowest quartile of household expenditures (STM: 0.35SD, $p = 0.020$; WPPSI-IV: 0.65SD, $p = 0.087$), and those whose mothers completed secondary school or less (STM: 0.35SD, $p = 0.002$; total WPPSI-IV: 0.81SD, $p = 0.011$). For at risk preschoolers, school snack programs may help meet their developmental needs.

Keywords: school meals, WPPSI, school feeding program

Data Availability: Data available on request from the author

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Introduction

In 2020, 388 million children in 163 countries received a meal at school each day (World Food Programme [WFP], 2021). Such programs are broadly popular; they are present in nearly all countries, whether low, middle or upper income. These programs address several of the sustainable development goals - to end hunger, promote health and well-being, improve educational access and quality, and to support gender equality (United Nations, 2015). Other objectives include providing a social safety net and, in some settings, supporting local economies and agriculture (Alderman & Bundy, 2012). When these objectives are achieved school-feeding programs can improve the health and education of disadvantaged children (Greenhalgh, Kristjansson, & Robinson, 2007).

To this end, many school meal programs have been evaluated for their effects on the anthropometrical and nutritional status of malnourished children, as well as their effects on school enrollment, attendance, and academic achievement (Jomaa, McDonnell, & Probart, 2011; Kristjansson et al., 2006). However, fewer school meal programs have been evaluated for their effects on children's cognitive development. In particular, randomized controlled trials of school meal programs assessing preschool children have been rare (Grantham-McGregor, 2005). Understanding the effects of school meal programs on children's cognitive development is important because early cognitive performance is associated with performance in primary schools (McGrew & Wendling, 2010). For example, children's short-term memory, fluid reasoning, long-term retrieval, and processing speed have all been found to have associations with reading and math achievement in primary school (Evans, Floyd, McGrew & Leforgee, 2002; Floyd, Evans, & McGrew, 2003).

A recent systematic review of a range of education programs included an examination of the

effects on children's cognitive development of three school meal programs on low- and middle-income settings- in Burkina Faso, Peru, and Senegal (Snilstveit et al., 2016; 2015). The average child age among the three programs was 9 to 11 years (Jacoby et al., 1996; Diagne et al., 2014; Kazianga, De Walque, & Alderman, 2012). Of the three, only the program in Senegal found main treatment effects on child cognitive outcomes; the largest effects were among the youngest children (ages 6-7 years), and there were no significant effects among children ages 10 or older (Diagne et al., 2014). Furthermore, only the program in Peru provided a morning meal; the other two programs provided lunch (Jacoby et al., 1996). More generally, early child programs, including preschools can mitigate the effects of less than ideal home environments and, thus, reduce disparities in cognitive development. For example, Rubio-Codina and Grantham McGregor (2019) find that early schooling contributes significantly to the reduction in the appreciable wealth gap in cognition observed in children less than 42 months of age in Colombia.

The morning meal may be particularly important (e.g., Rampersaud et al., 2005). As noted by Worobey and Worobey (1999, p113), "The longest interval during which a child goes without an external supply of nutrients and energy is typically between the evening dinner and the morning breakfast." In lab studies, children who miss breakfast perform worse on short-term (same-day) assessments of attention, executive function, and memory than children who have consumed breakfast (Adolphus et al., 2016). The effects of missing breakfast on cognitive performance are particularly at issue for undernourished children (Pollit & Matthews, 1998; Adolphus et al., 2016). Undernourished children demonstrate poorer cognitive performance than adequately nourished children, and when they miss breakfast, the declines in their performance are greater than those experienced by adequately nourished children (Pollitt, Cueto, & Jacoby, 1998; Simeon & Grantham-Mcgregor, 1989).

Similar associations of breakfast consumption and cognitive performance are seen in school settings as well, although classroom structures may mitigate the effects (Grantham-McGregor, 2005). Despite the well-documented effects of breakfast on child cognition, randomized studies of interventions providing schoolchildren (i.e., in Uganda and Peru) with a meal or snack in the morning have not demonstrated significant treatment effects on children's cognitive development as measured by fluid reasoning or short-term memory (Adelman et al., 2008; Jacoby et al., 1996). This issue is particularly salient for preschool children who end their school day after lunch. For many preschool children, the absence of breakfast at home or at school means that their cognitive performance will be adversely affected for the entirety of the time that they are engaged in learning.

School meal programs usually provide children with either breakfast, a mid-morning snack, or lunch, and often do not provide children with more than one meal in a day. The potential to improve children's developmental outcomes by providing a morning meal in conjunction with school lunch is an important question with significant policy implications for school feeding programs worldwide. The purpose of this study is to evaluate the addition of a morning snack to an existing school lunch program, to determine if this addition improves the attention and capacity for learning of preschool children, particularly among those who are at risk. This study is registered in the AEA RCT Registry and the unique identifying number is: AEARCTR-0003581.

Methods

Study design

This study was designed as a paired randomized controlled trial with one intervention arm and one control arm. The study took place in three of the poorest regions in Armenia with rates of child anemia used as a proxy for diet quality in selecting the regions: Gegharkunik (48.8%), Lori (33.6%), and Shirak (21.4%) (WFP, 2018a). All schools in the study area participate in an existing school lunch program sponsored by the Government of Armenia and the WFP which provides daily midday meals to primary schools across the country (WFP, 2018b). This lunch program was initiated in 2010 following the economic contraction in 2009 and has been administered by the WFP with financial support from the Russian Federation.

For the current study, all eligible primary schools with preschool programs in each of the three study regions were paired on the basis of size and proximity to each other and then randomly assigned to either receive the school morning snack program or to the control condition, operating as usual. Schools in the treatment arm received a monthly stipend of 70 Armenian dram per student per day (1\$ = 475Armenian dram) to provide a morning snack to all preschool children. Schools were instructed to provide a snack of about 200 kcal around 9 am, using a list of specified foods intended to promote protein intake and dietary diversity. Schools could design their own menu from the foods list so that they had the flexibility to purchase foods that were in season. WFP monitors used existing systems to monitor implementation and fidelity of the school morning snack program in intervention communities in addition to the regular lunch program.

Study population and sample

In the three regions, or *marzes*, 123 schools were assessed for eligibility to participate in the study (see Figure 1). A total of 23 schools were excluded from participation: 21 schools had

existing morning meal (breakfast or snack) programs in place administered by the local community and 2 schools had fewer than 5 children in their preschool class based on the prior year's enrollment. The remaining 100 schools were paired, and one school within each pair was randomly assigned to treatment or control (50 in each arm) at the beginning of the school year (September 2018). The intervention was implemented in all treatment schools by the beginning of October. One month after program implementation (November), 12 students from each preschool class were randomly selected for cognitive assessment. A school roster provided to the study team was used to randomly pre-select the 12 children, along with 3 replacements for each school. In schools with fewer than 12 students, all children in the class were assessed.

The data collection was conducted by a team of psychologists (assessors) from Yerevan State University and interviewers from the Caucasus Research Resource Center-Armenia. The assessors were trained by the first author and tested on inter-rater reliability before data collection began. The study received approval from Institutional Review Boards (IRBs) at The International Food Policy Research Institute, the University of Michigan, and Yerevan State University. Children were excluded from selection for assessment if they had identified disabilities. On the day of testing, if a selected child was absent, ill, or refused, a replacement child was substituted using a predetermined list. Children were assessed between 9:00am and 10:30am, shortly after the school snack was provided in treatment schools and before they received lunch.

One school was lost to follow-up because the school taught children in Russian and most children did not speak Armenian in which the tests were adapted. This resulted in 49 schools in the treatment arm, and 50 schools in the control arm analyzed for program effects. A further 20 children were excluded from analysis (10 control, 10 treatment) because the child was too ill to be assessed (k=10, 5 in each arm) or refused to participate (k=3 control, k=2 treatment) or the

caregiver of the child refused to participate (k=2 control, k=3 treatment) and a replacement was not available. A further 9 children were excluded from analysis because they did not complete the child development assessments. This resulted in a final analysis sample of 951 children: 501 in the control arm, and 450 in the treatment arm.

Measures

Child Measures

Child cognitive development was measured using the Wechsler Preschool and Primary Scale of Intelligence, Fourth Edition (WPPSI-IV; Wechsler, 2012). The battery uses images of items familiar to young children and the assessment is primarily non-verbal, which facilitates the translation and adaptation process for implementation in different cultural contexts (Fernald et al., 2017). The WPPSI-IV and previous editions have been used in over 20 countries around the world to assess non-verbal domains of fluid intelligence, including many low- and middle- income country (LMIC) contexts (Fernald et al., 2017). For example, the WPPSI has been used for assessment of early childhood development in the context of program evaluations in several LMICs including Bangladesh (Aboud, 2006) and Pakistan (Rasheed et al., 2018), and to assess children's fluid reasoning in Bangladesh, Brazil, India, Nepal, Pakistan, South Africa, Tanzania, and Turkey (Ruan-Iu et al., 2019; Gülgöz, and Kağıtçıbaşı, 2004).

Fluid intelligence is a broad category of child cognitive abilities drawn from the Cattell-Horn-Carroll (CHC) theory of cognitive abilities, one of the most widely regarded psychometric taxonomies (Alfonso, Flanagan, & Radwan, 2005). We measured children's cognitive abilities in several interrelated domains, including *fluid reasoning*, a measure of children's ability for solving problems that requires their use of inductive and deductive reasoning; *short-term memory*, the ability of a child to hold onto new information (marked by the number of items a child can retain)

in the immediate (generally under a minute) time frame; and *processing speed*, the ability of a child to perform a basic task (marked by fluidity and accuracy) that requires a high degree of attention and focused concentration (McGrew, 2009).

Five subtests were administered across the three domains. The matrix reasoning and picture concepts subtests were used to assess fluid reasoning. Processing speed was assessed using the bug search and cancellation subtests, and short-term memory was assessed with the picture memory subtest. The standard instructions were translated into Armenian and back-translated by two psychologists at Yerevan State University. The subtests were pretested among 62 children ages 4 to 7 years (0 and 1st grades) in a non-study area. For the matrix reasoning subtest, one item was replaced after pretesting because the pictures were unfamiliar to children (i.e., squirrel and acorn was changed to rabbit and carrot). The WPPSI-IV subtests demonstrated an acceptable degree of internal consistency as measured by Cronbach's alpha (matrix reasoning $\alpha = 0.7405$; picture concepts $\alpha = 0.7338$; picture memory $\alpha = 0.7963$). The WPPSI-IV scores for each of the subtests were age normalized and summed to produce a summary z-score with a mean of 0 and standard deviation of 1. A total of 9 children were excluded from analysis because they were missing WPPSI-IV subtest scores: matrix reasoning had one child missing, picture concepts had two missing, bug search had four missing observations, cancellation had five missing, and six children were missing picture memory. In addition, one child was missing data on prior year enrollment, and three children were missing information as to whether they ate breakfast at home on the morning of testing. We imputed the community (school) average responses for these missing observations. No other child data was missing.

Household Questionnaire

A questionnaire administered to the primary caregiver collected data on household structure (number of adults and children), as well as participation in the Armenian Family Benefit Program [FBP], a means tested cash transfer, and whether any family members migrated for work in the past year. Household wealth was imputed by calculating estimated expenditures using household data on ownership of 12 assets (e.g., computer, color TV, car/truck, hot water, washing machine). This estimation was based on a regression of nationally representative data on monthly household expenditures on consumption items from the Armenian Integrated Living Conditions Survey (Statistical Committee of the Republic of Armenia, 2016) against a set of assets that corresponded to the assets in the current data. The parameters from this estimate then were applied to the study data to predict expenditures for each household.

Parental measures included parent educational attainment (secondary school completion or less, defined as zero and any-post secondary education or greater, defined as one) and employment status (unemployed/ employed). Six mothers and 55 fathers were missing data on their educational attainment, and 5 mothers and 54 fathers were missing employment data. No other data on parent or household characteristics was missing. We imputed the community (school) average responses for the missing observations. Caregivers also reported on child gender (male/female), age (birthdate), preschool enrollment in the prior year (yes/no) and regular attendance in the current year (was the child absent in the past week, yes/no). In addition, caregivers were asked if the child had breakfast at home on the morning of testing (yes/no).

The home learning environment was measured using questions from the Family Care Indicators on parent engagement in stimulation activities (i.e., told stories, sang songs, read books, counted or drew, took child outside the home, played) in the prior three days, and the number of

children's books in the home (Hamadani et al., 2010). Five children were missing data on the number of books in the home, for which the community mean was used. Aspects of the parent-child relationship, closeness and conflict, were measured using the Child-Parent Relationship Scale (Driscoll & Pianta, 2011).

Preschool Quality

To account for variations in the school environment and educational quality, 12 children in grade 1 from each study school were assessed for school readiness. Most of these students would have been in the same school's preschool the previous school year. The Bracken Basic Concept Scales Third Edition - Receptive version (BBCS-3:R; Bracken, 2006) was used for this assessment. The Bracken Scales are designed to assess children's performance on concepts that predict how well they will perform in first grade (Panter & Bracken, 2009). The first 6 subtests were used. These assess children's knowledge of colors, shapes, sizes/comparisons, letters, numbers/counting, and direction/position. The Bracken has been widely used to assess school readiness in Canada, Australia, and UK (Bradbury et al., 2011) as well as with other Eurasian populations (Hein et al, 2017). The standard instructions for interviewers were forward and backward translated to Armenian and the assessment was pretested among a sample of children in a non-study community.

Statistical Analysis

We used intention to treat analyses to examine the effect of the morning snack program on the cognitive development of preschool children. Several schools had a very small number of observations ($K < 5$) and as mentioned, one school was dropped due to the children not speaking Armenian, so we were not able to use the pairwise assignment in our analysis. We examined the distribution of child, parent, household, and school characteristics to evaluate balance between the

treatment and control group. We used OLS regression to determine the unadjusted treatment effects of the intervention on each of the WPPSI-IV subtest z-scores and the summary z-score. In addition, we studied the treatment effects of the intervention on child scores with control variables to account for differences between the treatment and control group. The control variables in the adjusted model were a dummy variable indicating preschool enrollment in the prior year, father's employment, number of children's books in the home, number of adults in the household, Family Benefit Program participation, and school size and quality - the average Bracken score of current children in grade 1. These variables were included in all the adjusted models. For all models we used cluster-robust standard errors to account for the clustering of observations within schools and fixed effects for the regions. In secondary analyses we tested whether mother's education, household wealth, or child gender modified the effects of the school snack on children's cognitive development scores in accord with the initial study protocols (WFP, 2019) For each outcome, all interactions were examined in one adjusted model. For household wealth, we created quartiles of household expenditures (0-24%, 25-49%, 50-74%, 75-100%), and then compared the bottom quartile to households at or above the 25th percentile. As a robustness check, we compared this approach to using expenditures as a continuous, and a dichotomous median split variable. All analyses were conducted using Stata 14 (StataCorp, L. P., 2016).

Results

Descriptive Statistics

About half (48%) of the children in the study were girls, and the average child age was 63 months (range 48 to 83 months). About a fifth of children in each group were absent from school in the past week, and about half (52%) of children had breakfast at home on the morning of testing. 17% of children in the control group attended preschool in the previous year, compared to 23% of

children in the treatment group ($p = 0.015$). About half of mothers and 28-32% of fathers had some post-secondary education, but employment rates were less than a quarter for mothers and 68-76% for fathers. Half of households (46-50%) had an adult migrate for work in the past year and about half (43-50%) were beneficiaries of the Family Benefits Program. There was an average of 10.5 children assessed per school (Table 1).

Raw WPPSI-IV scores are presented in Table 2. The mean scores for fluid reasoning subtests were low ($\mu = 11.91$ out of 50 possible). However, mean scores were higher for the other domains. The age-adjusted summary scores for the domains of processing speed, and short-term memory were normally distributed. The fluid reasoning domain was rightward-skewed, indicating that there were floor effects, however the total WPPSI-IV score was normally distributed.

Main Effects of School Morning Snack on Child Cognitive Development

At approximately one-month after the program began, there were no significant overall effects for children who received the morning snack (Table 3).. There was a 0.21 SD difference in total WPPSI-IV score between the treatment and the control group; this difference was also not statistically significant ($SE = 0.18$, $p = 0.243$). There was little change in these differences when covariates were included in the regression; the estimated treatment effects remained the same and there were no changes in significance (Table 3).

Effect Modifiers

We conducted secondary analyses to examine the interaction effects of potential modifiers. Per the initial project protocol, we assessed gender specific impact as well as the interaction of education and of expenditures and the treatment. Figure 2 indicates the impact of each of these taken individually. Table 4 indicates the results when all three effect modifiers are included in a single adjusted model. The ‘modifier’ is the coefficient of the variable – that is the impact of the

modifier on the score for the population as a whole, while the interaction indicates the difference in the treatment from the control. When all three modifiers were included, the overall treatment effect was negative but not significant (results not shown). However, the three modifiers are all positive. Girls responded more than boys to the intervention on their short-term memory ($\beta = 0.27$, $SE = 0.14$, $p = 0.039$). Thus, for girls, their initial advantage increases and the sum of the two positive gender coefficients is statistically significant for processing speed, short term memory, and total WPPSI score.

Children of mothers with less schooling from the control population had significantly lower test scores across all domains. However, mother's education significantly modified treatment effects for short-term memory and total WPPSI-IV score. For children of mothers who completed secondary school or less, the magnitude of the interaction effect (STM: $\beta = 0.31$, $SE = 0.11$, $p = 0.009$; total WPPSI-IV: $\beta = 0.71$, $SE = 0.31$, $p = 0.024$) approached that of the modifier effect (STM: $\beta = -0.45$, $SE = 0.08$, $p < 0.001$; total WPPSI-IV: $\beta = -1.09$, $SE = 0.18$, $p < 0.001$) indicating that the morning snack reduced the pre-existing gap. Thus, the sum of the initial difference and the effect for these children is no longer significantly different than the WPPSI-IV score for their classmates.

Children in the control group from households with lower imputed expenditures also had lower scores than children from higher socioeconomic status households on the WPPSI-IV subtests and total score. Children from households with predicted expenditures in the bottom 25th percentile had lower test scores for processing speed and fluid reasoning, with 0.67 SD lower total WPPSI-IV scores than their higher wealth peers ($SE = 0.24$, $p = 0.006$), and 0.26 SD lower short term memory scores ($SE = 0.11$, $p = 0.018$). However, while the coefficients for the interaction of household expenditures and the treatment are positive, they are not statistically significant. As with

education, the sum of the initial disadvantage for the poorest households and the treatment is not significantly different than that of their peers. Alternate bivariate classification for below median expenditures, as well as a continuous variable of the logarithm of expenditures give similar results (Supplemental Table 1).

Discussion

The morning snack appears to provide an important nutritional nudge to improve the cognitive development of at-risk children, particularly in the domains of short-term memory and fluid reasoning. In the absence of the snack, children from disadvantaged households had significantly lower test scores (Table 4). Breakfast consumption in our study population was also low, about half of children (52%) did not have breakfast at home on the morning of the testing. There was significant, but small, amount of substitution of the snack for breakfast at home in the treatment arm (48% had breakfast at home vs 56% in the control group, $p=0.015$). However, there were no differences in breakfast consumption or substitution effect between more and less disadvantaged households.

The trial found that although the provision of a morning snack to preschoolers did not have a significant effect on average fluid intelligence, test scores did increase among children whose mothers had comparatively less education (Figure 2). Test scores also increased for children from low expenditure households, although not significantly in a combined interaction model. Low expenditure in this case is relative to the average in the three regions, which is itself about 30% lower than the national average. The larger impact on households with low socioeconomic status is in keeping with the general literature (Aldolphus et al., 2016). It is also consistent with recent large-scale school meal program in Ghana, which also had only modest impact on learning and cognitive processing on average but had much larger impacts for low-income students (Aurino et

al., forthcoming). Children who were in the control group schools and also in either of these two subgroups performed less well on average on the tests that were administered. This implies that when a morning snack is provided it can offset some of preexisting differences in cognitive skills. This then reinforces another role of school meals, that of increasing equity (Bakhshinyan et al., 2019).

Plausibly, such an increased capacity for learning for these preschool students will close gaps in a broader range of cognitive skills and lead to increased acquisition of knowledge over time. That is, improved fluid intelligence may lead to improved crystallized intelligence and preschool readiness over the school year. The school day for preschool children begins around 9:00 AM and ends after lunch at about noon. The school lunch, then, cannot provide the same support to classroom alertness that the snack can provide.

In one important dimension the snack increased a preexisting gap. Girls in the control tested higher than boys in the domain of short-term memory. While the gender specific impact of processing speed was not significant at conventional levels, the joint contribution of preexisting different and the program impact was significant at $p < 0.01$. This was also the case for WPPSI-IV scores overall.

The current trial employed randomization to identify the causal impact, but it did not conduct a baseline to utilize differences in differences. For this reason, the adjusted differences assist in controlling for any preexisting differences in the communities. An additional limitation is that we were not able to collect precise data to confirm if the children in the study did in fact eat their snack; rather, we conducted intent to treat analyses that examine program effects based on group assignment. Finally, an aspect of this intervention that is both a strength and limitation is the implementation of the program by schools. In many school meal programs in LMICs, commodities

are provided to students by an NGO or other agency outside the ministry of education. In contrast, in the current study, schools were provided with funds and a list of approved foods from which they could choose; this promoted greater dietary diversity and program sustainability although it also increased variability in the treatment between schools.

In summary, our study found positive effects of adding a morning snack to a school lunch program on the fluid intelligence of preschoolers from households with lower socioeconomic status. Our findings highlight the importance of providing a morning meal for at risk preschoolers and the need for such a program, as half of children did not have breakfast at home; a school lunch program is insufficient to address hunger in morning. Our findings may inform policy makers, national organizations and not-for-profits organization who are seeking methods to create cost-conscious and effective programs to support the educational achievement of at-risk children.

References

- About, F. E. (2006). Evaluation of an early childhood preschool program in rural Bangladesh. *Early Childhood Research Quarterly, 21*(1), 46–60.
- Adelman, S., Alderman, H., Gilligan, D.O., & Lehrer, K. (2008). The impact of alternative food for education programs on learning achievement and cognitive development in northern Uganda. Retrieved from: <https://economics.ca/2008/papers/0465.pdf>
- Adolphus, K., Lawton, C. L., Champ, C. L., & Dye, L. (2016). The effects of breakfast and breakfast composition on cognition in children and adolescents: a systematic review. *Advances in Nutrition, 7*(3), 590S-612S.
- Alderman, H., Bundy, D. (2012). School feeding programs and development: are we framing the question correctly? *The World Bank Research Observer, 27*(2), 204–221.
- Alfonso, V. C., Flanagan, D. P., & Radwan, S. (2005). The impact of the Cattell-Horn-Carroll theory on test development and interpretation of cognitive and academic abilities in D.P. Flanagan (Ed), *Contemporary Intellectual Assessment: Theories, Tests, and Issues*, 2nd edition (pp 185-202), The Guilford Press.
- Aurino, E., Gelli, A., Adamba, C., Osei-Akoto, I., & Alderman, H. (2021). Food for thought? Experimental evidence on the learning impacts of a large-scale school feeding program in Ghana. *Journal of Human Resources*. Forthcoming.
- Bakhshinyan, E., Molinas L., & Alderman H. (2019). Assessing poverty alleviation through social protection: school meals and family benefits in a middle-income country. *Global Food Security, 23*:205-211.
- Bracken, B. A. (2006). *The Bracken Basic Concept Scale Third Edition: Receptive* (BBCS: 3R). San Antonio, TX: Pearson.

- Bradbury, Bruce and Corak, Miles and Waldfogel, Jane and Washbrook, Elizabeth, (2011). *Inequality during the early years: child outcomes and readiness to learn in Australia, Canada, United Kingdom, and United States* (Discussion Paper No. 6120). Institute for Labor Economics [IZA]. Retrieved from: <https://ssrn.com/abstract=1965137> .
- Diagne, A., Moustapha, L. O., Sokhna, O., & L Diallo, F. (2014). *Evaluation of the impact of school canteen programs on internal efficiency of schools, cognitive acquisitions and learning capacities of students in rural primary schools in Senegal* (Working Paper Series 2013-14). Partnership for Economic Policy [PEP]. Retrieved from: <https://ssrn.com/abstract=3167973> or <http://dx.doi.org/10.2139/ssrn.3167973>
- Driscoll, K., & Pianta, R. C. (2011). Mothers' and fathers' perceptions of conflict and closeness in parent-child relationships during early childhood. *Journal of Early Childhood and Infant Psychology*, (7), 1-24.
- Evans, J. J., Floyd, R. G., McGrew, K. S., & Leforgee, M. H. (2002). The relations between measures of Cattell-Horn-Carroll (CHC) cognitive abilities and reading achievement during childhood and adolescence. *School Psychology Review*, 31(2), 246-262.
- Fernald, L. C., Prado, E., Kariger, P., & Raikes, A. (2017). *A toolkit for measuring early childhood development in low and middle-income countries*. Washington, D.C.: World Bank Group. Retrieved from: <http://documents.worldbank.org/curated/en/384681513101293811/A-toolkit-for-measuring-early-childhood-development-in-low-and-middle-income-countries>
- Floyd, R. G., Evans, J. J., & McGrew, K. S. (2003). Relations between measures of Cattell-Horn-Carroll (CHC) cognitive abilities and mathematics achievement across the school-age years. *Psychology in the Schools*, 40(2), 155-171.

- Grantham-McGregor, S. (2005). Can the provision of breakfast benefit school performance? *Food and Nutrition Bulletin*, 26(2), S144–58.
- Greenhalgh, T., Kristjansson, E., & Robinson, V. (2007). Realist review to understand the efficacy of school feeding programmes. *BMJ*, 335(7625), 858-861.
- Gülgöz, S. and Kağıtçıbaşı, C. (2004). Intelligence and intelligence testing in Turkey in R.J. Sternburg (Ed), *International Handbook of Intelligence* (pp. 248-269). New York, NY: Cambridge University Press.
- Hamadani, J. D., Tofail, F., Hilaly, A., Huda, S. N., Engle, P., & Grantham-McGregor, S. M. (2010). Use of family care indicators and their relationship with child development in Bangladesh. *Journal of Health, Population, and Nutrition*, 28(1), 23.
- Hein, S., Tan, M., Rakhlin, N., Doyle, N., Hart, L., Macomber, D., ... & Grigorenko, E. L. (2017). Psychological and sociocultural adaptation of children adopted from Russia and their associations with pre-adoption risk factors and parenting. *Journal of Child and Family Studies*, 26(10), 2669-2680.
- Jacoby, E., Cueto, S., & Pollitt, E. (1996). Benefits of a school breakfast programme among Andean children in Huaraz, Peru. *Food and Nutrition Bulletin*, 17(1), 1-11.
- Jomaa, L. H., McDonnell, E., & Probart, C. (2011) School feeding programs in developing countries: impacts on children's health and educational outcomes. *Nutrition Reviews*, 69(2), 83-98.
- Kazianga, H., De Walque, D., & Alderman, H. (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.

- Kristjansson, B., Robinson, V., Petticrew, M., MacDonald, B., Krasevec, J., Janzen, L., & Shea, B. J. (2006). School feeding for improving the physical and psychosocial health of disadvantaged students. *Campbell Systematic Reviews*, 2(1), 1-189.
- McGrew, K. S. (2009). CHC theory and the human cognitive abilities project: Standing on the shoulders of the giants of psychometric intelligence research. *Intelligence*, 37(1), 1-10.
- McGrew, K. S., & Wendling, B. J. (2010). Cattell–Horn–Carroll cognitive-achievement relations: What we have learned from the past 20 years of research. *Psychology in the Schools*, 47(7), 651 – 675.
- Panter, J. E. and Bracken, B. A. (2009). Validity of the Bracken School Readiness Assessment for predicting first grade readiness. *Psychology in the Schools*, 46: 397-409.
- Pollitt, E., Cueto, S., & Jacoby, E. R. (1998). Fasting and cognition in well-and undernourished schoolchildren: a review of three experimental studies. *The American journal of clinical nutrition*, 67(4), 779S-784S.
- Pollitt, E., & Mathews, R. (1998). Breakfast and cognition: an integrative summary. *The American Journal of Clinical Nutrition*, 67(4), 804S-813S.
- Rampersaud, G. C., Pereira, M. A., Girard, B. L., Adams, J., & Metz, J. D. (2005). Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. *Journal of the American Dietetic Association*, 105(5), 743-760.
- Rasheed, M. A., Pham, S., Memon, U., Siyal, S., Obradović, J., & Yousafzai, A. K. (2018). Adaptation of the Wechsler Preschool and Primary Scale of Intelligence-III and lessons learned for evaluating intelligence in low-income settings. *International Journal of School & Educational Psychology*, 6(3), 197–207.

- Ruan-Iu, L., Pendergast, L. L., Rasheed, M., Tofail, F., Svensen, E., Maphula, A., ... Murray-Kolb, L. E. (2019). Assessing early childhood fluid reasoning in low- and middle-income nations: Validity of the Wechsler Preschool and Primary Scale of Intelligence across seven MAL-ED sites. *Journal of Psychoeducational Assessment*.
- Rubio-Codina, Marta, and Sally Grantham-McGregor. "Evolution of the wealth gap in child development and mediating pathways: Evidence from a longitudinal study in Bogota, Colombia." *Developmental science* 22, no. 5 (2019): e12810.
- Simeon, D. T., & Grantham-McGregor, S. (1989). Effects of missing breakfast on the cognitive functions of school children of differing nutritional status. *The American Journal of Clinical Nutrition*, 49(4), 646-653.
- Snilstveit, B., Stevenson, J., Phillips, D., Vojtkova, M., Gallagher, E., Schmidt, T., Jobse, H., Geelen, M., Grazia Pastorello, M., & Eyers, J. (2015). *Interventions for improving learning outcomes and access to education in low-and middle-income countries: a systematic review*. Oslo, Norway: The Campbell Collaboration.
- Snilstveit, B, Stevenson, J, Menon, R, Phillips, D, Gallagher, E, Geleen, M, Jobse, H, Schmidt, T and Jimenez, E, (2016). *The impact of education programmes on learning and school participation in low- and middle-income countries: a systematic review summary report* (3ie Systematic Review Summary 7). London: International Initiative for Impact Evaluation.
- StataCorp, L. P. (2016). Stata SE 14.2 for Windows 64-bit. College Station, TX: StataCorp.
- Statistical Committee of the Republic of Armenia (2016). *Armenian Integrated Living Conditions Survey anonymised microdata database (by households)*. Retrieved from: <https://www.armstat.am/en/?nid=205>.

- United Nations (2015). *Transforming our world: the 2030 agenda for sustainable development* (A/RES/70/1). Retrieved from:
<https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf>
- Wechsler, D. (2012). *Wechsler Preschool and Primary Scale of Intelligence–Fourth Edition*. San Antonio, TX: The Psychological Corporation.
- World Food Programme (WFP), 2021, State of School Feeding Worldwide 2020. World Food Programme, Rome.
- World Food Programme (WFP). (2018a). *National strategic review of food security and nutrition in Armenia*. Retrieved from: <https://www.wfp.org/publications/armenia-strategic-review>
- World Food Programme (WFP). (2018b). *Armenia Annual Country Report*. Retrieved from: <https://docs.wfp.org/api/documents/WFP-0000104220/download/>
- World Food Programme (WFP) (2018c). Inception report. *Impact Evaluation of The Nutrition-sensitive Aspect of the "Development of Sustainable School Feeding" Project in Armenia*.
- Worobey J., Worobey H.S. (1999). The impact of a two-year school breakfast program for preschool-aged children on their nutrient intake and pre-academic performance. *Child Study Journal*, 29(2):113.

Table 1. Descriptive statistics of the sample N=951

	Control (N=501)		Treatment (N=450)		F-Test (p-value)
	Mean	S.D.	Mean	S.D.	
Child Characteristics:					
Gender (female=1)	0.48	0.50	0.48	0.50	0.866
Age in months	63.63	4.19	63.80	4.02	0.541
Preschool (previous year, yes)	0.17	0.38	0.23	0.42	0.015
Absent from school (past week, yes)	0.20	0.40	0.23	0.42	0.304
Ate breakfast today (yes)	0.56	0.50	0.48	0.50	0.015
Parent Characteristics:					
Mother education (secondary or less)	0.50	0.50	0.55	0.50	0.199
Father education (secondary or less)	0.68	0.47	0.72	0.45	0.219
Mother is employed	0.21	0.41	0.16	0.37	0.076
Father is employed	0.68	0.47	0.76	0.43	0.004
Parent-child relationship (CPRS)					
Conflict (out of 40)	17.99	6.24	17.71	5.85	0.469
Closeness (out of 35)	30.96	3.01	30.60	3.19	0.072
Home learning environment					
Parental involvement (out of 6)	3.98	1.52	3.81	1.60	0.104
Children's books	4.10	6.64	5.18	5.62	0.007
Household Characteristics:					
Migration (any, past year)	0.46	0.50	0.50	0.50	0.162
Household size					
Number of adults	3.56	1.39	3.78	1.60	0.023
Number of children	1.48	1.15	1.58	1.29	0.174
Estimated expenditures [Armenian Dram in logarithms]	11.72	0.51	11.77	0.55	0.135
Family Benefits Program recipient	0.43	0.50	0.50	0.50	0.047
School Characteristics:					
Number of children tested	10.97	2.09	10.29	2.43	0.000
School quality indicator (BSRC) (out of 209)	78.20	8.99	76.29	10.41	0.003
Region					
Lori	0.30	0.46	0.24	0.43	0.429
Shirak	0.37	0.48	0.44	0.50	
Gegharkunik	0.34	0.47	0.32	0.47	

Note. Parent-child relationship was measured using the Child-Parent Relationship Scale. Family Care Indicators were used to measure parent engagement in stimulation activities (i.e., told stories, sang songs, read books, counted or drew, took child outside the home, played) in the prior three days. Expenditures were estimated from survey questions on household assets and the Armenian Integrated Living Conditions Survey. The Family Benefits Program is an Armenian social safety net program. The school quality indicator is the average raw score of the first six subtests of the Bracken Basic Concept Scale: 3rd edition- Receptive.

Table 2. Mean raw WPPSI-IV scores among grade 0 students (N = 951)

WPPSI-IV Sub-test	Mean	S.D.	Min	Max	No. Items	Cronbach's Alpha
Fluid Reasoning	11.91	6.16	0	33		
Matrix Reasoning	6.08	4.05	0	19	23	0.74
Picture Concepts	5.83	3.50	0	21	27	0.73
Processing Speed	43.64	15.96	0	98		
Bug Search	15.56	9.48	0	42	1	n.a.
Cancellation	28.08	9.25	0	57	2	n.a.
Short-Term Memory						
Picture Memory	10.19	3.98	0	23	29	0.80
Total WPPSI-IV Score	65.74	21.74	0	138		

Table 3. Effects of a school breakfast program on child cognition (n=951)

	Unadjusted			Adjusted		
	β	S.E.	p-value	β	S.E.	p-value
Processing Speed	0.07	0.08	0.364	0.07	0.08	0.367
Fluid Reasoning	0.06	0.08	0.411	0.06	0.08	0.434
Short Term Memory	0.08	0.07	0.271	0.08	0.07	0.233
Total WPPSI-IV Score	0.21	0.18	0.243	0.21	0.17	0.228

Note. Child cognition scores were measured using the Wechsler Preschool and Primary Scale of Intelligence, Fourth Edition (WPPSI-IV). Scores are age-adjusted z-scores with a mean of 0 and standard deviation of 10. All models are OLS regression using intent to treat analysis. Adjusted models include variables that were not balanced between the treatment and control group (preschool attendance in the previous year, father employment, number of children’s books, number of adults in the household, participation in the Armenian Family Benefit Program, number of children tested per school, and a school quality indicator using the average score of grade 1 students on the Bracken Basic Concept Scale- 3rd edition, receptive version. All models include region fixed effects and robust standard errors accounting for clustering at the school level.

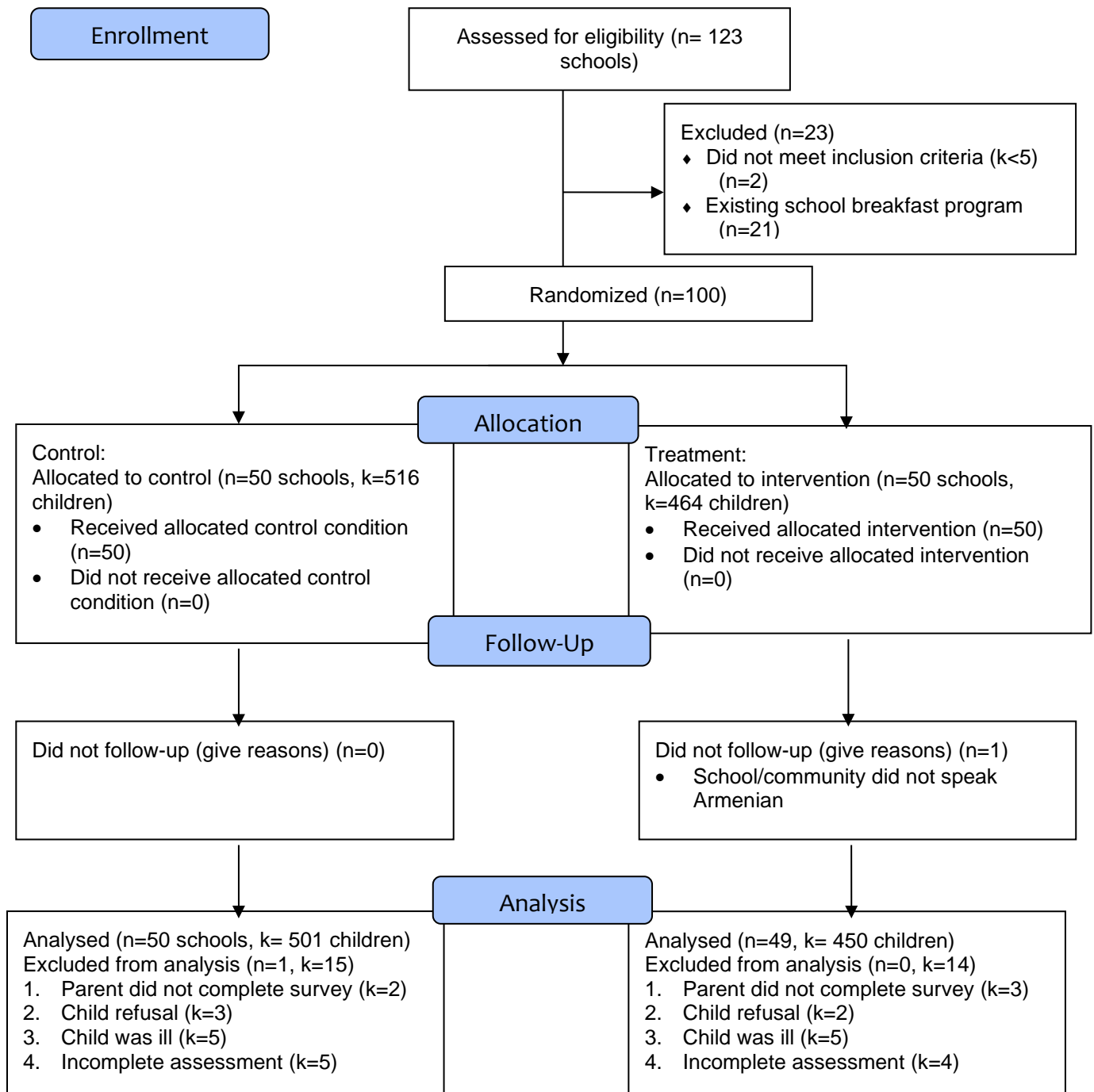
Table 4. Effect modifiers on WPPSI-IV scores adjusted for baseline covariates (n=951)

	Modifier			Interaction Effect			Total Effect of Modifier and interaction	
	β	S.E.	p	β	S.E.	p	F	P
Processing Speed								
Child is female	0.15	0.08	0.079	0.18	0.13	0.154	11.38	0.001
Mother completed secondary school or less	-0.31	0.09	0.001	0.17	0.14	0.229	1.68	0.198
Lowest household expenditures	-0.19	0.12	0.112	0.02	0.15	0.889	2.26	0.136
Fluid Reasoning								
Child is female	0.05	0.10	0.644	-0.06	0.14	0.699	0.01	0.923
Mother completed secondary school or less	-0.33	0.09	<0.001	0.23	0.15	0.116	0.71	0.403
Lowest household expenditures	-0.23	0.11	0.043	0.11	0.16	0.492	0.79	0.375
Short Term Memory								
Child is female	-0.003	0.10	0.979	0.27	0.13	0.039	9.64	0.003
Mother completed secondary school or less	-0.45	0.08	<0.001	0.31	0.11	0.009	2.56	0.113
Lowest household expenditures	-0.26	0.11	0.018	0.23	0.14	0.120	0.08	0.777
Total WPPSI-IV								
Child is a female	0.19	0.22	0.382	0.40	0.32	0.211	6.27	0.014

Mother completed secondary school or less	-1.09	0.18	<0.001	0.71	0.31	0.024	2.15	0.145
Lowest household expenditures	-0.67	0.24	0.006	0.36	0.35	0.314	1.17	0.283

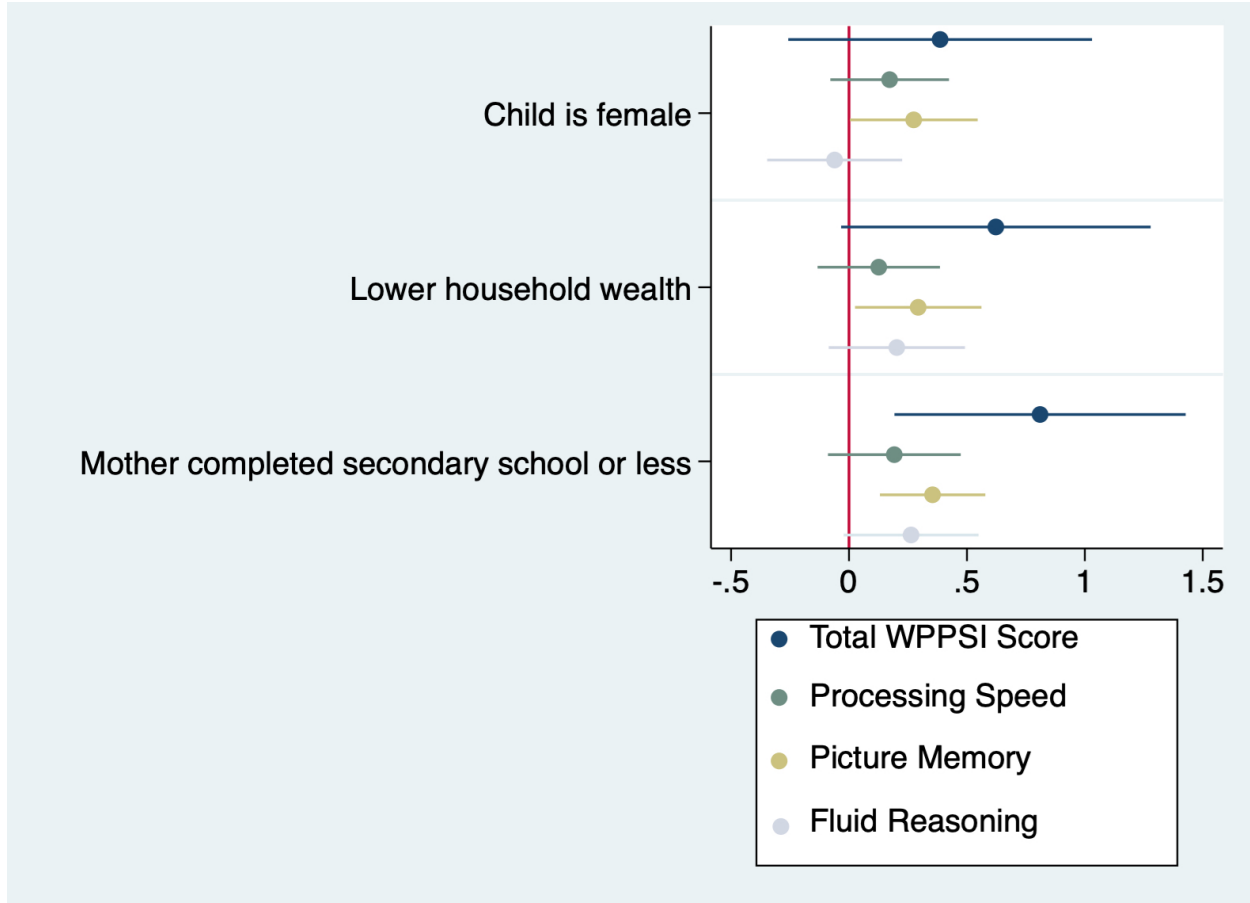
Note. Lowest household expenditures is the bottom 25th percentile of expected expenditures (Armenian Dram in logarithms). Child cognition scores were measured using the Wechsler Preschool and Primary Scale of Intelligence, fourth edition (WPPSI-IV). Scores are age-adjusted z-scores with a mean of 0 and standard deviation of 10. The total WPPSI-IV score is a summary score of five subtests across three domains (processing speed, fluid reasoning, and short-term memory). All models are intent to treat, and include variables that were not balanced at baseline between the treatment and control group (preschool attendance in the previous year, father employment, number of children’s books, number of adults in the household, participation in the Armenian Family Benefit program, number of children tested per school), and a school quality indicator using the average score of grade 1 students on the Bracken Basic Concept Scale- 3rd edition, receptive version. All models include region fixed effects and robust standard errors accounting for clustering at the school level. For each outcome, all interactions were examined in one adjusted model. Post-estimation Wald tests were used to test if the summed coefficients for each modifier is equal to 0.

Figure 1. Consort flow diagram



Note. Within each school allocated to treatment or control, up to 12 children per grade 0 class were randomly selected for assessment. If a class had fewer than 12 children, the entire class was assessed.

Figure 2. Effect modifiers of school breakfast on child cognition (WPPSI-IV) (n=951)



Note. Lowest household expenditures is the bottom 25th percentile of expected expenditures (Armenian Dram in logarithms). Child cognition scores were measured using the Wechsler Preschool and Primary Scale of Intelligence, fourth edition (WPPSI-IV). Scores are age-adjusted z-scores with a mean of 0 and standard deviation of 10. The total WPPSI-IV score is a summary score of five subtests across three domains (processing speed, fluid reasoning, and short term memory). All models are intent to treat, and include variables that were not balanced at baseline between the treatment and control group (preschool attendance in the previous year, father employment, number of children’s books, number of adults in the household, participation in the Armenian Family Benefit program, number of children tested per school, and a school quality indicator using the average score of grade 1 students on the Bracken Basic Concept Scale- 3rd edition, receptive version). All models include region fixed effects and robust standard errors accounting for clustering at the school level.

Supplemental Table 1: Robustness check of treatment interaction with household expenditures by variable construction (n=951)

	Lowest Quartile			Median Split			Continuous			Interaction Effect								
	Modifier		Interaction Effect	Modifier		Interaction Effect	Modifier		Interaction Effect	Modifier		Interaction Effect						
	β	S.E.		β	S.E.		β	S.E.		β	S.E.		p	S.E.	p			
Processing Speed	-0.19	0.12	n.s.	0.02	0.15	n.s.	-0.10	0.09	n.s.	0.05	0.13	n.s.	0.19	0.10	*	-0.05	0.12	n.s.
Fluid Reasoning	-0.23	0.11	**	0.11	0.14	n.s.	-0.10	0.11	n.s.	0.13	0.14	n.s.	0.22	0.10	**	-0.14	0.13	n.s.
Short Term Memory	-0.26	0.11	**	0.23	0.14	n.s.	-0.17	0.10	*	0.19	0.13	n.s.	0.25	0.11	**	-0.21	0.11	*
total WPPSI score	-0.67	0.24	***	0.36	0.35	n.s.	-0.36	0.24	n.s.	0.36	0.32	n.s.	0.67	0.25	***	-0.39	0.30	n.s.

Note. Household expenditures were estimated from survey questions on household assets and the Armenian Integrated Living Conditions Survey (Armenian Dram in logarithms). Lowest quartile is the bottom 25th percentile of expected expenditures. Median split is the bottom 50% of expected expenditures. Both lowest quartile and median split are compared to all higher expenditure percentiles. Continuous is measured as increasing log Armenian Drams. Child cognition scores were measured using the Wechsler Preschool and Primary Scale of Intelligence, fourth edition (WPPSI). Scores are age-adjusted z-scores with a mean of 0 and standard deviation of 10. The total WPPSI score is a summary score of five subtests across three domains (processing speed, fluid reasoning, and short-term memory). All models are intent to treat, and include variables that were not balanced at baseline between the treatment and control group (preschool attendance in the previous year, father employment, number of children’s books, number of adults in the household, participation in the Armenian Family Benefit program, number of children tested per school, and a school quality indicator using the average score of grade 1 students on the Bracken Basic Concept Scale- 3rd edition, receptive version). All models include region fixed effects and robust standard errors accounting for clustering at the school level, as well as interactions for child sex and mothers education. n.s. = not significant *p<0.1, **p<0.05, ***p<0.01

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