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EARLY STIMULATION AND NUTRITION: THE IMPACTS OF A SCALABLE INTERVENTION

By

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Early Stimulation and Nutrition: The Impacts of a Scalable Intervention[§]

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Abstract

This paper evaluates the effects of the implementation of a structured early stimulation curriculum combined with a nutritional intervention through public large-scale parenting support services for vulnerable families in rural Colombia, known as FAMI, using a clustered randomized controlled trial. We randomly assigned 87 towns in rural areas to treatment and control and 1,460 children younger than 1 year of age were assessed at baseline. The interventions were also complemented with training, supervision and coaching of FAMI program facilitators. We assessed program effects on children's nutritional status, and on cognitive and socio-emotional development; as well as on parental practices. The interventions had a positive and significant effect on a cognitive development factor based on the Bayley-III of 0.15 standard deviations. We also report a reduction of 5.8 percentage points in the fraction of children whose height-for-age is below -1 standard deviation. We do not find any effects on socio-emotional development. We report positive and statistically significant effects on the quality of the home environment (0.34 SD).

Key words: early childhood development, parenting, early stimulation, program scale-up

JEL codes: J13, I10, I20, H43.

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1. Introduction

Human capital underpins basic outcomes in the life of individuals, including career, marriage and even intergenerational outcomes (Becker, 1964). However, the process of human capital development is particularly problematic amongst deprived populations: individuals from low income environments typically underachieve in education and in their subsequent careers, are more prone to ill health, have shorter life spans, and are more often involved in crime (Britto et al., 2017; Black et al., 2017). Moreover, poor individuals are more vulnerable and more likely to be exposed to many negative shocks. Delays in the process of human development may, in turn, lead to a vicious circle of poverty: the underachievement of individuals from deprived backgrounds leads to an intergenerational persistence of poverty. These issues are particularly salient in developing countries where many individuals might be exposed to these problems and where limited human development is likely to be linked to slow economic growth and therefore to the persistence of poverty.

It is now widely understood that the process of human capital development starts very early in the life cycle and that the first few years are crucially important because the brain is particularly malleable at that time (Cunha, Heckman, Lochner & Masterov, 2006; Engle et al., 2007; Heckman, 2006; Yoshikawa et al., 2013), and what happens in the early years has important long run consequences (Almond and Currie, 2011). It is thus important to consider policies that promote human capital development from very early on. Well-designed interventions targeted at appropriate ages and populations may be crucial in promoting human development and breaking the intergenerational cycle of poverty. Such interventions may have to address both nutritional needs and psychosocial stimulation. Understanding how to design policies to improve the human capital of children is even more urgent in developing countries where high levels of poverty are prevalent.

Over the last couple of decades, the scientific evidence on the determinants of early childhood development (ECD), the types of interventions that improve it and the populations that most benefit from them, has advanced significantly (Britto et al., 2017; Black et al., 2017). And yet, the evidence on scalable policies is limited and they are often found or perceived to be ineffective, in part because they do not address effectively some of the central issues, namely that developmental deficits accumulate very early, possibly as a result of unstimulating environments. For example, the curriculum of the Indian Integrated Child Development Service program addresses (nominally at least) stimulation needs only for children three to five, while the component targeted to younger children focuses on free rice

and occasionally iron supplementation. If we have learned anything from several efficacy trials is that very early stimulation is key to human capital development.[1]

The effectiveness of *scalable* interventions that can be deployed given the available financial and human resources as well as the existing institutional structure and which, therefore, can form the basis of a realistic policy structure is not well explored, and certainly not in developing countries. And even in developed countries, such as the US or the UK, where there is evidence on the effectiveness of early years intensive interventions in generating long term impacts, such as the Perry Preschool Program (Belfield et al., 2006; Heckman et al., 2010, 2013) and the Abecedarian program (Campbell et al., 2012, 2014; Ramey et al., 1989), the evidence on programs at scale is still limited and inconclusive. Some important large interventions, such as Head Start in the US and Sure Start in the UK, both aimed at improving the process of human capital formation in the early years among poor families, have been implemented and evaluated. The results on their impact have been, however, mixed, although, in some cases, promising for deprived sub-populations (Bitler, Hoynes and Domina, 2014; Kline and Walters, 2016; Carneiro and Ginja, 2014; Melhuish et al., 2008). Similarly, while the evidence on the long run impacts from a small and intensive early stimulation and nutritional trial in Jamaica is very strong (Walker et al., 2005, 2006 and 2011, Gertler et al., 2014), evidence on its scalable version is limited (Attanasio et al., 2014).

In this paper, we address the question of whether it is possible to improve the development of children in poor communities with a scalable intervention to provide structured parent support and early stimulation as well as nutritional supplementation. Our starting point are existing studies (cited above) that show how intensive ECD interventions delivered through home visits can have large and long-lasting effects on human capital development. Using this knowledge, we designed, implemented and tested by a cluster randomized controlled trial a low-cost intervention, organized around an existing government program, and aiming to improve the quality of early childhood stimulation and nutrition in a scalable fashion. The fact that we used the infrastructure of a pre-existing government program and worked closely with the agency running it implies that our program can, almost by construction, be scaled up. Importantly it required only minimal extra human resources for training and supervision. The main question we are asking is whether offering better quality early stimulation and nutrition in poor environments through a scalable intervention can improve child human capital and ultimately mitigate the effects of poverty.

The *Family, Women and Infancy Program* (FAMI, for its acronym in Spanish), which is the program we build on, was first established in 1991 in Colombia. It aims at improving

[1] See the Lancet series on child development (2007, 2011, 2016).

pre-and postnatal services for vulnerable pregnant women and their new-born children up to age two. It is delivered through weekly group meetings and one monthly home visit. However, the program's operational guidelines are very vague and the actual content being delivered heavily relies on the initiative and creativity of the local women running it, known as FAMI mothers. In practice, the guidelines provide little structure or guidance to the FAMI mothers on how to offer effective and high-quality parenting support and early stimulation. One of the key research questions is precisely whether a structured curriculum provides the basis for high-quality ECD services in this environment, where low-skilled providers have little training and knowledge about ECD. In many ways this is possibly the most relevant question of broad interest because simple unstructured programs without any emphasis on stimulation can be found in many contexts. We answer the question as to whether it is important to introduce the structure that we do and to provide parenting support over and above such simple programs.

We use a curriculum inspired by the Jamaica home vising intervention model, currently known as *Reach Up and Learn* (Grantham-McGregor and Walker, 2015) but extensively adapted for use within the existing FAMI program, which is mainly delivered in weekly group sessions. Similar structured curricula have been successfully implemented in diverse settings such as Jamaica, Bangladesh and Colombia, India and Peru (see Grantham-McGregor and Smith (2016) for a review), using individual home visits.[2]

The importance of our study lies in showing that early stimulation and nutrition programs focusing on the youngest and poorest can form the basis of improved child development outcomes at very low cost. Our results are directly relevant for understanding the effectiveness of programs such as Head Start in the US and Sure Start in the UK but in a developing country context. In addition, we contribute directly to the literature on human capital formation through improvements in the quality of parenting programs.

To implement our program, we trained the FAMI mothers that run the existing program in the curriculum we developed. The fact that they are members of the community is another important aspect of this research. The success and in particular the sustainability of programs that aim at changing individual behavior, without necessarily providing beneficiaries with

[2] Attanasio et al. (2014) implemented a similar home visiting program in Colombia using the *Reach Up and Learn* curriculum suitably adapted to the Colombian context. Whilst the intervention was implemented at a larger scale than the original Jamaican study and used the infrastructure of an existing anti-poverty program for delivery, both these trials were tightly controlled and supervised by the research team and, what is more important, they were based on weekly one-hour one-to-one home sessions, which may limit their scalability. Similarly, Yousafzai et al. (2014) evaluate the integration of an early stimulation intervention into a community-based health service in 80 catchment areas in four districts in Pakistan. The authors use the Care for Development (UNICEF) curriculum and rely on *Reach Up and Learn* materials and play activities. After randomly allocating each one of the four districts in the study to treatment or control as a cluster, they report positive effects on cognitive and socio-emotional development.

additional resources, is likely to depend on community ownership and participation. Lastly, while the emphasis is on promoting early development through group sessions, the intervention also has a nutritional component and it also includes a home visiting component, as we describe in more detail below. The former can provide some important synergies to the operation of the program and an incentive to participation. The latter complements, in a novel way, group sessions with a more personalized intervention.

The FAMI improving intervention was randomly allocated across 87 towns in three of Colombia's 32 departments and lasted for an average of 10.4 months. We focus both on outcomes reflecting child development and on how parental investments in their children change as a result of the intervention. The intervention shows remarkable promise: it had positive and significant effects on overall child development as measured by the Bayley Scales of Infant and Toddler Development (0.15 SD, p-value=0.048). Importantly, we also report a reduction in the fraction of children whose height-for-age is below -1 SD (-0.058, p-value=0.098) and a corresponding increase in those with height between -1SD and 1 SD (0.068, p-value 0.046).[3] We also find that the impacts are considerably larger for the poorest beneficiaries. This evidence is consistent with the findings on other programs, such as those on Head Start in the US, reported by Bitler et al. (2014). Furthermore, as the intervention we study here aims to improve the quality of an existing program, the counterfactual is participation in the standard government program (or nothing if the child drops out of the program). Thus, similar to Kline and Walters (2016), who stress that the impact of Head Start is estimated relative to other child-care alternatives, we measure the impact of improving an existing program by changing its content and quality.

In addition to the main impacts, we present some suggestive evidence of the mechanisms through which the intervention achieves the impacts we estimate performing a mediation analysis, focusing, on parental investment, among other mediators. How the intervention changes parental behavior is important both for the long-run sustainability of the program and for understanding the channels through which the intervention yields the estimated impacts. We show that there was a large positive effect on the quality of the learning environment at home (0.34 SD, p-value=0.000), which indicates that parents are reinforcing the intervention with their own investments (crowding in). A simple mediation analysis seems to indicate that a large fraction of the program's impact is indeed explained by the change in parental behavior and investment.

Our paper has direct implications for the importance of safety net programs, such as Food Stamps in the US (see Hoynes et al., 2016), for child outcomes. These programs can

[3] The p-values we report are adjusted for multiple testing as explained in the main body of the paper.

improve nutrition for children by providing more resources to parents. We show that providing such nutritional supplementation directly (and in combination with child stimulation) can be an effective way of improving children's nutritional status, implying that parents do not crowd out these additional resources provided for the children, even when these are delivered for use at home, as in our case. The absence of (complete) crowding out is a key element for understanding whether such programs can work and the extent to which they do.

The rest of the paper is organized as follows. The next section describes the Colombian context in terms of ECD policy and the intervention we assess. Section 3 discusses the evaluation design and provides basic descriptive statistics. In Section 4, we present the empirical strategy and the main evaluation results. Finally, Section 5 concludes and discusses policy implications.

2. Background and Intervention

In this section, we describe the details of the pre-existing program on which our intervention operated and of the intervention itself.

2.1 Description of the existing parent support program

The FAMI program, run by the Colombian Family Welfare Agency *(ICBF* for its acronym in Spanish),[4] is aimed at supporting families during pregnancy, childbirth and early childhood with nutrition, health monitoring and childrearing. Beneficiaries are identified by their score in SISBEN, Colombia's proxy means test for the targeting of most social policies and based on household socio-economic characteristics. For the child stimulation component, which is our focus, the program is delivered through weekly group sessions of about two hours each, and one monthly home visit that lasts about an hour for parents of children 0-24 months of age. The program also delivers a nutritional supplement that corresponds to 22%-27% of the (monthly) recommended nutritional intake. The size of each FAMI unit varies between 12 and 15 beneficiaries. Of these, approximately 75% are parents of children 0-24 months of age and 25% are pregnant women.

The program is delivered by women in the community with a high school degree but no specific training on ECD, necessarily. More importantly, there is no national guideline for the content (i.e. curriculum) to be delivered during the group sessions or home visits, other than some general operational guidelines and broad learning standards.[5] The average cost of the FAMI program delivery is 310 US dollars (USD) per child per year (Bernal, 2013).

[4] The ICBF is a governmental agency that runs most government programs targeted to children in Colombia.
[5] This applies to all public ECD services in the country. The Board for Early Childhood has emphasized the principle of curricular freedom, and national standards are intentionally broad. Program providers are expected to adapt the learning standards to their own programs.

2.2 Description of the intervention

The enhancement to the existing FAMI program that we evaluate aims at improving its quality in a scalable fashion. The main idea is to introduce a structured curriculum, implementable at scale that offers precise guidelines to the facilitators who, at the beginning of the intervention, receive specific training on its delivery. The program consists of four complementary elements: (i) a structured early stimulation curriculum to improve child development; (ii) accompanying pedagogical materials such as books, puzzles and toys; (iii) itinerant training, supervision, and coaching for FAMI program facilitators; and (iv) a nutritional supplement that is larger and of better quality than the one that had been typically received by FAMI participants, along with nutrition education during group sessions and home visits, and other materials such as recipe books and cards with age appropriate nutrition messages.

The proposed curriculum is based on *Reach Up and Learn*, although it required extensive adjustment since the FAMI program is mostly delivered through group meetings and *Reach Up and Learn* was designed for home visit delivery. For example, the adapted curriculum includes several new components such as group discussions, additional language activities, activities for children aged birth to 6 months, and cards with nutrition information. It aims to support mothers to provide developmentally appropriate activities for their children (in particular, activities that promote language, cognitive and motor development), as well as reinforcing maternal knowledge about feeding and nutrition. The program also aims at training mothers in sensitive and responsive parenting and appropriate behavior management. The activities designed for the curriculum include 24 home visiting sessions and 20 group meeting sessions for children 6 to 24 months of age, and four additional group sessions for babies under 5 months. It is important to stress that the curriculum was designed to be delivered by facilitators without specific or specialized knowledge of child development. For this reason, it is purposefully quite prescriptive.

Although most of the program content was delivered through the weekly group sessions, the monthly home visits provided an opportunity to better tailor the activity to the developmental level of the child, and to introduce other, more difficult activities to handle in groups, additional language activities, and specific ideas on how to use daily home activities (care routines and household chores) to promote child development. The curriculum involved materials to be used during the sessions, including age-appropriate books, puzzles, home-made toys, pictures, construction blocks and nutrition cards. The cost of these materials was of about USD 27 (at the 2015-16 exchange rate) per child per year. The intervention also included sessions to teach mothers how to elaborate home-made toys with recyclable materials

that could be used to practice the activities proposed by the curriculum with children at home. This way, most mothers were able to set up a toy library for home use.

A team of nine tutors, with college degrees in psychology and social work, trained and supervised by the research team, trained the FAMI mothers in the intervention before it started. They also coached them continuously throughout its entire duration by means of on-the-job observations and feedback sessions, which took place approximately every 6 weeks.

Finally, the intervention also included a nutritional component, delivering a monthly nutritional supplement to FAMI participants. The nutritional supplement provided 35% of daily calorie intake requirements and 54% of daily protein intake requirements for pregnant women, breastfeeding mothers and children younger than 2 years of age each month. Its composition directly aimed at improving the height for age indicator, given the provision of high protein content, as well as, fats, vitamins and minerals. The cost of the package and delivery was USD 26 per month.[6]

The hypothesis that we test is whether these enhancements to the FAMI program had positive effects on children's development and maternal knowledge, maternal self-efficacy, and parental investments in children (or the quality of the home environment). Whether it did or not depends both on the design and the delivery of the program but also on how parents react to it. Specifically, the parents may crowd in resources and time if the program turns what used to be inaccessible goals for their children into realistic targets. On the other hand, they could redistribute resources amongst household members, leading to crowding out of household effort and resources by the program. Our data design will only estimate the overall effect. Appendix 1 provides greater detail on the curriculum, the intervention and its practical implementation.

3. Sampling design, descriptive statistics and implementation

The study took place between September 2014 and July 2016. The intervention itself was intended to operate for 15 months between the end of 2014 and March 2016. In practice, the total duration varied by community mainly to accommodate the initial training, lasting 45 weeks on average with a range of 34-58 weeks.

The study towns were located in three departments in central Colombia (Cundinamarca, Boyacá, and Santander). They were all chosen to have (i) less than 40,000 inhabitants, to avoid large urban centers; (ii) at least two FAMI units;[7] and (iii) no more than one unit of another

[6] The nutritional component was designed in collaboration with Fundación Éxito (FE). FE's main strategy, known as *Gen Cero,* is aimed at reducing the prevalence of stunting (13%) and risk of stunting, i.e., height for age between -2 and -1 SD (30%), among children younger than five.

[7] This requirement is associated with the power calculations for the trial, and to facilitate the logistics associated with training and coaching by tutors who had to travel across various towns.

public parenting program called *Modalidad Familiar* (MF), launched nationally in 2014.[8] Out of a population of 135 such towns we randomly drew 49 for the treatment group and 47 for the control. We further assigned the remaining 39 towns of our universe to a randomly ordered waiting list. When we realized that some towns had made the complete transition to the new MF program we dropped these towns and drew from this waiting list (whether in treatment or control). We could successfully replace 10 of the 19 towns that no longer ran the FAMI program. That yielded a final sample of 87 towns, with 46 in the treatment group and 41 in the control group.[9] Towns in the final sample had an average of four FAMI units (SD of 2.3, range between 1 and 13), which translates in a total of 171 FAMI units that received treatment and 169 FAMI units that remained as control. Appendix 3 includes the RCT flow chart showing how the final study towns were selected.[10]

The number of children per FAMI unit varied from one to 11, with a mean of 4.3 and SD of 1.9. Within each unit, we enrolled in the study all children under 12 months of age at baseline, leading to a sample of N=1,460 children (17 children per town on average). Overall, a total of 702 children in 171 FAMI units in 46 towns received the treatment; and there were 758 children in 169 FAMI units in 41 towns in the control group, which continued to receive the FAMI program as usual. At follow-up, we tried to reach all children in the study sample, regardless of whether they were still attending a FAMI or not, and regardless of the length of their exposure to FAMI.

3.1 Data and child developmental measures

Our experimental design defined a number of primary outcomes. These include measures of nutritional status—namely, externally standardized height-for-age Z-scores following World Health Organization (WHO) standards (WHO Multicentre Growth

[8] The MF is a public parenting program that was introduced during the first half of 2014. MF is similar to FAMI in that it serves beneficiaries through one monthly home visit and one weekly group meeting but: (1) it serves children 0-5 years of age while FAMI units serve children aged 0-2; (2) it has infrastructure for group meetings while FAMI uses other community spaces or the FAMI's own home; (3) serves, on average, 45 beneficiaries as compared to 15 in FAMI; (4) is led by a professional and an assistant, as compared to a single person who is not required to have a college degree in FAMI; (5) offers a nutritional supplement that is five times bigger than in FAMI; and (6) has access to a group of professionals including a psychologist and a nutritionist who support MF activities. The presence of MF is balanced between control and treatment samples, so that our RCT estimates the effect of enhancing the FAMI *in the presence of some MF*. In our sample, only 7% of the children left a FAMI to join the MF.

[9] The Figure in Appendix 2 shows the final distribution of treatment and control towns in the sample.

[10] Power calculations assumed program effects of 0.25 of a SD relative to the control on the Bayley, obtained using 4 FAMI units per town and 4 children aged 0-12 months of age per FAMI. We assumed an intra-class correlation within towns of 0.04 (in the Bayley-III scale and conditional on observables), as reported by Attanasio et al. (2014) for a similar study in Colombia that was implemented in towns with similar characteristics and targeted to the same population. This sample provided 95% power at the 5% significance level, allowing for an attrition rate of 10%.

Reference Study Group, 2006, 2007); cognitive, language and motor development, measured by the Bayley Scales of Infant and Toddler Development, third edition (Bayley, 2006); and socio-emotional development, as measured by the Ages and Stages Questionnaire: Socio-Emotional (ASQ:SE) (Squires, Bricker, and Twombly, 2009a). Height and weight were collected in both rounds, whereas developmental measures were only collected at follow up. We chose developmental tests that have been used extensively in evaluations of early care or education and/or have been recommended for developing countries (Fernald et al., 2017). These instruments were either available in Spanish, or had been previously translated, as had been used in Colombia before amongst similar populations. Further details on the measures used are provided in Appendix 4.

We always report age-standardized scores to deal with differences in scores across ages. For the analysis, we use internally age-standardized scores, where raw scores were standardized using the sample mean and SD calculated from weighted local smoothing regressions. Using internally standardized scores also allows us to examine each scale separately. In addition, we assume the existence of a unique cognitive factor that is measured with noise by the Bayley III subscales. We recover that factor by factor analyzing the internally age-standardized scores of the five scales. We call this the Bayley-III factor in what follows. To describe the study population in a more general context, we report the composite—or externally standardized—scores. These scores are obtained following the norms provided in the test manual, which use as a reference a population of US children[11] and hence might not be appropriate for Colombia.

We also collected detailed socio-economic information, including maternal vocabulary scores—a proxy for maternal IQ—measured by the Spanish version of the Peabody Picture Vocabulary (PPVT or TVIP, Padilla, Lugo & Dunn, 1986) and a number of other variables that speak to the mechanisms underlying the effects.[12] Specifically, we consider the quality of the home environment, maternal self-efficacy, maternal knowledge on child development, and food insecurity. We will discuss these in the empirical results section.

Finally, background information on FAMI mothers was collected directly from them in both rounds. In addition to basic socio-demographic characteristics, we also collected their vocabulary scores and knowledge on child development using the same tests as for mothers.

[11] The externally standardized scores have mean 100 and SD 15 in the reference population.

[12] Child assessments and anthropometric measures were collected by testers with degrees in psychology and health respectively, and the rest of the household survey variables were collected by interviewers. The household survey was collected prior to the child assessments.

3.2 Descriptive statistics

Table 1 shows some baseline characteristics by treatment status. At baseline, children were, on average, 5.6 months of age and in about 27% of the cases the father was absent from their household. Households had two children, on average; maternal average schooling was 8.6 years; and 23% of mothers were teenagers. In 2010, the teenage pregnancy rate was 21% nationwide and 30% for young girls living in households in the poorest income quintile.

Table 1. Sociodemographic characteristics of children and families at baseline by randomization status

	Treatment	Control	p-value	RW
Sociodemographic characteristics				
Child's age in months	5.72	5.51	0.353	0.976
	(3.39)	(3.26)		
Child's birth weight (gr)	3189	3156	0.442	0.981
	(572)	(500)		
Maternal age (number of years)	26.16	26.47	0.421	0.981
	(6.84)	(6.70)		
Maternal years of schooling	8.85	8.41	0.121	0.751
	(3.42)	(3.31)		
Household Income (COP thousands)	526.1	477.2	0.232	0.930
	(388.1)	(340.7)		
Household size	4.08	4.10	0.931	0.990
	(1.47)	(1.43)		
Maternal PPVT (raw score)	22.32	19.76	0.037**	0.379
	(8.53)	(8.08)		
Child's gender (% male)	51.9	50.9	0.729	0.990
First born (%)	46.6	45.1	0.648	0.990
Teenage mothers (%)	25.4	20.9	0.059*	0.567
Father present (%)	69.7	75.1	0.035**	0.379
Owns home (%)	37.1	39.6	0.623	0.990
Household in poverty (%) [a]	58.7	64	0.298	0.950
Intermediate outcomes				
FCI Home Environment Quality [b]	-0.03	0.03	0.625	0.866
	(0.96)	(1.02)		
Parental knowledge [c]	29.26	29.49	0.680	0.944
	(3.61)	(3.44)		
Maternal self-efficacy	26.50	26.49	0.974	0.977
	(5.51)	(4.67)		
Food insecurity (%)	50.4	41.9	0.222	0.520
No. of observations	700	756		

Note: ***p<0.01; **p<0.05; *p<0.1. Standard deviations in parentheses. RW: p-values adjusted for multiple testing using the Romano-Wolf (2005, 2016) step-down method. [a] % of households with total income below the poverty line in 2014 (USD 50 person/month). [b] First Principal Component of age-standardized FCI subscales. [c] Only available at follow-up (raw scores presented).

Average household income was COP 501 thousand per month (US 178) which represents 81% of the legal monthly minimum wage in 2014. Close to 70% of these households had answered the SISBEN survey for screening of social program eligibility—a good proxy for poverty—and 96% of those surveyed were deemed eligible for social programs (i.e., they scored in SISBEN levels 1 and 2). Similarly, 62% of households in the sample had a total income below the poverty line adjusted for household size. In 2014, the poverty rate was 42% in semi-urban and rural areas of Colombia.

In terms of the home learning environment, on average, these households owned 2.6 books, magazines or newspapers, 1.4 different varieties of play materials for young children in the household, and the adults report to have engaged in 2.5 different types of play activities with young children over the past 3 days[13]. Finally, close to 45% of households in the sample report to be food insecure. According to data available in the National Nutritional Status Survey (ENSIN for its acronym in Spanish, 2010), 42% of Colombian households reported to be food insecure by the same measure.

Comparing baseline characteristics, we find some statistically significant differences when we use standard single hypothesis p-values: the proportion of fathers living with the child is larger in the control group (75% vs. 70%) and maternal verbal raw scores by PPVT are higher in the treatment group (22.32 vs. 19.76 score points). On the other hand, stunting is lower in the treatment group than in the control group at baseline (9% vs. 14%) and the difference is statistically significant at 7.5%. However, once we adjust for multiple hypotheses testing using the Romano and Wolf (2005, 2016) step-down procedure none of these differences is significant.

In Table 2, we show averages for the baseline nutritional status of children. In particular, we report weight-for-age, height-for-age and height-for-weight z-scores. In addition, we report a variety of nutritional indicators by deficit or excess by international standards.

Stunting is 12% in the sample. For comparison, stunting was about 7.6% in urban areas in Colombia in 2013 (as measured in the Colombian Longitudinal Household Survey ELCA, 2013) and 14% in the lowest urban socio-economic groups (SES). Bernal et al. (2018) assessed the effects of another ECD national program using a sample of comparable children in urban areas of Colombia. In their sample, height for age is -1.03 SD compared with -0.11 SD in our sample, and stunting was 17% compared with 12% in our sample. The Table also shows that an additional 15% of children are at risk of stunting, i.e., children whose height-for-age is between -2 SD and -1 SD. These results indicate that children in this sample were

[13] Not shown in Table 1 but these correspond to subscales that make part of the FCI home environment.

not as developmentally vulnerable in terms of nutritional status as we would have expected for regions and households with considerable levels of poverty.

Table 2. Nutritional status of children at baseline by randomization status

	Treatment	Control	p-value	RW
Weight-for-age z-score	0.26	0.27	0.921	0.988
	(1.39)	(1.42)		
Length/height-for-age z-score	-0.01	-0.21	0.241	0.856
	(1.68)	(1.74)		
Weight-for-length z-score	0.37	0.55	0.167	0.829
	(1.59)	(1.65)		
Underweight (%)	6	5.1	0.423	0.936
Risk of underweight (%)	9	10.7	0.377	0.936
Wasting (%)	5.9	6.4	0.746	0.988
Risk of wasting (%)	10.6	8.2	0.159	0.829
Stunting (%)	9.2	13.9	0.075*	0.574
Risk of stunting (%)	14.7	15.5	0.791	0.988
Overweight (%)	9.9	9.2	0.691	0.988
Obesity (%)	4.8	7.3	0.165	0.829

Note: ***p<0.01; **p<0.05; *p<0.1. Standard deviations (clustered by town) in parenthesis. Adjusted p-values using the Romano-Wolf (2005, 2016) procedure (2,000 iterations, clustered by town) are included in the last column. All variables in the table are considered as one group of hypotheses. Underweight: weight-age < -2 SD; risk of underweight: weight-age between -1 and -2 SD; wasting: weight for height < -2 SD; risk of wasting: weight for height between -1 and -2 SD; stunting: height-age < -2 SD; risk of stunting: height-age between -1 and -2 SD; overweight: weight-height between 2 and 3 SD; obesity: weight-height > 3 SD.

In addition to nutritional status, we would want to characterize the status of this population in terms of cognitive and socio-emotional outcomes. Unfortunately, these variables were not measured at baseline, partly because the age of the children made some of these measurements difficult to obtain and because of funding limitations. Therefore, in Table 3, we report some statistics on cognitive, language and socio-emotional skills measured at follow up, at ages 17 to 33 months, in the control group to characterize the population.

As for the Bayley-III composite scores, we see that the average is 0.6 SD below the norming sample mean in both the cognition and language scales, and 0.4 SD below in the motor scale. We also observe that 18% of children score between -1 and -2 SD with respect to the norming sample in cognition, 23% in the case of language and 15% for motor development. Only about 2-3% would be considered at risk of developmental delay given that their composite scores are below -2SD.

For comparison, children between 18 and 36 months of age in Bogota (Colombia's capital) residing in households close to the mean of the income distribution, scored 0.08 SD below the norming sample in cognition, 0.1 SD below in language and 0.06 SD above in motor

development (Rubio-Codina et al., 2015). These results indicate that the children in our sample are significantly worse in these three dimensions when compared to children in better socio-economic conditions. Instead, they are similar to children in samples of comparable socio-economic conditions.

Table 3. Developmental outcomes of children in the control group at follow-up

	Mean	N
Bayley III		
Cognitive Composite Score	91.98 (13.07)	703
Language Composite Score	91.59 (12.31)	702
Motor Composite Score	93.97 (12.58)	701
ASQ:SE		
% of children at socio-emotional risk	0.23	705

Note: ***p<0.01; **p<0.05; *p<0.1. Standard errors clustered by town in parenthesis
Bayley III composites computed based on external standardization provided by test developers, the fraction of children at socio-emotional risk by ASQ is computed using the thresholds provided by the test developers (Squires et al., 2009b).

In terms of socio-emotional development, 23% of the children are at risk of developmental delay according to thresholds defined by the ASQ:SE using the test norming sample. For comparison, we know from the ELCA (2013) that 22% of children in low SES urban households were at risk of developmental delay by the same measure, 26% in high SES urban households and 19% in rural households in 2013.

Finally, in Appendix 5 we present basic characteristics of FAMI mothers by study group. On average, they are 42 years of age, have completed 13 years of education, and they have almost 12 years of work experience in the FAMI program. They have an average of 2.5 children of their own. There are no jointly significant differences between FAMI mothers in treatment and control towns.

3.3 Implementation and Compliance

During the period considered in the study, a family could have attended a total of 44 weekly group sessions and received 11 monthly home visits (if age-eligible throughout the period). In terms of effective attendance, 74% of all children in the treatment group assessed at follow-up participated in at least one FAMI activity during the intervention, while the rest did not attend at all; all children were however followed up for data collection, irrespective of

their attendance status.[14] In Appendix 6 (Figures a. and b.), we show the distribution of children in the intervention group by the duration of exposure to the pedagogical component of the program. Conditional on having attended at least one session, the median number of pedagogical activities attended was 28 out of a total of 55. Children with lower program attendance are older, less likely to live with their fathers, and have younger mothers. On the other hand, they also exhibit better learning environments at home.

The curriculum we introduced was intended to add both structure and content to the child sessions, progressing in difficulty as the child ages. In the control group, the FAMI mothers were not constrained or directed in how they should run the sessions. The FAMI mothers in the treatment group found the intervention to be substantially different to what was going on in the status quo: 57% report to have found the curriculum very different from their usual practice and 25% found it different. In particular, the issues that seem to be different with respect to how they had typically worked were: (i) practicing play activities with mothers and their children, (ii) practicing language activities with babies, (iii) making homemade toys with mothers, (iv) encouraging parents to play with their children at home, and (v) listening to parents about their achievements at home. Almost all of them (99%) reported that they would continue to use the proposed curriculum after the end of the project.

Regarding, the nutritional component of the intervention, close to 29% of children in the treatment group did not receive any nutritional supplements and those who received at least one, received on average, 9.8 (SD=3.6) supplements out of a maximum of 14. Compliance with both components of the program largely overlapped the same subsamples of children. In particular, 69% of children in the treatment group received at least one nutritional supplement and attended at least one session, 19% did not receive any nutritional supplements nor attended any sessions, 8% attended at least one session but did not receive any nutritional supplements and 4% received at least one supplement but never attended sessions (see Appendix 6, Figures c. and d.).

4. Empirical Strategy

For each outcome of interest, we estimate *Intent to Treat (ITT)* effects on children's development. To improve efficiency and take into account the minor baseline differences observed between treated and control towns, we control for various baseline variables and use the following regression:

[14] This information is available from attendance lists that FAMI providers collected as part of the supervision protocol of this intervention. Thus, the data is only available for participants in the treatment group.

$$Y_{isl,1} = \beta_o + \beta_1\ T_{sl} + \delta' X_{isl,0} + D_0\theta + F_{l,0}\sigma + Z_{isl,1}\rho + \varepsilon_{isl,1} \qquad (1)$$

where $Y_{isl,1}$ is an outcome of interest for child *i* in FAMI unit *s* in town *l* at follow-up (*t*=1); T_{lsl} is a dummy equal to 1 if the FAMI unit *s* in town *l* was in the treatment sample. $X_{isl,0}$ is a set of basic child and household characteristics at baseline, which includes the child's weight-for-age and height-for-age z-scores, child's age and gender, the household's wealth index, maternal PPVT scores and an indicator for adolescent mother;[15] D_0 are a set of department fixed effects. The vector $Z_{isl,1}$ represents a complete set of tester or interviewer dummies, and $\varepsilon_{isl,1}$ is the residual term. $F_{l,0}$ are a set of town level variables including dummies indicating the presence or not of the alternative parenting program MF and whether the town population size is above or below 10 thousand inhabitants (both included due to our stratified randomization procedure). The presence of alternative programs in the town does not bias our impact estimates as such incidence is independent of treatment allocation (it was decided by the government independently). Furthermore, even if the children that attend FAMI are systematically different from those that attend the alternative program, such selection occurred before treatment assignment.

To compute standard errors of the estimates, we cluster at the town level *l* (the unit of randomization). We exclude from the analyses a number of children whose measures were particularly extreme.[16] As we discuss below, we also consider heterogeneity of impacts by interacting the treatment indicator with relevant conditioning variables.

At baseline, we assessed 1,460 children and surveyed their households, and 340 FAMIs. The child attrition rate between baseline and follow-up was 8.6% (N=125) across treatment arms: 74 (10.5%) of the children from the treatment arm were not measured at follow-up and 51 (6.7%) from the control arm, the difference being significant at the 5% level.

In Appendix 7 we present an analysis of attrition. Children lost to follow-up were older, less likely to have a resident father at home, and more likely to have mothers with lower vocabulary (PPVT) scores. To address the possible bias introduced by non-random attrition, we jointly estimated the outcome equation (1) and a selection model into follow-up where we use interviewer dummies at baseline and interviewers assigned to the household at follow-up as exclusion restrictions. The identity of the interviewers (and presumably their quality) were a good predictor of attrition and, as they were allocated randomly across towns, they constitute

[15] Item non-response in baseline covariates is not correlated with treatment status. Thus, we imputed missing covariate values with the average of the non-missing observations and accounted for this imputation with a dummy variable in equation (1).

[16] 12 children who scored more than 3 SD below the mean on the Bayley-III cognitive scale (possible disability) and 15 children who were 6 SDs below the mean and 6 SD above the mean of height-for-age (extreme observations).

a valid instrument. As it turns out, the main impacts of interest, reported in Appendix 8, are not sensitive to this correction: attrition does not bias the results. We therefore report estimates that do not correct for attrition in the main text.

We also use the same specification of equation (1) to assess whether the intervention had positive effects on intermediate outcomes. All these instruments were also measured at baseline, so we can control for baseline intermediate outcomes in all cases.

In addition to the average impacts, we also analyze the possibility of heterogeneous impacts. We do this in two ways. First, we consider the entire distribution of the outcomes of interest in the treatment and control samples and test for differences in these distributions using the Anderson-Darling statistics (Anderson and Darling, 1952). Such a test is considered more powerful to detect differences in the tails of the distribution than the Kolmogorov-Smirnoff test (Engmann and Cousineau, 2011). Second, we re-estimate equation (1) for subgroups in the evaluation sample. In particular, we divide the sample by wealth, as measured by a wealth index, mother's education and gender.

5. Results

For most outcomes, we measure impacts in terms of standard deviations (SD) of the variable of interest in the control group. We also include the 95% confidence interval, the standard p-value for two-tailed null hypotheses and the Romano-Wolf stepdown p-values adjusted for multiple hypotheses testing for the specific groups of hypotheses presented in each table.[17]

5.1. Main Outcomes

In Table 4, we report average effects by intent to treat, regardless of whether children actually attended the program or how many times they attended, i.e., OLS estimates of equation (1). The measures we use are the Bayley-III factor for a summary measure of cognitive development, the ASQ:SE for socio-emotional outcomes and the height-for-age Z-score for nutritional status.

The effect of the program on the Bayley-III factor was 0.152 SD and it is statistically significant at the 5%, after adjusting for multiple hypotheses testing. We find no significant impact of the program on socio-emotional development or height-for-age Z-scores. Socio-emotional development makes part of the set of potential outcome variables as the program also aimed at training mothers in sensitive and responsive parenting and appropriate behavior management. While the program was quite intensive in cognitive stimulation through

[17] The Romano-Wolf procedure was performed using 2,500 iterations and clustering by town.

instruction and practice in site and at home, responsive parenting was only encouraged through messages and group discussions. This might explain the lack of effect on socio-emotional development. We discuss further the results on nutritional status below.

Table 4. Impact on children's outcomes

VARIABLE	Beta (95% CI)	P Value	RW P Value
Bayley-III Factor	0.152 (0.030,0.274)	0.016**	0.048**
ASQ:SE Total Score	0.060 (-0.067,0.187)	0.355	0.346
Height for age Z-Score	0.093 (-0.045,0.230)	0.190	0.330

Note: ***p<0.01; **p<0.05; *p<0.1; 95% confidence interval in parenthesis for two-tailed tests. Standard errors clustered by town; D = beta /SD (Controls). P values are computed using Romano-Wolf (2005, 2016) step-down procedure. We consider 3 hypotheses for children outcomes. Covariates included: gender, household wealth index, maternal PPVT score, teenage mother and BL weight-for-age and height-for-age Z-scores. Bayley III factor is the principal factor of the five age-standardized Bayley III scales. ASQ:SE total score is the age-standardized ASQ:SE score.

In terms of cognitive development, the intervention thus eliminated 25% of the deficit in development in the treatment population with respect to the reference population (the US). This is all the more remarkable if we take into account that the intervention lasted on average no more than 45 weeks and the attendance rate was quite low (just 75% attended any sessions). It also compares very favorably to impacts of nearly 0.21 SD obtained in Attanasio et al. (2014), which was a one-on-one home visiting program that lasted for 18 months – nearly 75% longer.

We can address the effect of non-compliance by an instrumental variables procedure, which in this case (where non-compliance is one sided) provides us with the effect of treatment on the treated. Specifically, we divide the ITT parameter by the effective participation rate in the intervention. There are many different ways of thinking of the intensity of the program: if we measure effective participation as the fraction of children who attended at least one pedagogical activity, which is 77.5%, then the TOT on the Bayley-III factor is 0.20 SD. If, instead, we measure effective participation as the fraction of children in the treatment group who attended at least the unconditional median number of sessions (i.e., 21 out of 55 total), which is 53.2%, the TOT on the Bayley-III factor is 0.29 SD. Finally, if we define effective participation as the fraction of children who attended the median number of pedagogical activities conditional on having attended at least one (i.e., 28 sessions), which is 38.6%, then

the TOT effect is 0.39 SD.[18] Thus, the potential effects are very large even for such a short intervention, delivered in groups. To realize such potential compliance, we would need to improve our understanding of the factors that drive attendance and whether parents miss-perceive the returns of the program in terms of child development. This is a key area of further research.

In Table 5, we look at the scales of the Bayley-III separately to study which dimensions of cognition are most affected by the intervention. We consider five scales: cognitive development, receptive and expressive language, and fine and gross motor development. The largest impact is in expressive language, followed by gross motor and then cognition and receptive language. Clearly, as we increase the number of outcomes, the power requirements implied by multiple hypotheses adjustments become more stringent. After correcting for multiple hypotheses testing, the expressive language scale remains the most significant (0.151 SD, p-value=0.065). This is another important result because expressive language has proven the hardest to affect; for example, Attanasio et al. (2014) find no effect on that dimension. Moreover, language is a key conduit for cognitive development and for learning (Bernal and Keane, 2011; Morgan et al., 2015).

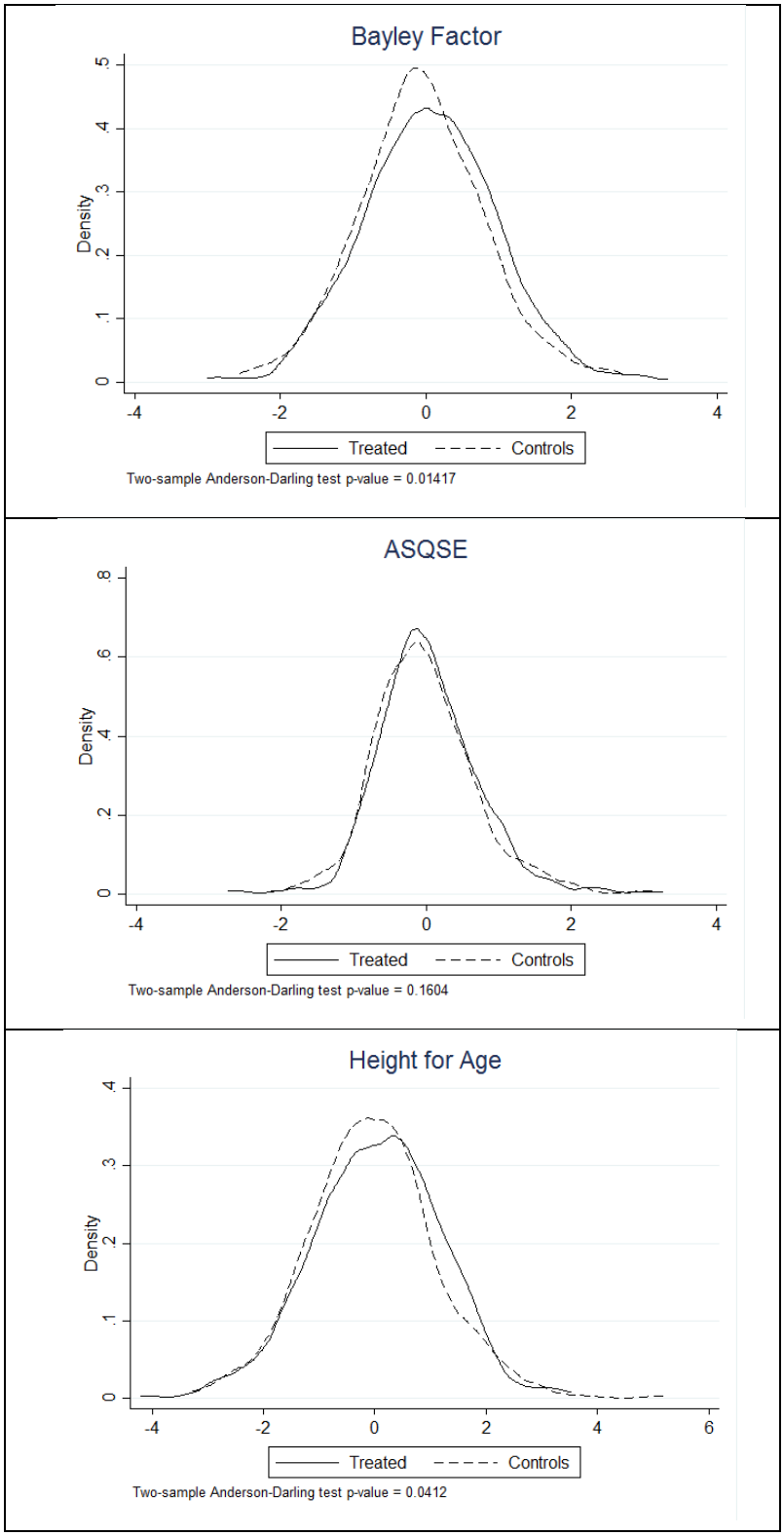
Table 5. Impact on children's development by Bayley-III scales

VARIABLE	Beta (95% CI)	P Value	RW P Value
Cognitive Scale	0.101 (-0.017,0.220)	0.098*	0.202
Receptive Language Scale	0.105 (-0.006,0.215)	0.066*	0.202
Expressive Language Scale	0.151 (0.031,0.271)	0.016**	0.065*
Fine Motor Scale	0.083 (-0.045,0.210)	0.206	0.202
Gross Motor Scale	0.142 (-0.009,0.293)	0.069*	0.202

Note: ***p<0.01; **p<0.05; *p<0.1; 95% confidence interval in parenthesis for two-tailed tests. Standard errors clustered by town. P values computed using Romano-Wolf (2005, 2016) step-down procedure consider 5 hypotheses for children development. Covariates included: gender, household wealth index, maternal PPVT score, teenage mother and BL weight for age and height for age Z-scores.

[18] There is an additional complication in estimating TOT effects from the ITT impacts we report. As we mentioned above, our estimate represents the impact of the improved FAMI relative to the existing FAMI, which is attended by the children in the control group. Presumably there are compliance problems in the control program on which, unfortunately, we do not have data. The TOT estimate we have discussed should be interpreted as the impact of a fully compliant improved FAMI over the existing FAMI in which compliance does not change.

Figure 2. Distribution of conditional outcomes by treatment status



Note: Plot of the distribution of the residuals resulting from a regression of outcomes on observed characteristics described in equation (1), for the treatment and the control samples separately.

In addition to the mean effects, it is useful to consider the entire distribution of outcomes. Figure 2 reports the distribution of the outcomes considered in Table 4 by study group. To obtain each figure, we first regress the outcome of interest on the control variables included in equation (1) and then plot the distribution of the residuals of this estimation for the treatment and the control samples separately. In the graph, we also report the p-value of the Anderson-Darling test for the null hypothesis of identical distributions by groups.[19] What is apparent from the graphs and the results of these tests is that the program had a significant impact on the entire distribution of the Bayley-III factor and no effect on socio-emotional development. In terms of height-for-age, the graph also depicts a difference in favor of the treatment group and the Anderson-Darling test has a p-value of 0.04.

As we saw in the descriptive analysis, 12% of the children in our sample are stunted (height-for-age < -2 SD) and 15% are at the risk of stunting (-2 SD < height-for-age < -1 SD). It is well-established that height at this age is a good indicator of long-term malnourishment and that malnourishment at this age can have long-run negative impacts on human capital development (Hoddinott et al., 2013). The program included a rather significant nutritional component, which, given the nature of our sample, could have both a short and long-term impact.

Table 6. Impacts on height-for-age by ranges of the distribution

VARIABLE n1=597, n0=674	Beta (95% CI)	P value	RW P value
Pr(Height-for-age between -5 SD and -1 SD)	-0.058 (-0.115,0.000)	0.054*	0.098*
Pr(Height-for-age between -1 SD and 1 SD)	0.068 (0.012,0.124)	0.020**	0.046**
Pr(Height-for age between 1 SD and 5 SD)	-0.011 (-0.035,0.014)	0.399	0.385

Note: ***p<0.01; **p<0.05; *p<0.1; 95% confidence interval in parenthesis for two-tailed tests. Standard errors clustered by town. P values are computed using Romano-Wolf (2005, 2016) step-down procedure. We consider 3 hypotheses for children development. Covariates included: gender, household wealth index, maternal PPVT score, teenage mother and BL weight for age and height for age Z-scores.

The results in Table 6, indicate that the fraction of children whose height-for-age is below -1 SD decreased by 5.8 percentage points or 0.13 SD, while the number of children with normal height increased by a similar fraction (6.8 percentage points). Both results are statistically significant even after adjusting the p-values for multiple testing. This result is

[19] The Anderson-Darling test focuses more on the tails of the distribution and has been shown to have greater power than alternative tests, such as the Kolmogorov-Smirnov test (Bennet, 2008), which focuses on first order dominance.

quite powerful as achieving impacts on height-for-age is generally difficult (Andrew et al., 2016; Bernal, 2015).

These results are associated with two important facts. First, the program combines the delivery of a nutritional supplement with nutrition education provided to parents during the program's pedagogical activities. In addition, participant mothers received printed materials with information regarding good nutritional practices at home, and recipe books specially designed for children in this age range. Second, the program is delivered during the first thousand days of life, which is a period of rapid growth and development. The nutritional supplement was specifically designed to take this fact into consideration. Finally, the results indicate that the nutritional supplementation was actually used by the parents for the subject children, at least to a reasonable extent. The typical concern with such programs is that they crowd out parental inputs (Jacoby, 2002). However, this result is a strong indication that the crowding out is at most partial and that a substantial part of the supplement "sticks" with the children.

5.2. Heterogeneous impacts

Given the overall strong impacts we now consider how these differ across key groups. This can help us understand whether the intervention helps the most vulnerable and from a policy perspective it helps improve targeting. We investigate whether the effects of the intervention on children's development vary by the child's gender, household wealth and maternal education at baseline. In looking at heterogeneous impacts, we focus on cognitive development[20] as measured by the Bayley-III factor.

For each of the three baseline variables we consider, we divide the sample in two groups: level of maternal education (less than high school versus more), gender and household wealth (above or below the sample median).[21] The results are reported in Table 7. The level of maternal education does not seem to affect the impact. Although the point estimates are larger for mothers with complete high school (0.18 SD v 0.12 SD), this difference is not significant. Turning to gender, the point estimates suggest that the intervention worked better for boys, but the differences are, again, not significantly different from zero.

However, we do find significant effects of wealth on the impacts, even after correcting for multiple testing, across all the six hypotheses considered jointly. The effects, at 0.22 SD, are estimated to be much stronger for children originating in poorer households. Moreover,

[20] No significant heterogeneous effects were found in the case of socio-emotional or nutritional outcomes.
[21] The wealth index is computed as the first principal component of a number of dwelling characteristics (such as the material of walls, floors and roofs, the number of bathrooms and rooms, access to utilities, etc.) and durable goods ownership.

the difference between the impact on children from poorer households and that on children from the higher wealth group is significant, with a p-value of 0.042.

Table 7. Heterogeneous impacts on the Bayley-III factor by child and household characteristics

Group (Number of observations)	ITT (RW-pvalue)	Estimated Difference (pvalue)
Maternal education ≥ complete high school (N=658)	0.18 (0.078)*	0.064 (0.568)
Maternal education < complete high school (N=632)	0.116 (0.439)	
Male (N=671)	0.209 (0.078)*	0.119 (0.272)
Female (N=619)	0.09 (0.439)	
Wealth index above the median (N=655)	0.011 (0.892)	-0.213 (0.042)**
Wealth index below the median (N=635)	0.224 (0.036)**	

***p<0.01; **p<0.05; *p<0.1. Standard errors clustered by town. Heterogeneous effects estimated by subsamples: Difference is a cross-model test for ITT associated parameter. Covariates included: gender, household wealth index (binary), maternal PPVT score, teenage mother and BL weight for age and height for age z-scores. P-values adjusted by Romano Wolf (2005, 2016) for 6 multiple hypotheses.

This result is key and contains both a positive and a negative message: the intervention can indeed improve the outcomes of the most deprived group in this already poor population. However, the better off children from this group are in no way "well-off" or middle class and neither do they measure up well in their development against, say even the Bogota middle class, never mind the international standards. Hence the intervention would need to improve for this group. These results generally highlight the difficulty with improving ECD programs for broad populations – targeting interventions to the needs of separate groups is likely to be important.

5.3. Effects on intermediate outcomes and mediation analysis

The intervention can be viewed as a transfer in kind. As such, it can affect the behavior of altruistic parents in other dimensions. Parents may reduce other forms of investment as a consequence of the transfer, therefore, mitigating or even neutralizing the effects of the intervention. In our case, the food supplement could be clawed back by reducing other food inputs to the subject child; and the additional stimulation of the target children could cause parents to switch attention to other children or to themselves, therefore mitigating the

intervention's impact. However, although this possibility has to be considered, we also notice that it may not be salient in our specific context. It is also possible that poor parents are not fully aware of the returns to investing in their children (Cunha et al., 2013; Attanasio et al., 2018) so that the effects of the intervention may have been generated by an increase in investment induced by a change in these beliefs. Moreover, the marginal return to parental investment may actually increase when the child is getting better early childhood programs. Exploring the mediating factors and the mechanisms underlying the effects we observed is a way of obtaining answers to some of these questions. Moreover, understanding the mechanisms through which the intervention had its effects is important to improving its design and targeting.

In Table 8, we present the effects of the program on a number of intermediate outcomes described in detail in Appendix 4. The quality of the home environment is a strong indicator of how much parents are investing in their children. To measure it, we combine information from the number of magazines, books or newspapers in the home, the number of toy sources, the number of varieties of play materials in the home and the number of play activities the child engaged in with adults. We extract the first principal component and age-standardize it.

The impact on this indicator was of 0.34 SD and statistically significant with a p-value of 0.[22] This is a very strong result and does indicate that the intervention induces parents to invest more in their children. However, we do not find any statistically significant program effects on maternal knowledge about child development, maternal self-efficacy or food insecurity.

Table 8. Program impacts on intermediate variables

VARIABLE	Beta (95% CI)	P Value	RW P Value
FCI Home Environment Quality (PCA)	0.338 (0.202,0.474)	0.000***	0.000***
Parental Knowledge (Raw Score)	-0.054 (-0.550,0.442)	0.831	0.836
Maternal Self-Efficacy (Raw Score)	0.126 (-0.348,0.599)	0.604	0.823
ELCSA Food Insecurity Status	-0.046 (-0.112,0.019)	0.169	0.399

Note: ***p<0.01; **p<0.05; *p<0.1; 95% confidence interval in parenthesis for two-tailed tests. OLS estimation; standard errors clustered by town; D = beta /SD (Controls). P values are computed using Romano-Wolf (2005, 2016) step-down procedure. We consider 4 hypotheses. Covariates Included: gender, household wealth index (binary), maternal PPVT score, teenage mother and BL outcome. FCI Home Environment Quality is the principal component of age-standardized FCI subscales.

[22] For comparison, Attanasio et al. (2013) report program effects of 0.5 SD on play materials and play activities with adults at home in the home visit intervention described in Attanasio et al. (2014).

Having documented the existence of impacts on intermediate outcomes, we perform a mediation analysis similar to Heckman, Pinto and Savelyev (2013). In particular, we consider a simple model of mediation that relates the outcome of interest, Y_{isl}, to an intermediate outcome, I_{isl}, in a linear fashion:

$$Y_{isl} = \alpha + \gamma I_{isl} + u_{isl} \quad (2)$$

where u_{isl} is a residual term which is crucially assumed to be independent of I_{isl}. Given the random nature of the trial, one can easily estimate the impact of the intervention on Y_{isl} and I_{isl} using regression (1), which we reproduce here omitting some of the control variables for simplicity:

$$W_{isl} = \beta_0^W + \beta_1^W T_{sl} + \varepsilon^W{}_{isl}; \quad \text{where } W = Y, I; \quad (3)$$

where T_{sl} is equal to 1 if FAMI *s* in town *l* is assigned to the treatment sample and 0 otherwise. If we consider equation (3) for Y_{isl}, by augmenting it in the following fashion:

$$Y_{isl} = \beta_0^Y + \tilde{\beta}_1^Y T_{sl} + \gamma I_{isl} + \varepsilon^Y{}_{isl}; \quad (4)$$

We can then test the hypothesis that the observed impact is generated by a change in I_{isl}, by comparing the estimates of $\tilde{\beta}_1^Y$ in equation (4) and β_1^Y in equation (3): if the former is significantly smaller (in absolute value) than the latter, it is an indication that part of the intervention impact on Y_{isl} is generated by the impact on I_{isl}. Of course, this procedure assumes the linearity of the relationship between I_{isl} and Y_{isl} and the fact that I_{isl} is exogenous relative to Y_{isl}. In Table 9, we present the results of this simple mediation analysis.

In particular, we report estimates of equation (4) to assess the relative importance of the different intermediate outcomes on the program impacts on the Bayley-III factor. The first column reproduces the baseline program impact. The following columns add, one at a time, each of the intermediate outcomes presented in Table 8. In addition, in the last column we add all the mediators considered at the same time.

The results seem to suggest that while all intermediate outcomes significantly explain children's cognitive outcomes, only the learning environment at home, as measured by UNICEF's FCI indicators, absorbs a large part of the program ITT effect. Taking this at face value implies that half the effect of the intervention operates through increasing the engagement with and investments of the parents in their children. The other half, at least in terms of point estimates is attributable to the direct effects of the intervention itself.

Table 9. Effects of the program and of intermediate outcomes on the Bayley-III factor

VARIABLES	Treatment effect regression	add FCI	add Knowledge	add Self-Efficacy	add Food-Insecurity	add all
ITT	0.1520**	0.0860	0.1545**	0.1504**	0.1433**	0.0837
	(0.0621)	(0.0626)	(0.0608)	(0.0616)	(0.0620)	(0.0617)
FCI Home Environment		0.1967***				0.1834***
		(0.0343)				(0.0338)
Parental Knowledge			0.0337***			0.0262***
			(0.0085)			(0.0083)
Maternal Self Efficacy				0.0213**		0.0157
				(0.0098)		(0.0096)
ELCSA Food Insecurity					-0.1673**	-0.1461**
					(0.0654)	(0.0648)
Observations	1,290	1,290	1,290	1,290	1,290	1,290
R-squared	0.2227	0.2461	0.2320	0.2259	0.2273	0.2582
F-test	21.14	17.38	21.05	22.88	23.27	16.26
Prob > F	0	0	0	0	0	0

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Covariates included: gender, household wealth index (binary), maternal PPVT score, teenage mother and BL weight for age and height for age z-scores.

We also note that the direct effect of the intervention, as measured by the first coefficient in the last column of Table 8, is not statistically different from zero. Of course, this result needs to be taken with some caution since parental involvement and all other mediating factors are potentially endogenous; dealing with this issue would require additional sources of exogenous variation affecting the mediators. Nevertheless, it is also important to note that the parents did increase inputs to children: this, together with the fact that this short intervention had such large impacts, implies that, if anything, parents reinforce the activities and there is no substantial crowding out.

6. Discussion and conclusions

Interventions that promote ECD, starting from birth, may well be the key to successful human capital policies, particularly in poor environments. However, the characteristics of such programs and their effectiveness at scale are not well understood. It is precisely in this field where the inputs from both economics and child development can prove crucial for our understanding.

In this study, we present results from an experiment where we designed a group-based parenting support and early stimulation intervention, combined with a nutritional intervention, and implemented it *within* the infrastructure of an existing parenting program targeted to the poorest in Colombia. Our intervention is based on a curriculum shown to be effective in altering the long-run cognitive trajectory of children from deprived environments (Walker et al., 2011; Gertler et al., 2014). The well-known effective parenting programs with rigorous evaluations are based on individual home visits (Grantham-McGregor et al. 1991; Olds et al., 1986a, 1986b and 1994) while the program we work with is mostly based on group sessions.

To the best of our knowledge, the evidence on the impacts of a quality enhancement based on the implementation of an early stimulation structured curriculum and a nutritional intervention, implemented within the context of a standard ECD government program at scale, is very limited. The fact that we find sizeable impacts is remarkable. The evidence we present also points to potentially large gains where they are most needed, namely among the poorest. The importance of these results is even more apparent if we consider the fact that compliance with the number of sessions actually attended by children and their caregivers was relatively low and the intervention was relatively short, at least in comparison with the most successful efficacy trials referred to in this study. And yet our program had an ITT effect of 15% of a SD and a treatment on the treated effect of up to 39% of a SD in cognitive development, driven by improved expressive language skills; and moreover, and a reduction in the fraction of children whose height-for-age is below -1 SD of 5.8 percentage points.

We should also stress some features of this particular study that makes us believe that the estimates reported here are lower bounds of the potential of this intervention. First, the control group had access to the basic program without the quality enhancement—unlike similar pilot studies in the literature in which the control group does not receive any intervention. Second, as we stressed, the average impact is a reflection of larger impacts for the children most in need and a small or null impact for the better off children. Third, and most importantly, given that the current program was implemented within an already existing public parenting program, it was not possible to fully control and enforce in its implementation all the elements that one might expect to have an impact on development.[23] In fact, the implementation of the intervention was far from smooth and faced various challenges. Examples of the problems encountered included the low duration of exposure to the program. The implementation problems we document in our context are common to many programs implemented at scale.

[23] FAMI mothers were strongly encouraged by ICBF to implement the curriculum and attend the study's training and coaching. However, they could decide not to use some or all of these elements, and they could continue to run their FAMI as usual with no practical consequence.

These issues suggest that implementing at scale interventions such as this one is challenging. On average, children attended about half the intended number of sessions and many never attended. Similarly, 70% of children who received at least one nutritional supplement received 9 out of a maximum of 14. The focus on the scalability of the intervention under analysis is one of the most salient facts of this study, reflecting the difficulties policy makers face when moving from small trials to larger studies with reduced control over what actually happens in the field. At the same time, our results indicate that, despite the implementation and scalability problems, the intervention had a sizeable effect on the children most in need. The key issue is whether those at most risk of low development are likely to drop out from the intervention.

Attanasio et al. (2014) study a home visiting intervention in Colombia targeted to a very similar population and in a similar although broader geographical area in central Colombia. Their estimated impact on the Bayley-III factor was 0.21 SD. The intervention studied in that paper lasted about 75% more time than the current one (18 months vs 10.4 months), can be considered more intensive since it consisted of weekly 1-hour individual home visits designed for the age of the specific child and the attendance by program participants was higher (effective home visits delivered were, on average, 81% of those intended). Moreover, the control of the research team over implementation fidelity was significantly higher than for the program studied in this paper, given that home visitors, whilst also being local women, were hired and paid directly by the study. The intervention studied here continued to be ran and funded by the government throughout the duration of the study. Finally, the control group in Attanasio et al. (2014) was not active, while in the current study received the 'unimproved' FAMI. Both interventions included a nutritional component. However, in Attanasio et al. (2014) this consisted of micronutrients and was shown to have no effect—all the impact of the program coming from the stimulation component. Here the nutritional intervention is more comprehensive, with a broad array of suitable food items and education about nutrition. Despite these differences, it is remarkable that a comparable effect was achieved with an intervention that was designed to strengthen an on-going program, whose duration was shorter than that based on home visits, that did not achieve a perfect level of compliance and that was cheaper than home visits.

This study offers important new evidence that quality low-cost enhancements of already existing programs, which leverage local low-skilled human resources, can be effective at scale. The intervention we have studied costs about $320 per year per child ($28 in pedagogical materials, $82 in supervision and $212 in additional nutritional supplementation) plus $12 one-off cost per child for FAMI pre-service training. The cost of the unenhanced FAMI program is about $310 per child per year. That means that the pedagogical enhancement

(excluding the nutritional supplement) corresponds to approximately 40% of the cost of the unenhanced version of the program. This is equivalent to 1.7 monthly minimum wages per child per year, or 2.5 monthly minimum wages per year including the nutritional supplement. For comparison, the cost per child per year in center-based child care in Colombia is approximately $1,100 or 4.4 monthly minimum wages per child per year. In sum, the evidence we have presented shows that it is possible to gradually improve the quality of nationwide programs at scale in a way that is affordable, while maintaining quality and with a reasonably sized impact on children's developmental outcomes.

These considerations make it clear that one of the most important findings of the current study is the characterization of the impacts of an intervention that can be developed at scale. For this reason, it is worth comparing its impacts and its cost to other interventions recently implemented in Colombia, which is what we do in Table 10.

Bernal (2015) studies the impact of vocational training of the women running the family nurseries considered. She reports a sizeable impact at a low cost per child. Bernal et al. (2018) consider the transfer of children from home-based daycare services offered in the provider's own home to large childcare centers and find virtually no impacts at a very large cost.[24] Finally, Andrew et al. (2016) study the impacts of (1) targeted pedagogical improvements to center-based care in large cities and (2) staffing of these centers with nutritionists and psychologists. The impacts are comparable to ours at a slightly higher cost for the pedagogical component. Incidentally, the hiring of professional personnel in centers had no effects on children's cognition.

This summary highlights the importance of enhancements to what is known in the specialized literature as process quality (such as the integration of a structured curriculum and improved interactions between caregivers and children supported by coaching and mentoring) with respect to changes and improvements in the so-called structural quality alone (such as infrastructure, as in Bernal et al., 2017; or staffing, as in the second intervention studied in Andrew et al., 2016). In particular, the former seems to have more cost-effective impacts with respect to the latter.

[24] The cost reported in the table corresponds to the difference in the cost per child/year in a childcare center and the cost in a family nursery.

Table 10. Costs and impacts of alternative quality enhancements of ECD programs in Colombia

Program	**Age of children at baseline**	**Cost child/yr** (USD)	**Impact** (SD of standardized scores)	**Duration of intervention** (months)	**Detailed result** Effect (SE or p-value)
Training paraprofessional care providers (Bernal, 2015)	6 months-5 years of age	101	0.25	12	+5.2 (2.65) score points for children 0-3 years of age on ASQ language scores, and +3.5 (2.0) score points for children 3+ years on Woodcock-Muñoz (WM) mathematical ability.
Transfer from home-based to center-based childcare (Bernal et al., 2018)	6 months-5 years of age	780	0.05	10-18	+0.05 (0.02) SD on nutrition factor, and -0.11 (0.05) SD on ASQ cognitive factor.
Targeted pedagogical improvements in center-based care (Andrew et al., 2016)	18-36 months of age	373	0.15	18	+0.15 (0.076) SD on cognition, language & school readiness (based on TVIP, WM cognition, Daberon and pencil tapping test)
Staffing of center-based care with professionals (Andrew et al., 2016)	18-36 months of age	150	0.1	18	Null effects on cognition. +0.1 (0.06) SD on height for age for children older than 30 months of age.
This study	0-12 months of age	320	0.15	10	+0.15 (p-value 0.048) on Bayley-III factor and -0.06 (p-value 0.09) reduction in risk of stunting.

Source: Own elaboration.

This study faced some limitations apart from the difficulties associated with offering the intervention at a large scale. On one hand, we restricted the study sample to a few regions in central Colombia because of their similarity in terms of cultures, customs and socioeconomic context. This would make the use of a single curriculum—and associated materials such as picture books—more feasible, which was particularly important given the ethnic and geographical diversity of Colombia. This implies that it is not clear that the curriculum used to improve FAMI, as currently designed, would be suitable for other regions of Colombia, specifically, for diverse communities such as those with afro-Colombians and indigenous populations—although it should (and could) be easily adapted.

On the other hand, it is possible that some developmental outcomes might have been collected with significant measurement error (particularly those that are reported by parents such as Ages and Stages for socio-emotional development), and that these specific measures lack enough sensitivity to measure the impacts of an intervention. Similarly, some intermediate outcomes are difficult to measure. For instance, maternal knowledge was collected using 10 items—some coming from a much longer instrument to measure knowledge of child development (McPhee, 1981)—and some developed by us and might have failed to capture the construct of interest. These second set of difficulties points to the importance to develop and implement richer measures of child development as well as of the drivers of development.

To conclude, our paper has shown that high quality ECD interventions are both a feasible and effective policy tool for developing countries and can form a key element of the policy toolkit for fighting poverty.

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Supplemental Materials.

Appendix 1. Detailed Description of the Interventions

The curriculum aims at assisting mothers to provide developmentally appropriate activities for their children (in particular, activities that promote language, cognitive, and motor development), as well as reinforcing maternal knowledge and practices about feeding and nutrition. In doing so, it aims at improving mothers' knowledge, practices, enjoyment in child up-bringing, and self-esteem. Given that the program is delivered mostly through group meetings and home visits, this intervention includes two complementary curricula. In both cases, the components, actions and activities used to promote better maternal child rearing practices are similar. These include making the mother the agent of change and empower her to improve her child's development, demonstrating the use of age-appropriate play materials and activities and providing opportunities to practice with them, and provide supportive feedback. The program also aims at training mothers in sensitive and responsive parenting and appropriate behavior management, and encouraging positive mother-child interactions and preventing child maltreatment.

Most of the program content was delivered through the group meetings as they were held on a weekly basis. In addition to being spaces where to demonstrate and practice the use of age-appropriate play materials and language activities, the groups provided opportunities for discussing and practicing effective child rearing skills and positive interactions with children with other caregivers, sharing experiences, group problem-solving, as well as opportunities for social support. Group meetings also provided the opportunity for mothers to discuss how play activities promoted children's development, and show them how to make simple toys so that each family could set up a toy library for home use. Group meetings were 1 hour long. An average of 5 mothers attend each session (min=1, max=15, SD=2.6).

The home visits were delivered monthly and provided the opportunity to introduce activities that were more difficult in the context of the group (such as puzzles and matching activities), additional language activities and specific ideas on how to use routine home activities to promote child development and identify materials in the home that could be used to promote child development. Home visits were, on average, one hour long.

Mothers were asked to attend one group meeting according to the age of their children. Separate group meetings were offered for pregnant and lactating women with children up to 6 months, mothers with children 6 to 11 months, and mothers with children aged 1-2 years. We expected mothers of children 6 to 24 months of age to attend four meetings per month and pregnant and lactating with children up to 6 months to attend two meetings per month. However, in practice, this did not always occur, and, in anticipation, the curriculum had been

designed so that it could be delivered to groups with children over the entire age range. Each group session is structured in six different moments: arrival and free play; feedback from the previous group session (10 minutes); song (5 minutes); demonstration and practice of age-appropriate play activity and language activity for the week with material that will be taken home (30 minutes); discussion around a parenting theme or activity (15 minutes); review of the session to ensure that mothers understand the activities and commitment to practice with children at home (10 minutes), and finally, they share a snack. If mothers cannot attend their group according to their children's age, then play and language activities are divided into age bands (birth-5 months, 6-11 months and 1-2 years). The themes for discussion during the group meetings include issues such as the importance of spending time playing with the child, praising the child, talking to the child, things to do at bath time or mealtimes, learning to trust, understanding the child's feelings, teaching the baby about her environment, and child behavior.

Similarly, each home visit consisted of i) greeting and discussion of any issues, ii) feedback from the previous home visiting session, iii) song, iv) introduction of new play and language activities (including how to integrate into everyday routines, v) nutrition message, and vi) a review of activities to be conducted over the next month.

The curriculum involves simple play materials to be used during home visits and in the group meeting, including books, pictures to talk about, home-made toys, puzzles and building blocks. The curriculum includes discussion topics or key parenting messages, age-appropriate activities to promote child development using the play materials, as well as everyday activities to encourage adult-child interactions. The curriculum also includes a set of nutrition cards relevant to the children's ages that are discussed with the mother during each home visit. The complete kit of materials has a cost of USD 27[25] per child per year.

In addition to the set of activities and materials, the qualification of the FAMI program also included a training and coaching component (pre- and in-service training) to support and maintain the quality of home visits and group meetings. Shifting away from a supervision model, the new approach consists of a team of tutors with degrees in psychology and social work, who provided the initial pre-service training and then continued to provide in-service training and support during the implementation period. Tutors trained and supervised by the research team, were in charge of training FAMI mothers. Training was provided sequentially by town. All FAMI mothers were trained simultaneously in a given town for an average of 3.5 weeks and 85 hours.[26] Towns with a larger number of FAMI units spent up to 170 hours of training in cases with more than 10 FAMI units per town. More specifically, towns with

[25] Computed at the average exchange rate 2015-2016.

[26] This was done in two stages: an initial stage of 2 weeks and a second stage of 1.5 on average two months later.

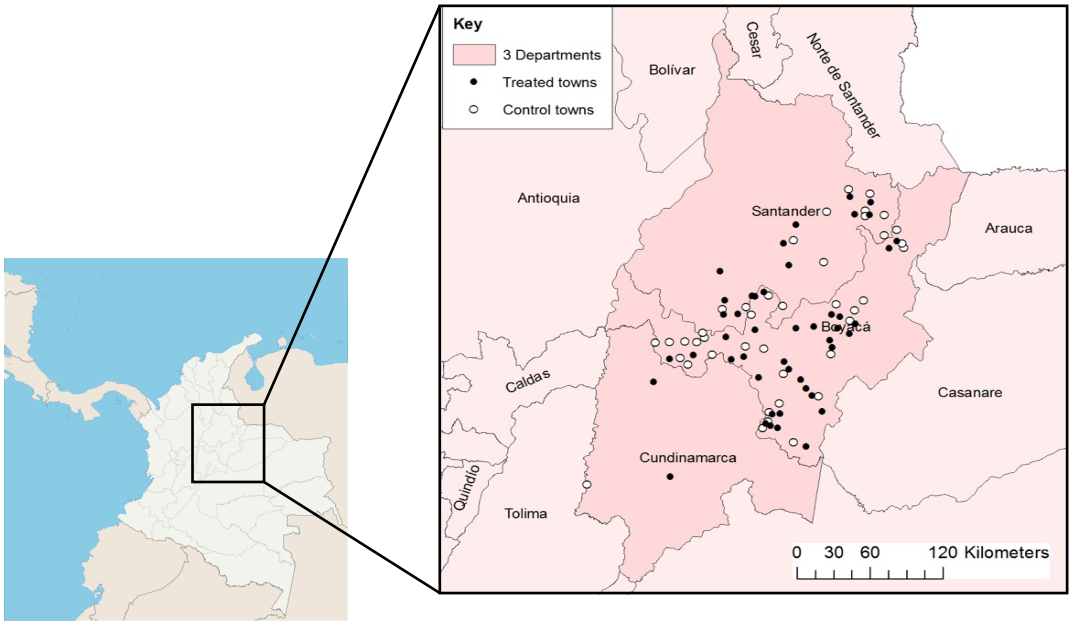
less than 5 FAMI units received 75 hours of training in 3 weeks, towns with 6 to 9 FAMI units were trained for 100-125 hours in 5-6 weeks and towns with more than 10 FAMI units received training during 150-175 hours offered during 6-7 weeks. The training involved demonstration, practice and feedback in running the group sessions and conducting the play and language activities with mothers and children, and training in how to make the toys. The one-time cost of pre-service training per FAMI provider was of about USD 113 or USD 11 per child.[27]

After training was finalized, tutors coached FAMI mothers continuously throughout the duration of the intervention. Tutors observed one group session and one home visit, and provided feedback to the FAMI, in each supervision round which took place approximately every 6 weeks. Each tutor was in charge of 5 towns and 19 FAMI mothers, on average. Whenever possible, they also facilitated a group meeting of FAMI mothers in each town to discuss and share positive experiences and challenges and engage in problem-solving. The tutors were supervised by an intervention supervisor (a member of the research team) who conducted visits with each tutor every 2 months. The cost of coaching was around USD 82 per month per FAMI provider or USD 8 per child per month.

In addition to the introduction of the early stimulation curriculum, the intervention also includes a nutritional component. It is comprised of the delivery of a monthly nutritional supplement to FAMI participants, and psychoeducation around feeding and nutrition during group meetings and home visits. The nutritional supplement corresponds to 35% of daily calorie intake requirements for pregnant women, breastfeeding mothers and children younger than 2 years of age (for 30 days). The cost of the package is USD 26 per month including shipping costs. It contains tuna, sardines, canola oil, and whole milk with iron supplement, beans and lentils. In terms of educational contents, we developed a cooking book that takes into account the socioeconomic characteristics of households in our sample, brochures used to handle and classify foods and 19 nutrition cards that are discussed with the mother during each home visit. Mothers receive a nutrition card relevant to their child's age at these monthly home visits. The topics covered include things like breastfeeding, bottle-feeding, breastmilk extraction and storage, weaning, hygiene, finger foods, menu ideas, mealtimes, and chatting while feeding.

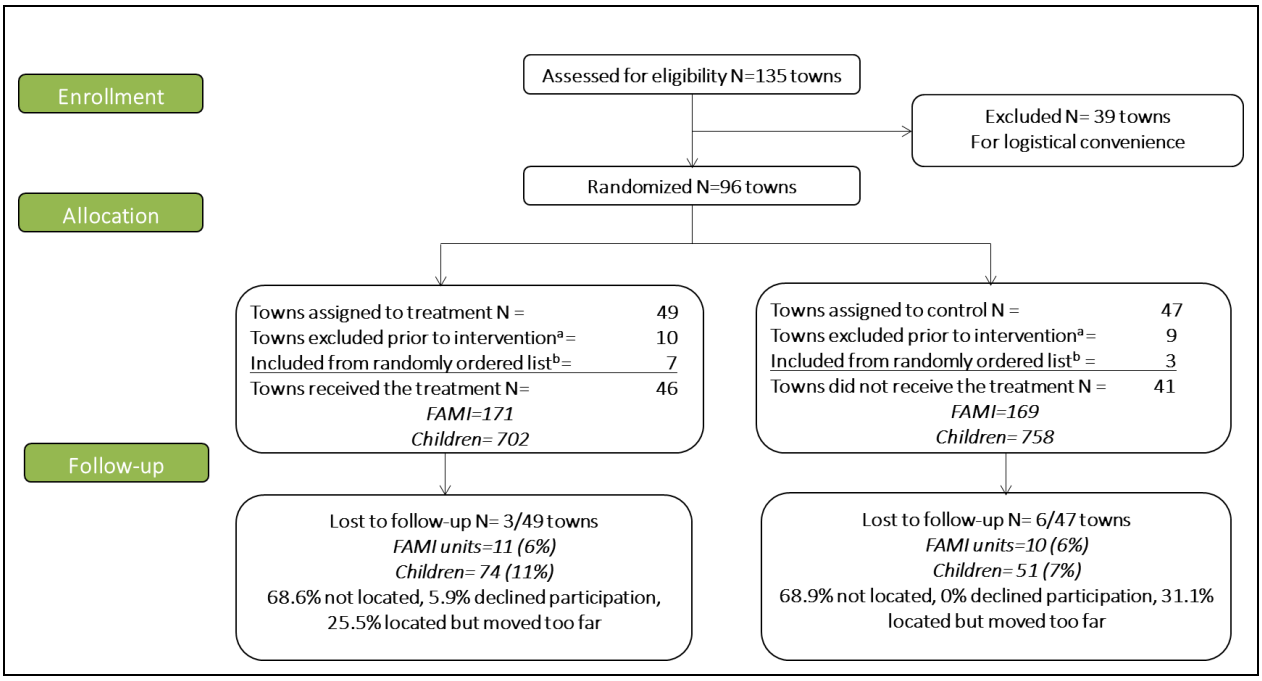
[27] Both computed at the average exchange rate 2015-2016 ($2,800 COP/USD).

Appendix 2. Geographic location of the sample



Note: Treated towns depicted in black and control towns depicted in white.

Appendix 3. The study's flow chart



Source: Consort Flow Chart. Own Elaboration

[a] Once in the field for data collection, we realized some towns did not have any FAMI units as they had made the transition to other public parenting programs (MF)

[b] Towns in the list of 39 towns excluded initially form the sample, were randomly ranked and used as replacements. However we did not have enough replacement towns in all randomization strata.

Appendix 4. Data and Measurements

The primary outcomes included in this study are the following.

Nutrition. In line with similar international studies (Walker et al., 2004; Fernald, Gertler, and Neufeld, 2008), we collected information on height and weight and computed externally standardized Z-scores following World Health Organization (WHO) standards (WHO Multicentre Growth Reference Study Group, 2006, 2007) for all children in our sample, both at baseline and follow-up.

Cognitive, language, and motor development. We used the Bayley Scales of Infant and Toddler Development, third edition (Bayley-III) (Bayley, 2006) at follow-up only. We administered the cognitive, receptive language, expressive language, fine motor, and gross motor scales, following standard procedures, in local community centers, and in the presence of the children's mother.

The Bayley-III scales were translated into Spanish, back translated to English to ensure accuracy, and piloted by testers.[28] Testers held degrees in psychology and had six weeks' training, including practice sessions with children of the target age groups. Inter-rater reliability (intra-cluster correlation) was above 0.9 on each scale of the test.

In the analysis, we use internally age-standardized scores, where raw scores have been standardized using the sample mean and SD calculated from weighted local smoothing regressions. Using internally standardized raw scores also allows us to examine each scale separately. We also constructed a Bayley-III factor score by factor analyzing the internally age-standardized scores of the five scales.

Socio-emotional development. To measure the socio-emotional domain, we used the Ages and Stages Questionnaire (ASQ:SE) (Squires, Bricker, and Twombly, 2009a) for all children at follow-up only. The ASQ:SE is a parent-completed assessment system for children ages 6 to 60 months completed through culturally sensitive questionnaires focusing on socio-emotional development and the identification of children at risk of social-emotional difficulties. It includes self-regulation, compliance, communication, adaptive functioning, autonomy, affect, and interactions with others. The ASQ:SE shows high levels of consistency, reliability, validity, and specificity (Squires et al., 2002; Squires, Bricker, and Twombly, 2009b), and has been used for early development assessments in low and middle low-income

[28] The Institute for Fiscal Studies had already translated the Bayley-III record forms and administration manual to Colombian Spanish in the context of a prior research study entitled "Early Childhood Development: Identifying Successful Interventions and the Mechanisms behind Them". Translation activities were carried out under the research translation license agreement between Pearson and the IFS, dated August 2009.

countries (Handal et al., 2007; Heo, Squires and Yovanoff, 2007). Given the relatively low education levels of the mothers, we administered it as an interview to the mother (caregiver). We report internally age-standardized total scores. It is important to note that the ASQ:SE is an instrument that screens for developmental risk and is traditionally not the best measure for assessing changes in children's behavior.

We did not collect any measures of child cognitive, language, motor or socio-emotional development at baseline.

In addition to primary outcomes, we consider intermediate outcomes that could have mediated the effect of the intervention on children's developmental outcomes. In particular, we focus on variables that measure the home environment, maternal self-efficacy, maternal knowledge about child development, and food insecurity. All these measures were collected by maternal report in the home (19%), in the FAMI (43%) or in a different community center, such as, the town's school, town hall or library (38%), both at baseline and at follow-up. We assessed the quality of the home environment using four age-standardized variables constructed from items in UNICEF's Family Care Indicators (Kariger et al, 2012): the number of magazines, books or newspapers in the home; the number of toy sources; the number of varieties of play materials in the home; and the number of varieties of play activities the child engaged in with an adult over the three days before the interview. These four indicators were then summarized in an individual factor using standard factor analysis.

We assessed maternal self-efficacy using the Self-efficacy in the Caregiver Role Test – Modified (Pedersen et al., 1989; Porter and Hsu, 2003), which evaluates feelings mothers could have while taking care of their children.

To measure maternal knowledge about child development, we used 10-items, some selected from the Knowledge of Infant Development Inventory (KIDI) (MacPhee, 1981), a much longer tool, and some developed by us. In the statistical analysis, we used raw total scores for both variables.

Finally, we measured food insecurity by using the ELCSA scale –Latin American Scale for the Measurement of Food Insecurity - which was validated in Colombia (ELCSA Scientific Committee, 2012) at baseline and follow-up. Total scores allow classification of households in four different levels of food insecurity: secure, mild insecurity, moderate insecurity and severe insecurity (Álvarez et. al, 2008). In the statistical analysis, we use an indicator for food insecurity which equals 1 if the household is food insecure (mild, moderate or severe) and 0 otherwise.

We collected household demographic and socio-economic status data both at baseline and follow-up. These included data on dwelling characteristics such as type of property, type of floors, roofs, and walls, number and type of bathrooms, access to public utilities,

availability of durable goods, characteristics of members of the household such as educational attainment, employment status and wages, ethnicity, participation in social programs, and household income by source. The socio-economic status score was computed as the principal component of a set of dichotomous variables that describe characteristics of the household, ownership of durable goods, and access to public utilities. A lower socio-economic status score is denoted by a negative factor and a higher status by a positive factor (Vyas and Kumaranayake, 2006).

Background information on FAMI mothers was collected directly from them in both rounds. Apart from basic sociodemographic characteristics, we also collected verbal ability by the Peabody Picture Vocabulary Test and knowledge on ECD based on the same 10-item inventory used for mothers.

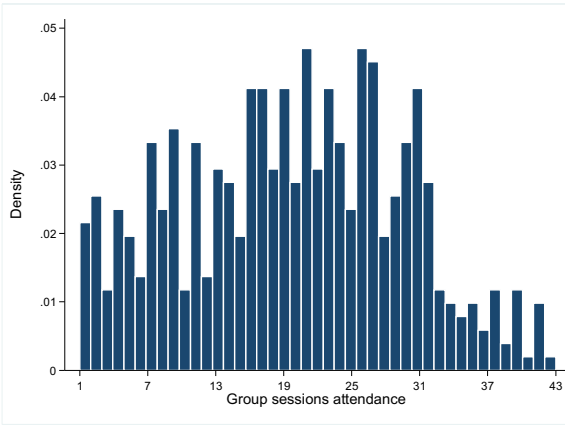
Appendix 5. Baseline characteristics of FAMI program facilitators by randomization status

	Treatment		Control			
Variables	Mean	SD	Mean	SD	p-value	RW
Age	41.80	(10.04)	41.40	(10.36)	0.790	0.998
Education (years)	13.30	(1.66)	13.00	(1.96)	0.379	0.992
Work experience (years)	11.70	(7.96)	11.90	(8.48)	0.856	0.998
Number of children	2.70	(1.35)	2.50	(1.50)	0.308	0.986
MC's household size	3.90	(1.48)	3.90	(1.43)	0.950	0.998
Number of children (0-12 months) attending	4.80	(2.06)	5.10	(2.29)	0.505	0.996
Number of pregnant women attending	1.80	(1.34)	1.90	(1.45)	0.588	0.997
Number of group sessions held last month	5.40	(4.50)	5.10	(3.39)	0.608	0.997
Number of home visits held last month	12.10	(6.66)	13.50	(7.12)	0.210	0.997
Hours devoted to planning activities (hours)	4.90	(3.02)	6.80	(6.92)	0.014**	0.195
Peabody Picture Vocabulary Test (Z-score)	0.16	(1.03)	-0.17	(0.94)	0.062*	0.610
Knowledge about ECD (Raw Score: correct)	7.29	(1.72)	7.11	(1.39)	0.384	0.992
Single, divorced or widowed (%)	24	-	21	-	0.555	0.997
No. of observations	171		169			

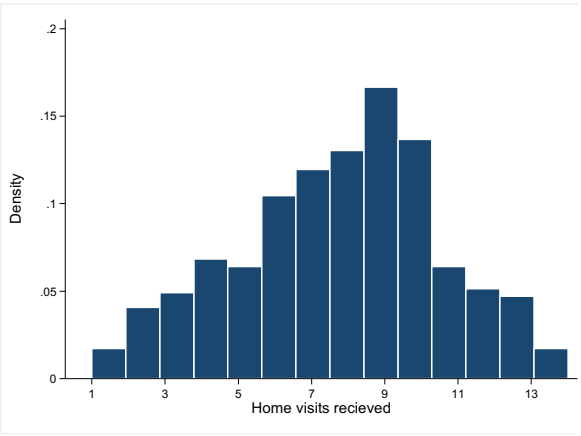
Note: ***p<0.01; **p<0.05; *p<0.1. Standard deviations clustered by town in parenthesis
Adjusted P-values using the Romano-Wolf (2005, 2016) procedure (2,000 iterations, clustered by town) are included in the last column. All variables in the table are considered as one group of hypotheses.

Appendix 6. Effective individual program participation

a. Attendance to group sessions

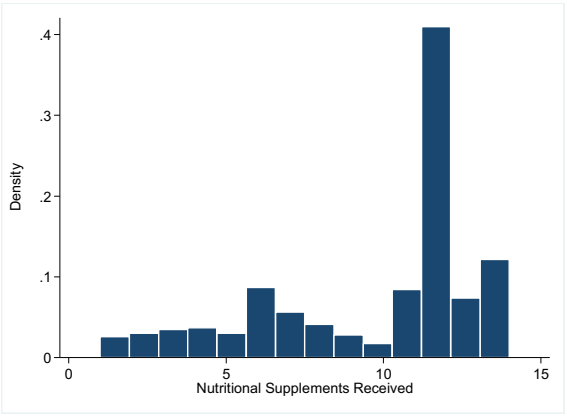


b. Attendance to group sessions

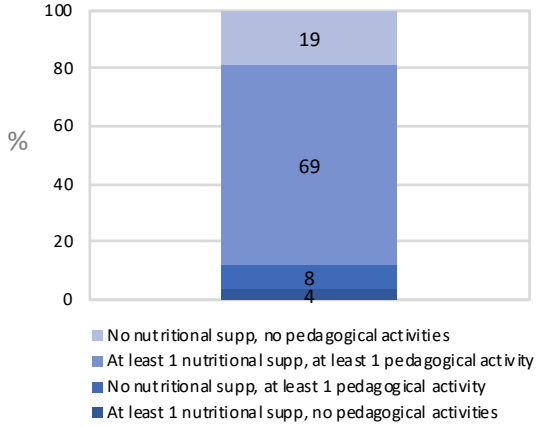


Source: Program attendance registry (recorded by FAMI facilitators)
Notes: a. Subsample of children registered at least once in group session attendance lists (74% of treated children found at follow-up). b. Subsample of children registered at least once in home visit attendance lists (72% of treated children found at follow-up)

c. Nutritional supplement



d. Joint compliance with the nutritional and pedagogical components



Source: Fundación Exito records.
Maximum nutritional supplements during the intervention period=14

Appendix 7. Attrition analysis

Explanatory variables	Dependent variable -> Lost at FU		
ITT	0.0383*	0.0401*	-0.0283
	(0.0213)	(0.0208)	(0.0462)
Age at BL (in months)		0.0159*	0.0139
		(0.0088)	(0.0092)
Age squared		-0.001	-0.0012
		(0.0008)	(0.0008)
Child Gender		-0.0176	
		(0.0127)	
First Born		0.0394**	0.0277
		(0.0165)	(0.0253)
High Household Wealth		-0.0279*	-0.0028
		(0.0148)	(0.0191)
Maternal Years of Education		-0.0011	
		(0.0026)	
Father is Present		-0.0450**	-0.0585**
		(0.0208)	(0.0269)
Household Size		-0.0094	
		(0.0066)	
Maternal PPVT		-0.0018	
		(0.0011)	
ITT * Age			0.0090**
			(0.0039)
ITT * First Born			0.04
			(0.0337)
ITT * High Household Wealth			-0.0524*
			(0.0284)
ITT * Father is Present			0.029
			(0.0411)
Constant	0.0675***	0.1408***	0.0718**
	(0.0116)	(0.0469)	(0.0344)
Observations	1,456	1,456	1,456
R-squared	0.0047	0.0334	0.0334
F-stat	3.229	2.908	3.281
Prob > F	0.076	0.004	0.001

Standard errors clustered by town in parenthesis
*** p<0.01, ** p<0.05, * p<0.1

Appendix 8. Program impacts on children's outcomes estimated by maximum likelihood correcting for self-selection into the follow up sample

VARIABLE	Beta (95% CI)	P Value	RW P Value
Bayley-III Factor	0.153 (0.032,0.274)	0.013**	0.038**
ASQ:SE Total Score	0.059 (-0.068,0.186)	0.365	0.403
Height for age Z-Score	0.083 (-0.053,0.218)	0.231	0.403

Note: ***p<0.01; **p<0.05; *p<0.1; 95%. Confidence interval in parenthesis for two-tailed tests. Standard errors clustered by town. P values are computed using Romano-Wolf (2005, 2016) step-down procedure. We consider 3 hypotheses for children outcomes. Exclusion restrictions: interviewer fixed effects at baseline and assigned interviewer fixed effects at follow-up. First stage F-stat=11.24. Bayley-III factor is the principal factor of the age-standardized Bayley III scales. ASQ:SE Total Score is the age-standardized ASQ:SE score.