Part I: Effects by Outcome

The effects of interventions on six domains—physical development, cognitive development, language development, socioemotional development, schooling outcomes, and employment and labor market outcomes—are commonly included in evaluations of early interventions targeting poor children because they are negatively affected by early poverty, are believed to benefit from early intervention, and contribute to well-being and adult productivity. Within each domain, outcomes measuring similar constructs were analyzed to simplify analysis and presentation. Evidence comes from 55 impact evaluations of 25 projects of 20 interventions types conducted in 22 countries.

Each chapter in Part I begins with a table of the outcomes reviewed in that chapter. The studies are organized by intervention type and then by age at evaluation, giving readers the opportunity to scan the data on each type of intervention within a domain and underscoring the emphasis of temporal trajectories this review. These tables of outcomes do not include all that are reported in the studies. Instead outcomes are included that have a sufficient number of comparable measures to draw conclusions. In some cases, outcomes with few measures were included because of their unique contributions. For example, the three studies that report on employment outcomes represent the entire body of evidence on post-early childhood employment effects from early childhood interventions.

Throughout the report, boxes are used to highlight well-known interventions or interventions for which there is a series of evaluations at progressing ages on the same subjects. These vignettes give more detailed information on the intervention itself as well as the outcomes across time and outcome domains. All of the interventions analyzed in this report are included in appendix A, which contains a brief description of the intervention, the relevant counterfactual, age at initiation, and age at evaluation. Finally, the numbered references in [brackets] used throughout this report correspond to the numbered list of studies that passed the inclusion criteria for quality, found in the References section.

Chapter 1: Physical Development—*There is no evidence of later-life effects on weight or mid-upper arm circumference, little evidence of an effect on head circumference, and the intervention types that appear to affect height do so inconsistently. The evidence on fine motor skill is too thin to draw firm conclusions.*

Chapter 2: Cognitive Development—*Cognitive development is improved by a range of interventions, and most improvements are seen in measures of general cognition. Nutritional programs had almost no effect.*

Chapter 3: Language Development—*The evidence suggests that early childhood development interventions can have lasting effects on language, although the results were mixed within intervention types and within outcome subcategories.*

Chapter 4: Socioemotional Development—*Improvements in externalizing behavior may multiply as participants age; conditional cash transfers and early stimulation show fairly consistent benefits. It appears harder to create a sustained change in internalizing behavior.*

Chapter 5: Schooling Outcomes—*Early stimulation, preschool, and conditional cash transfers seem most effective in improving schooling outcomes.*

Chapter 6: Employment and Labor Market Outcomes—*Early stimulation can improve labor outcomes, but the evidence base for these outcomes is particularly thin.*

1. Physical Development

There is little evidence of later-life effects on weight, mid-upper-arm circumference, or head circumference, and the intervention types that appear to affect height do so inconsistently. The evidence surrounding fine motor skill is too thin to draw conclusions.

The physical health and nutritional status of young children are important determinants of future well-being and development. Children who do not grow well in the first few years or who experience early illnesses or stressful environments may be at risk for increased likelihood of chronic conditions that can impede normal, healthy functioning (Irwin and others 2007; Shonkoff, Boyce, and McEwen 2009). For malnutrition in particular, and its associated effect on weight and height, the first 1,000 days are key, with some experts positing that stunting occurring during that period is irreversible (Black and others 2008; Lake 2012; Shrimpton and others 2001; UNICEF 2013). Long-term consequences can also extend beyond a person's health. A systematic review of observational studies from low- and middle-income countries found that undernourished children grew into shorter adults and had less schooling and lower economic productivity (Victora and others 2008). Other reviews find that early childhood undernutrition can cause long-term cognitive deficits (Grantham-McGregor and Baker-Henningham 2005; Grantham-McGregor 1995; Mendez and Adair 1999).

Although undernutrition has long commanded the focus of maternal and child health experts, overweight and obesity have increasingly become problems in developing countries (Ebbeling, Pawlak, and Ludwig 2002; Prentice 2006; Bhutta and others 2013; Black and others 2013). The prevalence of both has risen among children under five years old and has been linked to immediate health issues such as high blood pressure and cholesterol as well as type-2 diabetes in adolescence and later-life chronic diseases (Ebbeling, Pawlak, and Ludwig 2002; Black and others 2013). As with growth restrictions, the first 1,000 days is very important for preventing excessive weight gain. Rapid weight gain during that time period is associated with adult lean mass, while weight gain in later childhood is more likely to lead to adult fat mass (Black and others 2013).

Recent multidisciplinary efforts underway that combine the talents and skills of pediatricians, geneticists, and neuroscientists are testing the capacity for early interventions to improve a child's current health status and long-term risk for disease (Shonkoff and others 2012b). There is some evidence of this already. For example, former participants of the Carolina Abecedarian Project in the United States, now in their mid-30s, show significantly lower risk factors for cardiovascular and metabolic diseases (Campbell and others 2014). These health benefits can begin to accrue immediately. There is evidence that Head Start, a U.S. preschool program, had improved the overall health status of three and four year olds when they reached kindergarten (HHS 2010), although physical outcomes were not the primary indicator of interest.

In low- and middle-income countries, nutritional supplementation led to better growth among children under five as did various conditional cash transfer programs (Grantham-McGregor and others 2014; Bhutta and others 2008). However, only a few of the interventions were again examined the post-early childhood period, when some of these benefits disappeared soon after the end of the intervention while others persisted (Grantham-McGregor and others 2014). These mixed results highlight the need for a more systematic review of the evidence concerning the sustained effect of early childhood development (ECD) interventions on physical outcomes.

Table 1.1 maps the 19 studies across 12 countries in this review that investigate physical outcomes. There are 13 different projects and 11 intervention types. Results are measured for six specific indicators: body mass index (BMI), BMI z-score (BMIZ), head circumference, height-for-age z-score (HAZ), mid-upper-arm circumference (MUAC), weight-for-age z-score (WAZ), and weight-for-height z-score (WHZ).

Across the impact evaluations that included physical outcomes, authors consistently focused on commonly used anthropometric measures: height, weight, MUAC, and head circumference. All are proxies of a child's nutritional status, although the final one is less relevant to later-life outcomes as head circumference usually stabilizes by five years old (Figueiras and others 2012) and is often not measured after two to three years old. Furthermore, as these outcomes are indicators of nutritional status and, more broadly, the functional correlates of physical health such as cognition, schooling and employment, their value is more instrumental than intrinsic. For example, decreased height is not in itself necessarily a problem, but it is nonetheless a valuable measure as it can signal an increased risk of negative outcomes such as morbidity, mortality, and impaired cognitive development (Black and others 2013).

Some studies used as outcomes the group differences in the actual value measured (for example, PROBIT in Belarus[24, 33] and maternal supplementation study in The Gambia[1, 20] looked at height differences in centimeters), while others used standardized (z) scores based on a reference population to determine intervention effects. The use of z-scores is often preferable as it allows for easy comparison across ages and populations. Since their publication in 2006, most studies have used the growth standards of the World Health Organization (WHO 2006). Many of these reviewed studies, which gathered data prior to 2006, used the National Center for Health Statistics growth standards (Hamill and others 1979).

Table 1.1. Impact Evaluations Investigating Physical Development

	Study	Country (Project)	Average Age at Intervention (Years)	Average Length of Exposure (Years)[c]	Age at Evaluation (Years)	Evaluated Intervention	Reviewed Outcomes
Nutrition	Kramer and others 2007a [24]	Belarus (Promotion of Breastfeeding Intervention Trial [PROBIT])	0	1	6	breastfeeding promotion	BMI; head circumference*; height; MUAC
	Martin and others 2013 [33]	Belarus (Promotion of Breastfeeding Intervention Trial [PROBIT])	0	1	11	breastfeeding promotion	BMI; head circumference; height; MUAC
	Stewart and others 2009a [45]	Nepal (maternal nutritional supplementation)	in utero	0.75	6–8	vitamins, micronutrients, or fortified food for pregnant women (folic acid, iron, and zinc)	height (folic acid+iron+zinc)*; height (folic acid, folic acid+iron, multiple micronutrient)
	Stewart and others 2009b [46]	Nepal (maternal nutritional supplementation)	in utero	0.75	6–8	vitamins, micronutrients, or fortified food for pregnant women (folic acid, iron, and zinc)	BMI (folic acid, folic acid+iron, folic acid+iron+zinc, multiple micronutrient)
	Devacumar and others 2014 [15]	Nepal (maternal multivitamin supplementation)	in utero	0.17	8.5	vitamins, micronutrients, or fortified food for pregnant women (multivitamin supplement)	BMIZ; HAZ; head circumference; height; MUAC; WAZ; weight (z-scores based on WHO standards)
	Hawkesworth and others 2008 [20]	Gambia, The (maternal supplementation)	in utero	0.5 (DR1)	11–17	vitamins, micronutrients, or fortified food for pregnant women (protein biscuits)	BMI; height***; weight
	Hawkesworth and others 2011 [22]	Gambia, The (maternal supplementation)	in utero	0.5 (DR1)	11–17	vitamins, micronutrients, or fortified food for pregnant women (protein biscuits)	BMI
	Alderman and others 2014 [1]	Gambia, The (maternal supplementation)	in utero	0.5 (DR1)	16–22	vitamins, micronutrients, or fortified food for pregnant women (protein biscuits)	height
	Walker and others 1996 [50][a]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	7–8	supplementary feeding	HAZ; WAZ (z-scores based on NCHS standards)
	Walker and others 2000 [51][a]	Jamaica	1.55	2	11–12	supplementary feeding	BMI; HAZ (z-scores based on NCHS standards)

		(stimulation and supplementation to stunted children)					
	Pongcharoen 2010 [38]	Thailand (micronutrient supplementation to children)	0.5	0.5	9	micronutrients and fortified food for children (iron and/or zinc supplementation)	BMIZ; HAZ*; MUAC; WAZ (z-scores based on WHO standards)
Early Learning/Childcare	Martínez, Naudeau, and Pereira 2012 [35]	Mozambique (preschool)	3.45	1.5	5–9	quality early childhood and preprimary program	fine motor skills*; HAZ; WAZ (no information given on reference population used for calculating the z-score)
	Walker and others 1996 [50][a]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	7–8	stimulation	HAZ; WAZ (z-scores based on NCHS standards)
	Levin and others 2014 [29]	Romania (Bucharest Early Intervention Project)	1.88	2.7	8	stimulation (foster care)	motor skills
	Walker and others 2000 [51][a]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	11–12	stimulation	BMI; HAZ (z-scores based on NCHS standards)
Health	Barham 2012 [5][b]	Bangladesh (Matlab)	NA	continuous	8–14	well child visits	HAZ** (normalized using comparison areas means and standard deviation)
	Ozier 2013 [36]	Kenya (primary school deworming project)	0	1	8–15	deworming	HAZ; height (z-scores based on WHO standards)
	Barham 2012 [5][b]	Bangladesh (Matlab)	NA	continuous	15–19	family planning	HAZ (normalized using comparison areas means and standard deviation)
Social Protection	Behrman and others 2008 [8]	Mexico (Progresa)	1.5	1.5 (DR2)	7–11	CCT	BMIZ; height (z-scores based on WHO standards)
	Manley, Fernald, and Gertler 2012 [32]	Mexico (Progresa)	1	1.5 (DR2)	8–10	CCT—conditionalities	BMIZ; HAZ (z-scores based on WHO standards)
						CCT—cash	BMIZ; HAZ*** (z-scores based on WHO standards)
	Barham and others 2014 [6]	Nicaragua	in utero	3 (DR2)	10 (boys)	CCT	HAZ; WAZ (no information given on reference population

		(Red de Protección Social)					used for calculating the z-score)
	DSD, SASSA, and UNICEF 2012 [14]	South Africa (Child Support Grant)	1	2.5	10	unconditional or targeted income support	HAZ (no information given on reference population used for calculating the z-score)

Note: Bracketed numbers correspond to numbered studies in References. More details for each study are found in appendix A. BMI = body mass index; BMIZ = body mass index z-score; CCT = conditional cash transfer; DR = dose response; DSD = Department of Social Development; HAZ = Height-for-age z-score; MUAC = mid-upper arm circumference; NA = not applicable; NCHS = National Center for Health Statistics; SASSA = South African Social Security Agency; UNICEF = United Nations Children's Fund; WAZ = weight-for-age z-score; WHZ = weight-for-height z-score; WHO = World Health Organization.

a. Jamaica [50, 51] studies have a multiple intervention arm, and each intervention type has a separate row for these studies.

b. Bangladesh Matlab study [5] has "NA" on intervention age and length of exposure because of the nature of the family planning intervention.

c. DR in the length of exposure means the intervention period in terms of the dose response. DR is either randomized rotation (DR1) or phase-in (DR2). In terms of dose response, for instance, DR1 indicates that The Gambia study where treatment group receives protein biscuit only in utero whereas control group receives it only in postpartum, and length of exposure is the length of intervention for treatment. DR2 describes the dose response where early and late treatment effect is compared, and length of exposure is the difference of the intervention period between treatment and control group. "Continuous" indicates that the program effect could continue over time.

* Statistically significant at 10 percent.
** Statistically significant at 5 percent.
*** Statistically significant at 1 percent.

Box 1.1. Breastfeeding Promotion in Belarus Has Few Lasting Physical Benefits

Many ECD programs emphasize breastfeeding. However, because most of the evidence on breastfeeding benefits is based on studies that may have lacked adequate control of biases or confounding factors, some questions remain about the impact of breastfeeding on various medium to long-term child health outcomes (Kramer 2010). For instance, mothers who choose to breastfeed exclusively or for longer may differ in other ways in which they care for their children. One program carried out in Belarus was designed to examine the effects of breastfeeding promotion on children's well-being through cluster randomization. Between 1996 and 1997, 31 maternal hospitals and clinics were chosen as locations for the Promotion of Breastfeeding Intervention Trial (PROBIT), a 12-month intervention promoting breastfeeding among healthy mothers and full-term infants (Kramer and others 2001). The program involved community health workers facilitating breastfeeding and ongoing lactation, and providing postnatal support in the recipient clinics. Hospitals and clinics not assigned to the experimental intervention continued normal postnatal care practices. Unlike many other studies that problematically compare breastfed-only children to formula-fed (only) children, all mothers in both groups intended to breastfeed their children for at least some time (Kramer and others 2001).

The PROBIT program had several immediate impacts on breastfeeding behavior and child health outcomes (Kramer and others 2001). Mothers in the promotional program were more likely to be breastfeeding their infant at 3, 6, 9, and 12 months, compared with mothers attending health facilities following normal practices. These mothers were also more likely to exclusively breastfeed their babies in the first six months of age. Infants of participating mothers experienced less gastrointestinal infections and episodes of atopic eczema, although no significant difference was detected in the prevalence of respiratory tract infections.

Subsequent studies of the program evaluated the longer-term effects on physical health, nutritional status, socioemotional development and cognitive abilities, assessing children when they turned 6.5 years old. Contrary to results suggested from less rigorously designed observational studies, these impact evaluations found virtually no group differences for most outcomes. Children in the breastfeeding-promotion group did not have a significantly different risk of allergic symptoms, such as asthma, hay fever, and itchy rash.[25] The evaluations also did not find a detectable difference in dental health as recorded in routine dental exams conducted by a public health dentist.[26] Similarly, no significant differences were observed between 6.5-year-old children exposed to the breastfeeding promotion program and the control group for measures of height, body mass index, waist or hip circumference, triceps or subscapular skinfold thickness, or systolic or diastolic blood pressure. However, cluster adjusted difference in means of 0.2 centimeters in head circumference was marginally significant and a difference of 0.3 centimeters was significant for females.[24] The lack of physical differences between treatment and control children persisted with age; when measured again at age 11.5 years, no detectable difference was found in BMI, fat and fat-free mass indices, percentage of body fat, waist circumference, triceps and subscapular skinfold thickness, being overweight or obese, and whole blood insulin-like growth factor 1.[33] No significant socioemotional differences were observed on the Strengths and Difficulties Questionnaire ratings of total difficulties, emotional symptoms, conduct problems, hyperactivity, peer problems, or prosocial behavior assessed by either mother or the teacher.[28]

While the benefits of breastfeeding on infants' short-term health and nutritional status are well documented, and physical and cognitive developments have been noted among observational studies, the PROBIT studies provide quantitatively rigorous evidence of nuanced, mixed results of the PROBIT program on child development outcomes across a range of domains between 6.5 and 11.5 years of age. Despite the absence of detectable physical and socioemotional benefits, there were some signs of cognitive improvements and schooling gains. The table below presents the longitudinal findings of evaluations of the Belarus PROBIT program by age and outcome domain. The absence of evaluations measuring the effects beyond age six in many of the outcome domains is indicative of a significant research gap in the understanding of longer-term impacts throughout a child's life.

Outcome Domain by Age at Evaluation in Belarus PROBIT Project

Age	Study	Physical Development	Cognitive Develop-ment	Language Develop-ment	Socio-emotional Development	Schooling Outcome	Employment and Labor Market Outcomes
1	Initial study[a]	5/12	—	—	—	—	—
6	[24, 27, 28]	2/13[24]	1/4[27]	3/3[27]	0/16[28]	1/4[27]	—
11	[33, 34]	5/25	—	—	—	—	—

Note: To provide a more complete scope of these studies, this table includes all reported outcomes and not just those analyzed in the main body of this report (see box 1 in the Introduction for the decision rule for selecting outcomes for analysis). The numerator denotes statistically significant outcome at 10 percent level or better, and the denominator is the number of outcomes in the domain. The [bracketed] superscript number in the "Study" column is indicates study identifier (see References).
a. The "initial study" is the most rigorous evaluation of project effects at the earliest age of beneficiaries available. In this case, the initial study is Kramer and others (2001).

The most common anthropometrics found in the included studies are weight related (that is, weight, BMI, BMIZ, WAZ, and WHZ) and height related (that is, height and HAZ). These outcomes are used to define serious limitations in physical growth. Stunting, an indicator of chronic malnutrition, is defined as a height-for-age z-score that is less than minus two standard deviations from the reference median. Wasting or acute malnutrition is defined as a weight-for-height z-score less than minus two standard deviations from the reference median, while overweight is defined as a weight-for-height z-score at least two standard deviations above the reference median. Weight-for-age z-scores that are less than minus two standard deviations from the reference median indicate a child is underweight, which can reflect both acute and chronic malnutrition.

It is widely believed that nutrition during the early childhood stage has a real and lasting effect on children's weight and height (UNICEF 2007; Leroy and others 2014; Black and others 2013; Bhutta and others 2008; Black and others 2008; Walker and others 2007). It follows that interventions that improve early childhood nutrition would be poised to improve post-early childhood anthropometrics. However, the relationship between nutrition and anthropometrics in the developing world is based primarily on noncausal longitudinal studies, near-term impact evaluations, or theory, none of which can authoritatively speak to the post-early childhood effect of nutrition programs.

For most of the studies that can address this hypothesis, interventions to improve ECD did not have a detectable effect on post-early childhood measures of these outcomes. The lack of significant findings does not necessarily mean that early childhood interventions are unable to affect these indicators long-term, but rather implies that an effective method (for example, intervention type, timing, and duration of intervention) for doing so has not yet been established.

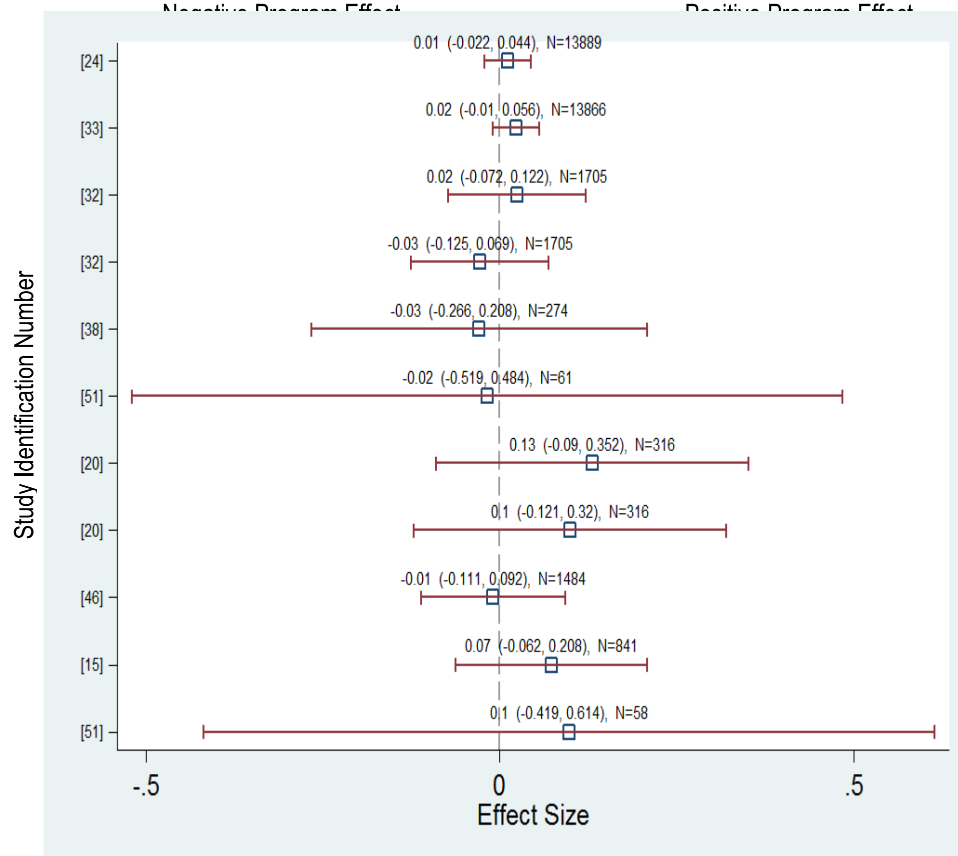
Weight

Early childhood interventions do not appear to have sustained effects on weight.

Evidence from seven different intervention types across five geographical Regions, over a range of ages from six to 17 years old, suggests that early childhood interventions may not have a lasting effect on weight (see figures 1.1 and 1.2). Of the 16 studies that tested for a post-early childhood effect on weight-related measures—WAZ, BMI, BMIZ, or WHZ—none found a significant effect. Meta-analysis on weight-related and BMI outcomes also found no overall effect nor an effect by intervention type (see figure 1.2).

Figure 1.1. Forest Plot for BMI and BMI for Age z-Score

Country	Intervention	Measurement	Average Age at Evaluation (years)	Study and Forest Plot
Belarus	Breastfeeding promotion	BMI	6.5	
Belarus	Breastfeeding promotion	BMI	11.5	
Mexico[a]	CCT cash	BMI for age z-score	9	
Mexico[a]	CCT conditionality	BMI for age z-score	9	
Thailand	Nutrition (child, micronutrient)	BMI for age z-score	9	
Jamaica[b]	Nutrition (stunted children)	BMI	11.5	
Gambia, The[c]	Nutrition (mother)	BMI (girl)	13.8	
Gambia, The[c]	Nutrition (mother)	BMI (boy)	13.8	
Nepal[d]	Nutrition (mother)	BMI	7	
Nepal	Nutrition (mother)	BMI for age z-score	8.5	
Jamaica[b]	Stimulation (stunted children)	BMI	11.5	



Note: The forest plot describes standard mean difference, 95 percent lower and upper bound confidence interval in parentheses, and sample size (N = number). The standard mean difference and confidence interval were calculated by Comprehensive Meta-Analysis software. Study numbers in [brackets] correspond to the numbered studies in References. Studies [32, 38] use 2006 National Center for Health Statistics growth reference to compute standardized z-score. BMI = body mass index; CCT = conditional cash transfer.

a. For Mexico study [32], the CCT effect is disentangled in cash and conditionality, and both estimates are reported in the forest plot. The Mexico [8] study is not included in this forest plot given that it looks at the same average age at evaluation with [32].

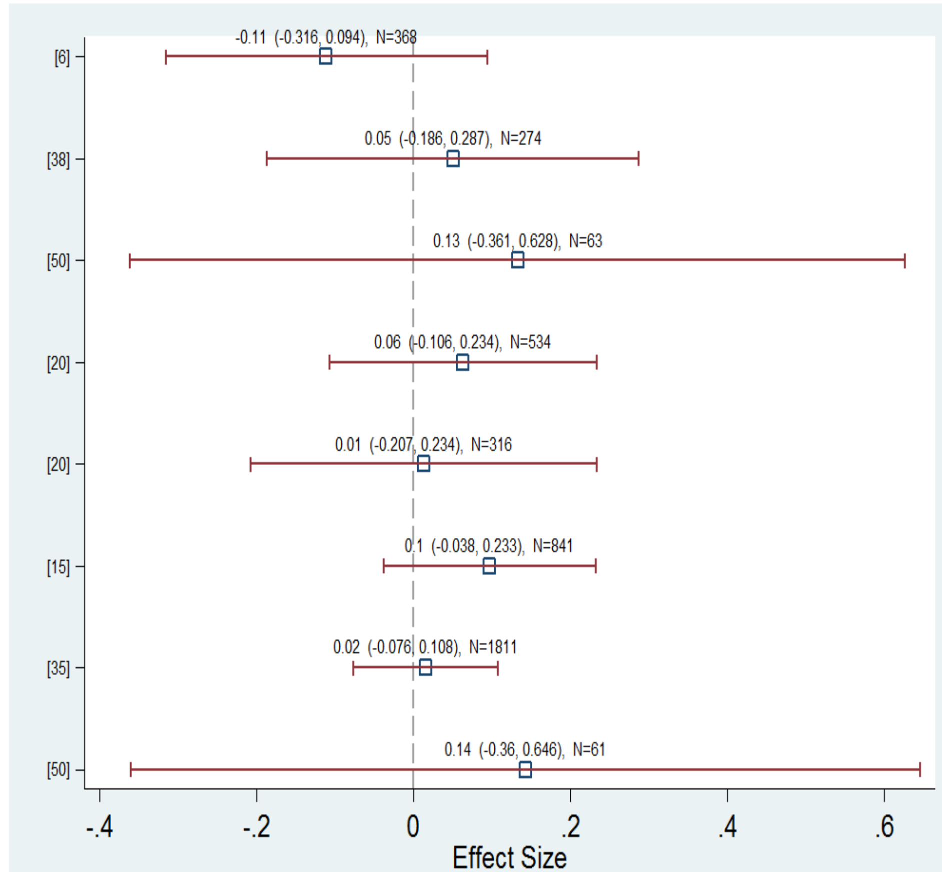
b. For The Gambia study [20], each gender estimate is included in the forest plot because the combined total estimate is not available.

c. For Jamaica study [51], given the combined intervention, information is not available in the article; stimulation intervention compares “stimulation only” and “control group.” Similarly, supplementation intervention compares “supplementation only” and “control group.”

d. For Nepal study [46], “multiple micronutrient” treatment group compared to the control group is used to compute the effect size.

Figure 1.2. Forest Plot for Weight and Weight-for-Age z-Score

Country	Intervention	Measurement	Average Age at Evaluation (years)	Study and Forest Plot
Nicaragua	CCT	WAZ (boy)	10	
Thailand	Nutrition (child, micronutrient)	WAZ	9	
Jamaica	Nutrition (stunted children)	WAZ	7.7	
Gambia, The[a]	Nutrition (mother)	Weight (boy, kg)	13.8	
Gambia, The[a]	Nutrition (mother)	Weight (girl, kg)	13.8	
Nepal	Nutrition (mother)	WAZ	8.5	
Mozambique	Pre-primary program	WAZ	7	
Jamaica	Stimulation (stunted children)	WAZ	7.7	



Note: The forest plot shows standard mean difference, 95 percent lower and upper bound confidence interval in parentheses, and sample size (N=number). The standard mean difference and confidence interval were calculated by Comprehensive Meta-Analysis software. Bracketed numbers correspond to the numbered list in References. Study [50] uses National Center for Health Statistics growth reference data to compute standardized z-score. Study [38] uses World Health Organization (WHO) 2006 growth references. Studies [6] and [35] do not; however, because they have been published recently, it is not unlikely these studies use WHO 2006 data as the growth benchmark. CCT = conditional cash transfer. WAZ = Weight for Age z-score.

a. For The Gambia study [20], each gender estimate is included in the forest plot because total estimate is not available in the article.

Height

Although a few interventions resulted in post-early childhood effects on height, the evidence is inconclusive across any specific intervention type.

Evidence shows that it may also be difficult to produce post-early childhood effects on height (see figure 1.3). Although evaluated interventions were more likely to affect height than weight measures, meta-analysis found no overall effect on height-related outcomes. Nor was there a significantly positive meta-effect for the intervention subgroups on height—including for nutrition interventions for which the estimated effect is centered at zero (not shown, available upon request).

When taken individually, only five of 20 impact evaluation (IEs) that examine height outcomes report significant effects. Three of those IEs evaluate nutritional supplementation programs; the other two are a conditional cash transfer program and the Matlab family planning and maternal and child health program. However, other IEs examining nutritional supplementation and cash transfers found no effect, making it difficult to draw firm conclusions based on the available causal evidence.

Despite strong theoretical arguments and IE evidence demonstrating short-term reductions in stunting due to nutrition, the evidence for post-early childhood effects from nutrition programs is thin. Eleven nutrition interventions were evaluated in nine studies, all of which occurred during the first 1,000 days of life when children are thought to be particularly susceptible to stunting (Black and others 2008; Black and others 2013; Bhutta and others 2008). Only two of them had a positive effect on height (the third significant result was negative).

The majority of these interventions (9 of 11) provided micronutrients either to pregnant mothers or to infants.[1, 15, 20, 38, 45, 46] Two of the nine caused a marginally significant increase in height: at nine years old, Thai children who had received iron and zinc as infants experienced a .14 standard deviation increase in HAZ, while six- to eight-year-old Nepalese children whose mothers received folic acid, iron, and zinc while pregnant were 0.64 centimeters taller than those whose mothers did not receive micronutrients.[38, 45]

The third significant micronutrient program, however, led to an initial decrease in height. Protein-rich biscuits given to pregnant mothers in The Gambia caused 11- to 17-year-old girls receiving the supplement in utero to be 1.3 centimeters *shorter* than peers whose mothers received the biscuits for nine months post-partum. There was no corresponding effect for boys, and five years later there was no overall difference in height between children whose mothers had received the supplementation during pregnancy versus postpartum[1] [1, 20] There was no effect on height found from the other six micronutrient interventions.[15, 38, 45, 46]

The remaining two nutrition interventions were the Jamaican supplementary feeding and Belarussian breastfeeding promotion programs.[24, 33, 50, 51] Both were studied soon after early childhood (six to eight years old) and again a few years later (11 to 12 years old), and neither found a detectable effect on children's height.

Taken together, this evidence would seem to indicate that nutrition interventions are generally ineffective at promoting long-term growth, but it is important to note the composition of the available evidence. Only one of the evaluated interventions provided supplementary feeding (though it did not find a lasting effect, possibly due to starting at nine months of age when stunting may have already begun), and there were no causal evaluations of complementary feeding programs or interventions focused on nutrition education. Whereas micronutrient programs typically solely provide essential nutrients foregone because of a limited diet, supplementary and complementary feeding interventions increase caloric intake and have been shown to increase height in the near-term (Bhutta and others 2013). Consequently, it is reasonable to hypothesize that such programs may have a greater and longer-lasting effect on anthropometrics than would micronutrient interventions.[2] At present, the majority of the later-life evidence comes from the latter. So while micronutrient programs seem incapable of producing lasting physical effects, there is almost a complete lack of post-early childhood causal anthropometric evidence regarding feeding interventions; this potential relationship—strongly indicated by theory—should be thoroughly examined before nutrition programs are deemed to be generally ineffective.

Of the three cash transfers—two conditional and one unconditional —only one found a significant overall effect on height, although there is evidence that the unconditional cash transfer (UCT) program significantly helped certain groups. The Mexican conditional cash transfer (CCT) program, Progresa, was examined 10 years after it began by two IEs that looked at the dose-response effect of an additional exposure of 18 months, which occurred before the recipient turned three years old. The first did not find any significant effect on height, but the second used an instrument to isolate the effect of the cash transfers as separate from the program and its conditionalities. It found a highly significant but ultimately small increase in height-for-age because of the cash transfer but no effect stemming from the conditionalities.[3] [8, 32]

The largest effect on height came from the South African Child Support Grant, a UCT to poor households with children, but this effect was isolated to certain groups; there was no effect on children's HAZ overall. The authors theorized the grant would at least be partially spent on improving health and nutrition for the child it was intended to support, but no condition required it.[14] In this particular evaluation of the program, the authors target households with children who were age two years or younger when they received the grant and compares them to children who received the grant starting from two to five years old. There was an increase of approximately 0.2 standard deviations that was marginally significant among girls, and significant among children whose mothers had at least eight years of schooling. The third CCT, which occurred in Nicaragua, found no difference on height-for-age among 10-year-old boys who had started the program in the first 1,000 days rather than as two to five year olds.[6]

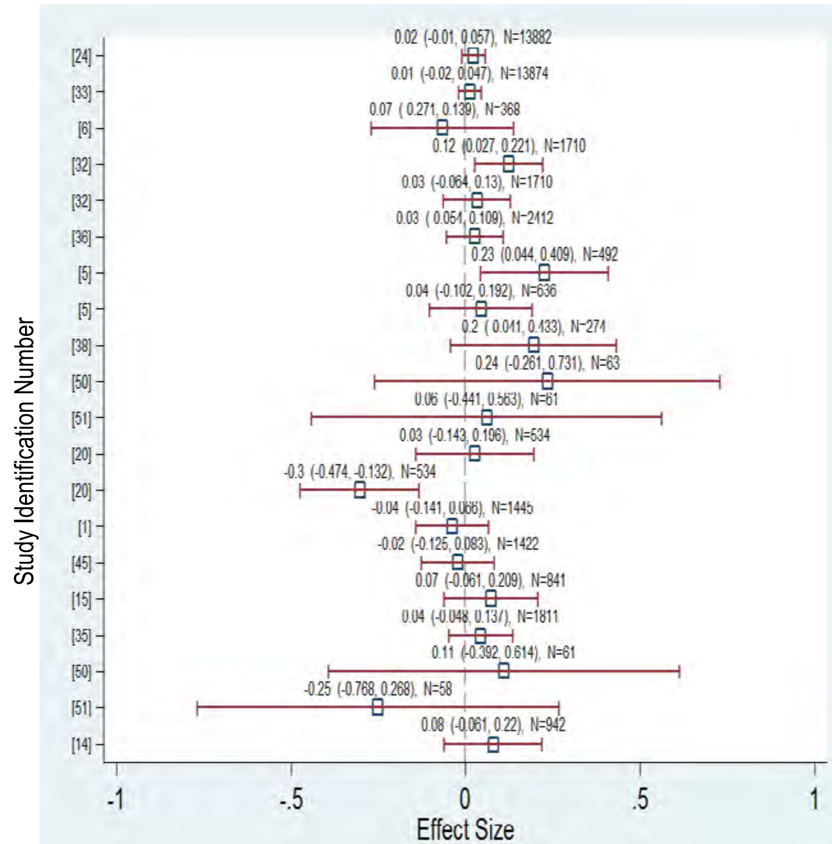
Evidence from two early stimulation programs suggests that this type of intervention may not have a sustained effect on height. Neither the early stimulation program in Jamaica nor community preschool in Mozambique found significant effect on height.[35, 51]

The final two interventions to be evaluated for height were health-related. Starting in 1977, women in Matlab, Bangladesh, were visited in their homes to encourage family planning. Starting in 1982, child health interventions were added in which children under five received immunizations, vitamin A supplementation, and nutrition rehabilitation for children at risk. The impact evaluation that examined this program disaggregated the effects by age group in accordance with when the child health intervention started. The older children—those who were 15–19 years old at evaluation—were not significantly taller than their peers who lived outside the program area, but the younger children—those who were 8–14 years old at evaluation and therefore would have benefited from the child health and nutrition intervention—experienced a significant increase in height-for-age.[5] This evidence suggests that the child health intervention was the driving force behind the change in height, but such a conclusion has not been definitively established. The other health-related IE studied the indirect effect of a community deworming project in western Kenya by focusing on the preprimary younger siblings of primary school children who received the treatment. Ten years later, there was no effect on height or height-for-age.[36]

Figure 1.3. Forest Plot for Height and Height for Age z-Score

Country	Intervention	Measurement	Average Age at Evaluation (years)
Belarus	Breastfeeding promotion	Height (cm)	6.5
Belarus	Breastfeeding promotion	Height (cm)	11.5
Nicaragua[a]	CCT	HAZ (Boy)	10
Mexico[b]	CCT cash	HAZ	9
Mexico[b]	CCT conditionality	HAZ	9
Kenya	Deworming	HAZ	10
Bangladesh	Family planning and MCH	Height z-score	9
Bangladesh	Family planning, maternal health	Height z-score	9
Thailand	Nutrition (child, micronutrient)	HAZ	9
Jamaica	Nutrition (stunted children)	HAZ	7.7
Jamaica[c]	Nutrition (stunted children)	HAZ	11.5
Gambia, The[a]	Nutrition (mother)	Height (girl, cm)	13.8
Gambia, The[a]	Nutrition (mother)	Height (boy, cm)	13.8
Gambia, The[a]	Nutrition (mother)	Height (cm)	19.6
Nepal[d]	Nutrition (mother)	Height (cm)	7
Nepal	Nutrition (mother)	HAZ	8.5
Mozambique	Pre-primary program	HAZ	7
Jamaica	Stimulation (stunted children)	HAZ	7.7
Jamaica	Stimulation (stunted children)	HAZ	11.5
South Africa	Unconditional cash transfer	HAZ	10

Study and Forest Plot



Note: The forest plot describes standard mean difference, 95 percent lower and upper bound confidence interval in parentheses, and sample size (N = number). The standard mean difference and confidence interval were calculated by Comprehensive Meta-Analysis software. Bracketed numbers correspond to the numbered studies in References. Study [50, 51] use National Center for Health Statistics growth reference data to compute standardized z-score, and study [32, 36, 38] use WHO 2006 growth reference. Study [6, 14, 35] is not clear which growth reference data is used for computing the height for age z-score, but given they are published relatively recently, they are likely to use WHO 2006 growth reference. Study [5] height z-score is standardized by subtracting the comparison group mean and dividing by that group's standard deviation for people of the same age and gender. CCT = conditional cash transfer; MCH = maternal and child health; WHO = World Health Organization. HAZ = Height-for-age z-score.

a. For The Gambia study [20], each gender estimate is included in the forest plot because total estimate is not available in the article. Only boy's estimate is available for Nicaragua study [6].

b. For Mexico study [8], it is not included in this forest plot because it looks at same average age at evaluation with [32].

c. For Jamaica study [51], given the combined intervention information is not available in the article, stimulation intervention compares "stimulation only" and "control group." Similarly, supplementation intervention compares "supplementation only" and "control group."

d. For Nepal study [45], "multiple micronutrient" treatment group compared to the control group is used to compute the effect size.

Mid-Upper-Arm Circumference and Head Circumference

There is little evidence that early childhood interventions cause significant differences in MUAC or head circumference in the post-early childhood period.

Three studies examined head circumference or MUAC. Two of the IEs looked at the effect of the PROBIT in Belarus on both measures,[24, 33] while the third study examined the effect of the Thai iron and zinc intervention on MUAC.[38] None of the IEs found a significant effect overall on either outcome, although the head circumference of girls age 6.5 years who participated in PROBIT was 0.3 centimeters larger than girls who did not participate.[24] Gender-disaggregated results were not discussed in the later study of the same program, so it is not possible to determine if this difference persisted. However, the lack of a lasting effect on head circumference, and to a lesser extent on MUAC, is not necessarily concerning as it is really in the first two to three years of life when head circumference is routinely measured and used as an indicator of potential problems in the functional correlates around physical health.

Fine Motor Skills

Fine motor skills may be improved through preschool participation.

The final outcome examined is fine motor skills. Despite little evidence on this outcome, the intrinsic value as an indicator of school readiness warrants its inclusion (Grissmer and others 2010; Cameron and others 2012). In Mozambique, children who had participated in preschool experienced a marginally significant 6.3 percent increase in their fine motor skills scores over the control group.[35] Conversely, a program that promoted early stimulation by placing Romanian orphans with foster care families rather than in institutional homes had no detectable effect on the fine motor skills of 8-year-old foster care children.[29] Given the many differences in the two interventions, it is impossible to determine why one was effective while the other was not.

Physical Development Summary

Despite impact evaluations across various intervention types, Regions, and age groups, very little causal evidence exists of what works to create a sustained effect on a child's anthropometrics. There were no interventions that caused a detectable change in weight and few that affected height.

Given that three of the five effective interventions on height were nutrition programs, these results may seem to reinforce the widely held view that early nutrition is significantly positively linked to anthropometrics, and particularly to height (UNICEF 2007; Leroy and others 2014; Black and others 2013; Bhutta and others 2008; Black and others 2008; Walker and others 2007). However, the other eight nutrition interventions evaluated for their effect on height did not cause a notable change in beneficiaries' stature. Nevertheless, with evidence missing on the later-life effects of major nutrition interventions, additional high-quality IE evidence is necessary to determine whether physical benefits from early nutrition programs do indeed fade over time (as these results imply) or whether interventions that cause later-life effects merely have yet to be evaluated.

The remaining physical outcomes either appear unchanged by interventions during early childhood or else the evidence base is too thin to draw conclusions. Fine motor skills may be improved by preschool, but with two IEs on the outcome, this conclusion is still tentative. Neither MUAC nor head circumference were found to be significantly affected by the evaluated interventions, except for among 6.5-year-old girls in Belarus.[24] There is some evidence that even that effect might disappear four years later.

Almost all of the effective interventions occurred during the first 1,000 days from conception to the child's second birthday. The only intervention that was not specifically limited to that time period—Progresa—was studied by isolating the effect of program participation up to age three. While this reinforces the widely held belief that that time period is especially important, the evidence also suggests that merely intervening during the first 1,000 days is not a panacea. Other interventions, such as the supplementation and early stimulation project in Jamaica[50, 51] and the maternal supplementation project in The Gambia,[1, 20, 22] also occurred during that time period but did not produce significant effects.

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[1] While the effect on girls was highly statistically significant, there is some question as to the best interpretation of these results. In the original trial, pregnant women in the treatment group received protein-rich biscuits daily starting at 20 weeks' gestation. As the original outcome of interest was birthweight, the control group then received the treatment for 20 weeks after delivery, which in effect rendered subsequent measurements as dose response effects between prenatal and postnatal supplementation. However, there is some evidence from that same region of The Gambia that postnatal supplementation does not affect the quality or quantity of breast milk (Prentice and others 1983). If this is true, then the original intervention design would hold, and the results would represent the effect of prenatal supplementation alone.

[2] A supplementary feeding program in Colombia provides some evidence for this. In this program, participating children and their families received nutritional supplementation for the first three years of the participant's life, which caused a marginally significant increase in participant's height. However, this study did not pass the rigorous quality check employed by

this review because of concerns over high attrition (approximately 45 percent) (Super and others 1990).

[3] There are two versions of this study—the version published in *The Lancet* (Fernald and others 2008) and a subsequent working paper in which the authors address critiques they received on their original paper.[32] This review chose to use the results from the latter version as they were based on an instrumental variable and therefore addressed potential endogeneity problems from using actual transfer amounts as an explanatory variable for cognitive outcomes (children who are successful in school go on to higher grades, in which they earn larger transfers). The results between the two papers are largely similar, with only a change in significance level for two of the outcomes (see table 1.2 of study [32]).

2. Cognitive Development

Cognitive development is improved by a range of interventions, and most improvements are seen in measures of general cognition. Nutritional programs had almost no effect.

Cognition, or cognitive ability, includes problem-solving and analytical skills, short- and long-term memory, math abilities, verbal comprehension, general knowledge, and logic as well as how people respond to new or challenging situations (Johnson 1998). To date, there is no single, universal standardized assessment for measuring cognition across ages and cultures, unlike measures of physical growth, such as weight and height. For this reason, significant heterogeneity is found in the assessments used to capture an individual's capacities.

Explanation of Cognitive Tests

Most intelligence tests are comprised of subscales that measure several aspects of cognitive function. For example, the Wechsler tests for children and adults, widely used in research and as a clinical tool, include subscales assessing verbal abilities (for example, vocabulary and analogies) and nonverbal abilities (for example, perceptual skills and working memory). Most intelligence quotient (IQ) tests include a total, overall score as well as scores on these subscales, such as verbal abilities and performance or nonverbal abilities. Some tests are comprehensive ability tests that typically take at least an hour to complete, while others are abbreviated IQ or screening tests (completed in 15 minutes or so). Generally, the longer tests are considered to be more precise, sensitive, and exhaustive measures of cognition, while the shorter tests provide a more crude estimation of abilities.

Widely used, brief cognitive assessments, like pattern completion tests such as the Raven's matrices, are designed to measure specific aspects of cognition (for example, visual processing). The Raven's matrices in particular have been frequently used throughout the world in part because they are nonverbal assessments that (i) do not require the respondent to be literate or (ii) to have a certain acquired knowledge, and (iii) they are believed to be a highly valid measure of fluid intelligence.[1] Other tests included in this review are measures of executive function abilities[2]—processes such as short-term memory, ability to sustain attention, ability to shift strategies as needed, and inhibition of impulsive responses that reflect how an individual responds to new or challenging situations. These types of tests are often included in lieu of or in addition to more global measures.

While comprehensive measures typically include language subscales, this review separates all verbal and language-related tests from other cognitive assessments to make comparisons of impacts easier to understand across specific outcomes. Language outcomes are reported subsequently.

Evidence from Developed Countries

Several reviews of primarily center-based early child programs in the United States have examined the concurrent and long-term effects on cognition and other related outcomes. A 2003 systematic review of the effectiveness of comprehensive, publicly funded programs revealed sustained positive effects on cognition. Significant increases in IQ were observed in children during their participation in the program, one year later, and between three and 10 years later (Anderson and others 2003). More recent reviews of early education-focused interventions have also consistently found enduring effects on current and later cognitive abilities as well as achievement scores (Camilli and others 2010; Reynolds and Temple 2008).

Despite the existence of evidence showing benefits throughout the lifecycle, several U.S. studies have observed a disappearance of cognitive gains during the early primary years and a subsequent reemergence of these gains later in the child's life (Bitler, Hoynes, and Domina 2014; HHS 2010; Magnuson, Ruhm, and Waldfogel 2007, ultimately translating into improved schooling and labor market outcomes and better scores on tests of externalizing behaviors (Reynolds and others 2001).[3] Interpretations of these findings posit that inputs such as the availability of classroom materials and teaching styles are important for determining whether effects of interventions in preschool are sustained (Barnett 2011). Such findings reaffirm the need for more research on the medium- and long-term effects of early childhood development (ECD) interventions.

Although the majority of the evidence from the United States and developed countries comes from educational programs, parenting support and nonpreschool programs—typically targeting low-income families with children under three years—have also shown the ability to improve cognitive, health, and other developmental outcomes for children in a range of populations and contexts. These programs promote stimulation and teach various parenting skills through home visits, particularly by nurses or other healthcare professionals (Olds, Sadler, and Kitzman 2007). The findings from these programs suggest that similar efforts in low- and middle-income countries could also be successful.

Evidence from Developing Countries

The majority of the ECD literature from the United States and other developed countries focuses on early education and stimulation programs that aim to improve cognitive ability. However, the lower nutritional status and higher mortality rates of children in the developing world have necessitated the prioritization of programs that improve child survival and growth by promoting nutritional supplementation and appropriate feeding practices. Stimulation programs, especially scaled up to the national level, are also typically more expensive and difficult to implement effectively, meaning that very few have been undertaken. While this has contributed to the dearth of longitudinal data on ECD stimulation programs everywhere, the lack of evidence is most pronounced in the developing world.

Evidence from ECD programs in low- and middle-income countries has shown that early childhood interventions can improve children's cognitive, behavioral, health, and schooling outcomes. Among the programs reviewed, interventions that worked directly with children and their families, target more disadvantaged populations, and are integrated with health, nutrition, and educational services provided the largest benefits to children's development (Engle and others 2007, 2011). A review of early childhood interventions in 23 non-U.S. countries looked at both short- and long-term effects[4] of a range of ECD intervention types. Although cash transfers, nutritional supplementation, and educational programs were found to create significant and sustained gains across a range of child development outcomes, interventions including a stimulation component proved to be the most effective (Nores and Barnett 2010; Yousafzai, Rasheed and Bhutta 2013). Despite these encouraging findings, both program coverage and evaluation evidence for interventions from early childhood on later outcomes in developing countries, is low, as evidenced by the relatively few impact evaluations (IEs) and reviews that address this area.

The absence of universal, standardized outcome measures for cognitive and language ability increases the difficulty of designing ECD programs against concrete and well-defined benchmarks. In addition, many countries do not have national policies or guidelines for early childhood education and stimulation programs. However, there is an increasing recognition among developing countries that intervention types other than those focusing on health and nutrition are needed for the poorest children to fully develop their cognitive abilities. There has been a particular interest in combining education or stimulation with other ECD programs to improve nutritional status of young children and prevent the negative effects of stunting (Aguero, Carter, and Woolard 2007; Yousafzai, Rasheed, and Bhutta 2013). Nevertheless, much work remains to translate evidence into policy and ensure the quality and consistency of interventions.

Importance of Measuring Cognition

Cognitive ability plays an important role in enabling an individual to achieve success in areas such as schooling and employment. There is substantial evidence from the United States that low socioeconomic position in early childhood is associated with differential brain development (Hackman and Farah 2009; Raizada and Kishiyama 2010) and with poorer cognitive performance (Bradley and Corwyn 2002; Noble and others 2012; Pechtel and Pizzagalli 2011). Recent research from low- and middle-income countries also suggests that differences in language abilities between socioeconomic groups are apparent at a young age and that the differences persist and even increase once children enter school (Fernald and others 2011; Schady and others 2014). Consequently, one might hope to improve cognition at a young age by using early childhood interventions, and such improvements could have lasting effects not only in a person's cognitive development, but also on their subsequent socioeconomic status.

Table 2.1 maps the 16 unique studies in this review that investigate cognitive outcomes. The studies span 11 projects in 10 countries and include 9 distinct intervention types. Measurements of abbreviated, full-scale, and performance IQ, nonverbal cognition, and executive function are reported. The studies are grouped by the outcome category in which they report measurements; the specific intervention within each category is noted. More detail on each intervention is provided in appendix A. These classifications align with the taxonomy presented in figure 2 in the Introduction.

Table 2.1. Impact Evaluations Investigating Cognitive Development

	Study	Country (Project)	Average Age at Intervention (Years)	Average Length of Exposure (Years)[a]	Age at Evaluation (Years)	Evaluated Intervention	Reviewed Outcomes
Nutrition	Kramer and others 2008a [27]	Belarus (Promotion of Breastfeeding Intervention Trial [PROBIT])	0	1	6	breastfeeding promotion	abbreviated IQ (total score)*; abbreviated performance IQ; nonverbal subscales
	Pongcharoen 2010 [38]	Thailand (micronutrient supplementation to children)	0.5	0.5	9	micronutrients and fortified food for children (Iron and/or zinc supplementation)	executive function (processing speed); full-scale IQ; performance IQ; nonverbal cognition (Raven's matrices)
	Alderman and others 2014 [1]	Gambia, The (maternal supplementation)	in utero	0.5 (DR1)	16–22	vitamins, micronutrients, or fortified food for pregnant women (protein biscuits)	executive function (backward digit span); nonverbal cognition (Raven's matrices)
	Walker and others 2005 [52][b]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	17–18	supplementary feeding	full-scale IQ; performance IQ; nonverbal cognition (Raven's matrices)
	Walker and others 2011 [55][b]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	22	supplementary feeding	full-scale IQ; performance IQ
	Maluccio and others 2009 [31][c]	Guatemala (INCAP supplementary feeding to children)	0	5.3	25–42	supplementary feeding	nonverbal cognition (Raven's matrices)**
Early Learning/ Childcare	Walker and others 2010 [54]	Jamaica (stimulation to low birthweight infants)	0	2	6	stimulation	executive function (short-term memory)***; full-scale IQ; performance IQ**

	Fox and others 2011 [17]	Romania (Bucharest Early Intervention Project)	1.88	2.7	8	stimulation (foster care)	executive function (processing speed); executive function (working memory); perceptual organization full-scale IQ*
	Bos and others 2009 [11]	Romania (Bucharest Early Intervention Project)	1.88	2.7	8	stimulation (foster care)	executive function (spatial working memory); executive function (stockings of Cambridge)
	Walker and others 2000 [51]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	11–12	stimulation	executive function (processing speed); full-scale IQ**; nonverbal cognition (Raven's matrices)**; performance IQ*
	Walker and others 2005 [52][b]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	17–18	stimulation	full-scale IQ**; nonverbal cognition (Raven's matrices)*; performance IQ*; working memory
	Gertler and others 2013 [18]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	22	stimulation	cognitive factor score***
	Walker and others 2011 [55][b]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	22	stimulation	full-scale IQ***; performance IQ***
Health	Cas 2012 [12]	Indonesia (Safe Motherhood program)	in utero	3	11–14	Access to obstetric and child health care	nonverbal cognition (Raven's matrices)***
	Ozier 2013 [36]	Kenya (primary school deworming project)	0	1	8–15	deworming	cognitive factor score**; nonverbal cognition (Raven's matrices)***
Social Protection	Behrman and others 2008 [8]	Mexico (Progresa)	1.5	1.5 (DR2)	7–11	CCT	abbreviated performance IQ

Manley, Fernald, and Gertler 2012 [32]	Mexico (Progresa)	1	1.5 (DR2)	8–10	CCT—conditionalities	abbreviated cognitive performance IQ
					CCT—cash	abbreviated cognitive performance IQ*
Barham and others 2014 [6]	Nicaragua (Red de Protección Social)	in utero	3 (DR2)	10 (boys)	CCT	executive function (processing speed)**; cognitive factor score***; nonverbal cognition (Raven's matrices)**

Note: Bracketed numbers correspond to numbered studies in References. More details for each study are found in appendix A. CCT = conditional cash transfer; DR = dose response; INCAP = Instituto de Nutrición de Centroamérica y Panamá; IQ = intelligence quotient.

a. DR in the length of exposure means the intervention period in terms of the dose response. DR is either randomized rotation (DR1) or phase-in (DR2). In terms of dose response, for instance, DR1 indicates the study from The Gambia where treatment group receives protein biscuit only in utero whereas control group receives it only in postpartum, and length of exposure is the length of intervention for treatment. DR2 describes the dose response where early and late treatment effect is compared, and length of exposure is the difference of the intervention period between treatment and control group.

b. Jamaica [52, 55] each has a multiple intervention arm, and each intervention type has a separate row for these studies.

c. INCAP provided supplementation to pregnant and lactating women but could not isolate effects as children could also receive the supplement after birth, and the study lacked power to evaluate the intervention by developmental period.

* Statistically significant at 10 percent.
** Statistically significant at 5 percent.
*** Statistically significant at 1 percent.

Box 2.1. The Psychosocial Component of the Jamaica Supplementation and Stimulation ECD Program Produces Lasting Cognitive Benefits

Evaluations of Jamaica's stimulation and nutritional supplementation program tracked participants—stunted children between the ages of nine and 24 months when enrolled in the program—for more than 20 years to assess the long-term effects of the intervention on physical, cognitive, educational, and employment outcomes. Stunting, which is defined as height-for-age less than two standard deviations below the mean, is an indicator of chronic malnutrition that begins early in life (Victora and others 2008). It can be caused by many factors: poor nutrition during pregnancy, early introduction of nutrient-poor liquids and foods, illness, and a diet lacking in fruits, dairy, and protein (Black and others 2013). In addition to poor growth and susceptibility to illness, stunted children are also at risk for impaired cognitive development. Early supplementation has been proposed as a method to facilitate mental and physical development among malnourished children. However, the results of longitudinal studies of a randomized controlled program in Jamaica suggest the benefits of supplementation to stunted children dissipated relatively quickly after the program, whereas benefits of a psychosocial stimulation program provided to stunted children were sustained into adulthood.[18, 19, 50, 51, 52, 53, 55]

Stunted children from poor communities in Kingston participated in a two-year randomized controlled trial during which they were placed in one of four experimental groups: milk-based supplementation, stimulation through weekly home visits from a healthcare worker, supplementation plus stimulation, and a control group of stunted children who were not exposed to either intervention. For both groups receiving stimulation, the health worker facilitated interactions between mother and child, reinforcing positive messaging, engagement with toys, and active play (Grantham-McGregor and others 1991). A group of nonstunted children was later identified through a matching process for comparison purposes.

During the first two years of the program, participants' dietary quality, physical growth, locomotor skills, and hearing and speech were measured every six months. At the end of the 24 months, both the supplementation only and stimulation only groups showed improved hand and eye coordination and locomotor performance. Furthermore, the children receiving the combined interventions performed significantly better than children in the groups receiving either intervention independently. No effect was detected in hearing or speech tests (Grantham-McGregor and others 1991). Supplementation also significantly improved height, weight, and head circumference at 12 months after enrollment, although most of these physical benefits tapered off after the first six months. Stimulation alone did not have a significant effect on physical outcomes during the first 12 months (Walker and others 1991).

Later evaluations collapsed the two stimulation treatment arms (stimulation alone or with supplementation) into one group. At age 7–8 years,[50] 11–12 years,[51] 17–18 years,[52, 53] and 22 years,[18, 19, 55] children who had received stimulation (alone or with supplementation) were compared to children who had not (combining "supplementation only" and the pure control groups). Despite the initial gains observed in mental and physical development, these follow-up studies found that supplementation alone did not cause significant improvements in children's development between the ages of seven and 22 years.[50, 51, 52, 53, 55]

In contrast to the absence of effects observed in the supplementation groups, there were sustained benefits of stimulation across cognitive, language, and schooling outcomes. When assessed between ages 11 and 12, children who received stimulation (either alone or with supplementation) showed better cognitive functioning: they scored higher on IQ tests, verbal scales, and vocabulary exercises; in fact, test scores of the stunted but stimulated nearly caught up with observably comparable nonstunted children, suggesting that early stimulation may be able to mitigate some of the functional consequences of growth restriction in young children.[51] These cognitive advantages were again observed at 17 and 18 years of age.[52] In addition, the stimulation groups had lower dropout rates and higher scores on a battery of educational tests than the combined supplementation only and control group. When evaluated again at age 22, they also had completed more years of schooling.[55]

Children who received stimulation also exhibited better psychosocial functioning and achieved improved employment outcomes. Sixteen years after the intervention, they reported less anxiety and depression, higher self-esteem, and demonstrated better attentional abilities and less oppositional behavior when compared with the individuals who had not received stimulation. However, no difference was detectable in self-reported antisocial behavior between the groups.[53] A 20-year follow up study found that the stimulation intervention had an effect on adult employment. Individuals who received stimulation during their early childhood years reported 25 percent more earnings than nonstimulated individuals, putting them on par with the nonstunted group.[18, 19] These results present a clear picture that psychosocial stimulation produced lasting cognitive gains in stunted children within the context of the Jamaica study, suggesting that it may be able to mitigate some of the functional consequences of growth restriction in young children.

The table below presents the longitudinal findings from the series of studies evaluating the Jamaica early supplementation and stimulation program.

Outcome Domain by Age at Evaluation in the Jamaica Supplementation Project

Age	Intervention Arm	Physical Development	Cognitive Development	Language Development	Socioemotional Development	Schooling	Labor Market
≤ 5y[a]	Supplementation	1/2	1/1	0/1	-	-	-
	Stimulation	2/2	1/1	1/1	-	-	-
	Both	2/2	1/1	1/1	-	-	-
7–8 y	Supplementation	0/8[50]	-	-	-	-	-
	Stimulation	0/8[50]	-	-	-	-	-
	Both	0/8[50]	-	-	-	-	-
11–12 y	Supplementation	0/5[51]	0/8[51]	1/4[51]	-	-	-
	Stimulation	0/5[51]	5/16[51]	4/8[51]	-	-	-
	Both	1/5[51]	3/8[51]	2/4[51]	-	-	-
17–18 y	Supplementation	0/2[52]	0/12[52]	1/10[52]	1/8[53]	0/2[52]	-
	Stimulation	0/2[52]	7/12[52]	10/10[52]	6/16[53]	0/2[52]	-

	Both	0/2[52]	2/6[52]	4/5[52]	1/8[53]	0/1[52]	-
22 y	Supplementation	0/1[55]	0/5[18, 55]	0/4[55]	0/9[18, 55]	0/7[18, 55]	-
	Stimulation	0/1[55]	5/6[18, 55]	4/4[55]	4/11[18, 55]	10/16[18, 55]	5/8[18, 55]
	Both	0/1[55]	3/3[18, 55]	1/2[55]	2/3[18, 55]	1/4[18, 55]	-

Note: To provide a more complete scope of these studies, this table includes all reported outcomes and not just those analyzed in the main body of this report (see box 1 in the Introduction for the decision rule for selecting outcomes for analysis). The numerator denotes statistically significant outcome at 10 percent level or better, and the denominator is the number of outcomes in the domain. The [bracketed] superscript number in the "Study" column is indicates study identifier (see References). Results for supplementation include supplementation only versus the control group (unadjusted) and/or supplementation only and both versus the control and early stimulation only (adjusted with covariates). Results for stimulation include early stimulation only versus the control group (unadjusted) and/or early stimulation only and both versus the control and supplementation only (adjusted with covariates). "Both" is for the group that received both early stimulation and supplementation as compared to the control group (unadjusted). "Age" is the age at evaluation.

a. The sources for effects during early childhood are Gardiner and others (2003), Grantham-McGregor and others (1991), and Walker and others (1991, 2004).

General Cognition

General cognition was improved by stimulation, social protection, and sanitation interventions. Nutritional interventions did not have a measurable effect across a range of contexts.

Cognitive outcomes were reported for 10 early childhood programs (figure 2.1). However, only two of these programs, early stimulation and supplementation for stunted children in Jamaica,[51, 52, 55] and a conditional cash transfer in Mexico,[32] report results over multiple stages of the child's life. Evaluations of these programs suggest that ECD interventions have the ability to produce robust and sustained effects on cognitive outcomes. However, the lack of longitudinal data highlights the need for more research to fully understand the effects of the range of ECD interventions on cognitive outcomes throughout a child's lifetime.

Supplementation programs across a range of contexts did not demonstrate significant and sustained effects on multiple measures of cognition. Neither iron nor zinc, given together or individually in infancy, caused a significant difference in full-scale IQ or performance IQ at age nine in Thailand.[38] The PROBIT breastfeeding promotion program in Belarus sustained only a marginally significant effect up to age 6.5 on both abbreviated IQ and abbreviated performance IQ.[27] The supplementation-only component of the Jamaica stunted children interventions did not have a significant effect on any measures of cognitive ability from age six through 22.[18, 51, 52, 55] However, it may be that once stunting occurs—as with this study population—then supplementation alone is not sufficient for producing measurable improvements in cognitive outcomes. This conclusion is supported by evidence suggesting stunting is irremediable after the age of two or three years (Victora and others 2008). These findings support the assertion that the timing and duration of supplementation, in addition to other types of interventions, may be needed to affect the full range of cognitive outcomes beyond the early childhood years, particularly for children who are stunted (as in Jamaica) or are at risk for malnutrition.

The available evidence does suggest that programs incorporating stimulation were much more effective than nutritional programs alone in improving cognitive outcomes beyond the early childhood period. The same study in Jamaica found that already stunted children who were exposed to a stimulation component of the program had significantly higher full-scale IQ scores at ages 17–18 than children who had received only supplementation,[52] and the gains became much larger and highly significant at age 22.[55] Improvements in performance IQ were weakly significant for stunted children at ages 11–12[51] and 17–18 years,[52] but by age 22 the gap between children who had received stimulation either alone or with supplementation and those who had received supplementation only had widened and was highly significant.[55] A different early stimulation program in Jamaica that targeted low-birthweight children did not produce a measurable effect on full-scale IQ at age six years, but it did cause a significant increase in performance IQ.[54]

A study of a foster care program in Romania also found evidence that exposing children to a stimulating environment during early childhood can improve cognitive outcomes. The Bucharest Early Intervention Project (BEIP) randomly assigned Romanian orphans to either remain in institutional care or be placed with foster families. When assessed at age eight, 3.5 years after the program ended, children who had been placed in foster care exhibited marginally significant gains in full-scale IQ scores.[17]

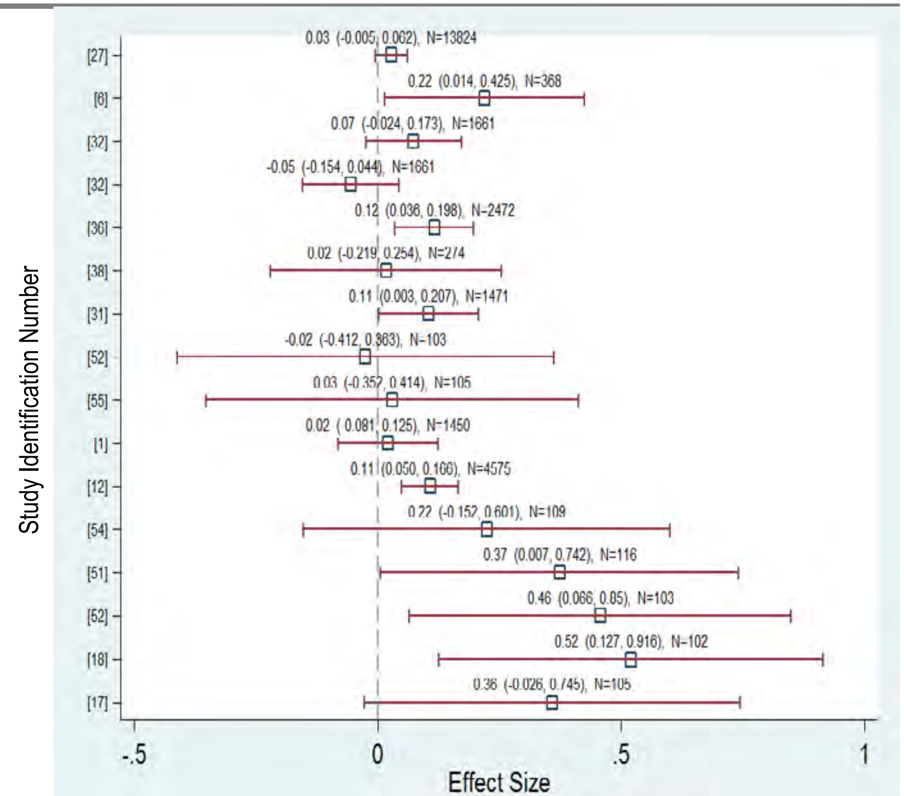
The evidence on the effect of CCTs on general cognition is mixed and particularly thin. An additional 18 months' participation in Progresa, a Mexican CCT that provided nutritional supplements to children under two years old and older if they showed signs of nutritional deficit, and health visits to children under five years old (among other program components), did not produce significant differences in abbreviated performance IQ at ages 7–11.[8] However, a second study of the same program was able to separate the effects of the conditionalities and the transfers and found that the cash component led to a marginally significant improvement in abbreviated performance IQ in 8- to 10-year-olds, while the conditionalities alone caused no detectable difference in cognitive scores.[32] The evaluation of Red de Protección Social, a CCT in Nicaragua[6] that required beneficiaries to receive regular health checkups and growth monitoring for children under five years old, reports some positive effects on cognition based on an index of a broad range of cognitive tests. Scores from Raven's matrices, the Peabody vocabulary test, the Denver screening test, digit spans, and subscales from the Wechsler

Intelligence Scale for Children III were processed into a cognitive factor score. When evaluated at age 10, no significant effects were observed for girls, though boys whose families received the program throughout the first three years of their lives showed a highly significant improvement in the cognitive index measure over boys whose family began the program when they were three to six years old.

Figure 2.1. Forest Plot for General Intelligence

	Intervention	Measurement	Average Age at Evaluation (years)
Belarus	Breastfeeding promotion	WASI	6.5
Nicaragua[a]	CCT	Raven's matrices	10
Mexico[b]	CCT cash	WASI	9
Mexico[b]	CCT conditionality	WASI	9
Kenya	Deworming	Raven's matrices	10
Thailand	Nutrition (child, micronutrient)	WISC-III	9
Guatemala[c]	Nutrition (child, SF)	Raven's matrices	32.3
Jamaica[d]	Nutrition (stunted children)	WAIS	17.5
Jamaica[d]	Nutrition (stunted children)	WAIS	22
Gambia, The	Nutrition (mother)	Raven's matrices	19.6
Indonesia	Safe motherhood program	Raven's matrices	12.5
Jamaica	Stimulation (LBW children)	WPPSI	6
Jamaica[d]	Stimulation (stunted children)	WISC-R	11.5
Jamaica[d]	Stimulation (stunted children)	WAIS	17.5
Jamaica[d, e]	Stimulation (stunted children)	Cognitive factor	22
Romania	Stimulation (foster care)	WISC-IV	8

Study and Forest



Note: The forest plot describes standardized mean difference, 95 percent lower and upper bound confidence interval in parentheses, and sample size (N = number). The standardized mean difference and confidence interval were calculated by Comprehensive Meta-Analysis software. Bracketed numbers correspond to the numbered studies in References. The WASI, WISC, WAIS, and WPPSI reported in this forest plot use total scale scores (i.e., full-scale IQ). CCT = conditional cash transfer; WASI = Wechsler abbreviated scale of intelligence; WISC = Wechsler intelligence scale for children; WAIS = Wechsler adult intelligence scale; WPPSI = Wechsler preschool and primary scale of intelligence. LBW = Low birthweight. SF = supplementary feeding.

a. Nicaragua study [6] includes Cognitive outcome, but they are measured through Denver Development Screening Test, which is not necessarily comparable to other Wechsler scale. Therefore, Nicaragua study uses Raven's Colored Matrices included in the study.

b. For Mexico study [8], it is not included in this forest plot because it looks at same average age at evaluation with [32].

c. Guatemala study [31] uses first three of five scales in Raven's matrices as non-verbal cognitive ability outcome.

d. For Jamaica studies [18, 51, 52, 55] on stunted children, the stimulation compares "stimulation only + stimulation and supplementation" vs "no intervention + supplementation only". Similarly, the supplementation compares "supplementation + supplementation + stimulation" vs "no intervention + stimulation".

e. Jamaica study [18] uses (i) WRAT math, (ii) WRAT reading comprehension, (iii) PPVT, (iv) Verbal analogies, (v) Raven's matrices, (vi) WAIS full-scale IQ tests to compute cognitive factor through factor analysis.

Nonverbal Cognition

Evidence of the effects of early childhood interventions on nonverbal cognition is particularly thin. Although positive outcomes were found for stimulation, deworming, and social protection interventions, these results are only observed for a single program in each intervention type. Only one of four nutritional interventions improved nonverbal cognition.

Nonverbal cognition reflects an individual's ability to reason and recognize relationships between concepts. Since assessments do not rely upon verbalization or existing knowledge, measures of nonverbal cognition can provide insight into the cognitive abilities of a child who might otherwise be limited by poor language abilities. The most commonly applied assessment of nonverbal cognition in the included IEs is Raven's Progressive Matrices, which ask an individual to progress through increasingly difficult pattern recognitions.

Single and multiple micronutrient supplementation interventions did not provide a statistical benefit for nonverbal cognition. No significant improvements in Raven's matrices tasks were observed in nine-year-old children who had participated in the Thailand iron and/or zinc program that compared infants four to six months of age who received supplementation for six months with infants who received a placebo.[38] Offspring of pregnant women in The Gambia who received two high energy, high protein biscuits daily for 20 weeks showed no detectable gains in nonverbal cognition at 16–22 years old when compared to children whose mothers received the biscuits for 20 weeks postnatally.[1] The nutritional supplementation component of the Jamaica also did not find any benefit on tests of nonverbal cognition compared to a control group when program participants were measured between the ages of 17 and 18 years old.[52]

The only nutritional intervention to improve nonverbal cognitive outcomes was the supplementary feeding program of Guatemala's Instituto de Nutrición de Centroamérica y Panamá. A high-energy high-protein supplement was made available to all pregnant and lactating women and children under six. Children who had received the supplement between birth and three years old registered large and lasting advantages in fluid intelligence when tested between the ages of 25 and 42.[31] This gives significant weight to the position that if (and perhaps only if) a nutrition intervention is sustained throughout the first thousand days of a child's life will a nutrition intervention be able to yield results that last beyond early childhood.

The effects of stimulation on nonverbal cognition was measured in two studies, both of which evaluated the Jamaica supplementation and stimulation program for stunted children. The early stimulation component resulted in significant improvements in nonverbal cognition when children were between 11 and 12 years old.[51] Those benefits were still large but marginally significant (perhaps because of the small sample size) when children were again evaluated between 17 and 18 years of age.[52] Non-verbal cognition was not measured at age 22, though general cognition effects become even stronger at that age (see previous section).

Improvements were also observed in nonverbal cognition for the Red de Protección Social for 10-year-old boys in Nicaragua.[6] However, no effects were found for girls. Siblings of children exposed to a deworming program in Kenya also demonstrated significant improvement in both nonverbal cognition and an overall cognitive factor score.[36] The authors posit that this could either be due to a direct nutritional effect from carrying a lower parasitic load, or it may also be that the better health status of children conferred upon the younger siblings of those affected by the intervention could have improved schooling outcomes such as attendance, which may also have contributed to improvements in cognition.

Finally, the Safe Motherhood Program (SMP) in Indonesia employed an army of nurses with one year of training to provide access to obstetric and child health care along with parent training on nutrition and health practices in rural villages.[12] Following children born into this program a decade later revealed a highly significant advantage of 0.11 standard deviations on the Raven cognition test for 10 to 14 year-olds compared to children born into villages that did not live in a beneficiary village or whose village did not receive a nurse until after the child was age four.

Executive Function

There is very little evidence of consistent effects on executive function across the range of intervention domains. Stimulation does not seem to improve executive function as much as other cognitive measures.

Executive function skills enable children to adapt to the changing environment around them, and are assessed by measuring cognitive processes such as working memory and problem solving. Measures of the executive function dimension of cognition were obtained in evaluations of nutrition, stimulation, and social protection interventions, although the evidence base is thin across all intervention types.

Two studies of nutritional programs reported effects on executive function measures, and neither the iron and zinc supplementation program in Thailand[38] nor the maternal supplementation program in The Gambia[1] noticeably improved executive function.

Only one of the three stimulation programs for which executive function was measured was found to improve outcomes, and the only program to measure outcomes at multiple stages of a child's life did not find any significant improvements. Stimulation for low birthweight infants in Jamaica resulted in improved short-term memory at age six. However, no measurable improvements in processing speed were observed among stunted Jamaican children at ages 11–12[51] or working memory at ages 17–18.[52] The Bucharest foster care program also did not measurably improve 8 year olds' executive function, as assessed by perceptual reasoning, working memory, processing speed,[17] and visual and spatial working memory metrics.[2]

Only a single study evaluated the effects of a CCT program on executive function. The assessment of Nicaragua's CCT program[6] found a significant improvement in processing speed among 10-year-old boys whose families were eligible for the cash transfer. No effects were observed among girls.

Cognition Summary

While the evidence base may not be sufficiently robust to be decisive, these findings suggest that stimulation programs may be more likely to be effective than supplementation alone in affecting both full-scale and abbreviated measures of IQ and of nonverbal cognitive ability as measured subsequent to the early childhood period. These findings are in line with the growing body of biological and environment design research that has shown that the relationship established between caregivers and children during stimulating interactions allows infants to tactilely and perceptually explore their environments, facilitating neuronal growth and the development of basic cognitive skills necessary for learning progression throughout adolescence (Ngure and others 2014; Grantham-McGregor and others 2014).

As the positive gains in cognitive development in stunted children in the Jamaica study suggest, stunted children may be poised to particularly benefit from stimulation programs (see box 2.1). Nutrition-deficient children tend to be less likely to interactively engage with their environment, inhibiting their ability to develop cognitive skills through tactile exploration and reciprocal relationships with caregivers. Thus an increasing focus has been given to combining necessary nutritional supplementation with stimulation interventions for stunted children (Grantham-McGregor and others 2014).

The ability of several cash transfer programs included in this review to produce sustained cognitive gains suggests that social assistance interventions, when received during the early childhood period, can result in effective investments in children's development. These investments in areas such as health, nutrition, or education may help to mitigate vulnerability during particularly sensitive periods of cognitive development, thus reducing the lasting negative impacts of toxic stress (Denboba and others 2014; Shonkoff and others 2012a).

Finally, the fact that both Guatemala's INCAP nutritional supplementation and Indonesia's Safe Motherhood healthcare access interventions were most successful when provided to very young children substantiates the view that sustained intervention throughout the first thousand days yields important, lasting cognitive benefits.

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[1] Fluid intelligence refers to being able to reason and apply logic, often requiring pattern recognition or the understanding of the relationships between things. This is distinct from crystallized intelligence, which refers to the ability to use acquired knowledge and vocabulary.

[2] Executive function abilities have become popular to assess in recent years as they are believed to be related to schooling and a number of life outcomes. See Center on the Developing Child, Harvard University (http://developingchild.harvard.edu/key_concepts/executive_function) for more information and discussion.

[3] For example, although randomized evaluations of the Head Start program detected cognitive gains among program participants between ages three and four (HHS 2005), nearly all of the gains disappeared by the start of first grade (HHS 2010).[3] Similarly, in the Early Childhood Longitudinal Study, Magnuson, Ruhm, and Waldfogel (2007) used nonexperimental methods to tease out the effects of preschool programs, and found that improvements on test scores diminished after kindergarten.

[4] Nores and Barnett (2010) define long-term as beyond age seven years.

3. Language Development

The evidence suggests that early childhood development (ECD) interventions can have lasting effects on language, although the results were mixed within intervention types and outcome subcategories.

The capacity to communicate begins to develop very early in life and is indicated by babbling, responding (nonverbally) to words, gesturing, and speaking. In the United States and in other countries, it has been noted that during the second year of life (12–24 months), children experience a vocabulary explosion during which time the learning of new words increases exponentially. As children enter the preschool years, language capacities become more sophisticated, not only in vocabulary but also in terms of spoken grammar and sentence structure. Children also develop the capacity to identify letters and perhaps words. These skills are important for enabling children to read and do well in school.

Much of the focus on interventions to promote language development come from research highlighting that children growing up in verbally rich households show greater knowledge of words (Hart and Risley 1995), and this is related to future learning (Walker and others 1994). There is substantial evidence that children in poorer homes are talked to far less and hear many fewer complex words than their better-off peers. Thus, the gaps in language abilities by wealth are likely from, in part, less verbal stimulation. As a result, many parenting, stimulation, and education programs emphasize activities involving verbal responsiveness to infants and young children and reading, singing, and telling stories.

The verbal assessments included by studies in this review are measures of receptive (that is, how much is understood) and expressive (that is, how many words are said) vocabulary, such as the Peabody Perceptual Vocabulary Test; scales that test other types of verbal skills (for example, verbal similarities, comprehension); and achievement tests that focus specifically on reading abilities.

Table 3.1 maps the 18 unique studies included in this review that investigate language outcomes. The studies span 15 different projects and 11 intervention types across 13 countries. They are grouped according to the outcome category in which they report measurements; the specific intervention within each category is noted. These classifications align with the taxonomy presented in (figure 2 in the Introduction). While there were a range of outcomes reported, as with other outcome domains, the estimates were separated into three subcategories (verbal abilities, vocabulary, and reading, literacy, and preliteracy) to make the interpretation of results more comparable across studies.

Table 3.1. Impact Evaluations Investigating Language Development

	Study	Country (Project)	Average Age at Intervention (Years)	Average Length of Exposure (Years)[b]	Age at Evaluation (Years)	Evaluated Intervention	Reviewed Outcomes
Nutrition	Kramer and others 2008a [27]	Belarus (Promotion of Breastfeeding Intervention Trial [PROBIT])	0	1	6	breastfeeding promotion	reading ability*; verbal abilities (abbreviated test)**; vocabulary**
Nutrition	Pongcharoen 2010 [38]	Thailand (micronutrient supplementation to children)	0.5	0.5	9	micronutrients and fortified food for children (iron and zinc supplementation)	verbal abilities
Nutrition	Alderman and others 2014 [1]	Gambia, The (maternal supplementation)	in utero	0.5 (DR1)	16–22	vitamins, micronutrients, or fortified food for pregnant women (protein biscuits)	vocabulary (expressive and receptive)
Nutrition	Walker and others 2000 [51][a]	Jamaica (stimulation and supplementation to stunted	1.55	2	11–12	supplementary feeding	receptive vocabulary; verbal abilities; vocabulary
Nutrition	Walker and others 2005 [52][a]	Jamaica (stimulation and supplementation to stunted	1.55	2	17–18	supplementary feeding	reading abilities; receptive vocabulary; verbal abilities; verbal analogies
Nutrition	Walker and others 2011 [55][a]	Jamaica (stimulation and supplementation to stunted	1.55	2	22	supplementary feeding	reading abilities; verbal abilities
Nutrition	Maluccio and others 2009 [31]	Guatemala (INCAP supplementary feeding to children)	0	5.3	25–42	supplementary feeding	reading abilities**
Early Learning/Childcare	Martínez, Naudeau, and Pereira 2012 [35]	Mozambique (preschool)	3.45	1.5	5–9	quality early childhood and preprimary program	receptive vocabulary
Early Learning/Childcare	Walker and others 2010 [54]	Jamaica (stimulation to low birthweight Infants)	0	2	6	stimulation	reading abilities; receptive vocabulary; verbal abilities

	Fox and others 2011 [17]	Romania (Bucharest Early Intervention Project)	1.88	2.7	8	stimulation (foster care)	verbal abilities**
	Walker and others 2000 [51][a]	Jamaica (stimulation and supplementation to stunted	1.55	2	11–12	stimulation	receptive vocabulary; verbal abilities**; vocabulary**
	Walker and others 2005 [52][a]	Jamaica (stimulation and supplementation to stunted	1.55	2	17–18	stimulation	reading***; receptive vocabulary**; verbal abilities**; verbal analogies**
	Walker and others 2011 [55][a]	Jamaica (stimulation and supplementation to stunted	1.55	2	22	stimulation	reading abilities***; verbal abilities***
Health	Ozier 2013 [36]	Kenya (primary school deworming project)	0	1	8–15	deworming	receptive vocabulary*
Social Protection	Secretariat of Social Development 2008 [8]	Mexico (Progresa)	1.5	1.5 (DR2)	7–11	CCT	reading comprehension; verbal abilities (abbreviated test)**
	Manley, Fernald, and Gertler 2012 [32]	Mexico (Progresa)	1	1.5 (DR2)	8–10	CCT—conditionalities	verbal abilities (abbreviated test)
						CCT—cash	verbal abilities (abbreviated test)***
	Barham and others 2014 [6]	Nicaragua (Red de Protección Social)	in utero	3 (DR2)	10 (boys)	CCT	receptive vocabulary**
	Rackstraw 2014 [39]	Honduras (Programa de Asignación Familiar)	1.5	2	13–15	CCT	reading abilities*
	DSD, SASSA and UNICEF 2012 [14]	South Africa (Child Support Grant)	1	2.5	10	unconditional or targeted income support	reading abilities
	Spears and Lamba	India	0	continuous	6–8	adequate sanitation	reading*

Water	2013 [44]	(Total Sanitation Campaign)					
Other	Pathak and Macours 2013 [37][c]	India (women's political reservation)	pre-birth birth	3 (DR1)	8	governance (women's political reservation)	reading abilities (in utero)*; reading abilities (0–5 years); receptive vocabulary

Verbal Ability

The evidence of ECD programs that improve verbal abilities is mixed, and only the stimulation component of a single program produced consistent improvements over an individual's life.

Together with performance IQ, verbal abilities make up full-scale IQ scores. As with other cognitive measurements, they can be measured using an abbreviated or full test. The effects on verbal abilities from nutritional interventions are mixed. Thailand's iron and zinc supplementation program for infants did not produce observable gains at age 9 years,[38] and an evaluation of Jamaica's supplementation programs did not find significant differences at ages 17–18 or 22 years of age.[52, 55] However, children whose mothers participated in Belarus's breastfeeding promotion program (PROBIT) had significantly better scores on an abbreviated measure of verbal abilities at 6 years of age compared to children's whose mothers had not participated (see figure 4.1).[27]

Similar to the trend seen with cognitive outcomes, stimulation interventions were more successful than supplementation interventions in producing improvements in verbal abilities. Of the four studies of stimulation programs that reported verbal ability measurements, all had a significant effect.[1] Three of these studies evaluated the stimulation arms of the Jamaica intervention at different points in the child's life: between the ages of 11–12 years, 17–18 years, and 22 years old.[51, 52, 55] An assessment of the BEIP foster care program in Romania (see box 3.1) also observed improved verbal abilities among 8 year olds who had been placed in foster care as compared to their peers who remained in institutional care.[17]

Box 3.1. Fostering and Stimulation in Romania Improved Language and Other Outcomes

The Bucharest Early Intervention Project was designed to give orphaned and abandoned young children living in institutional care a chance to be exposed to the type of stimulating environment believed to improve many development outcomes. At an average age of 21 months (range of 9–33 months), 136 children were randomly assigned to either remain in the government facility or be placed in a foster care home. The institutional environment was characterized by structured, unresponsive routines and a low caregiver-to-child ratio (Windsor and others 2011). All of the foster homes received ongoing support from program social workers, including training on how to provide a caring, stimulating environment for the children (Nelson and others 2007).

The program officially ended when children were 54 months old. Children could change care environments at any time during or after the project, with the one provision that foster care children would not return to institutional care (though institutionalized children could be fostered or adopted, making the intent-to-treat estimates a lower bound of program effectiveness). Children's development was periodically assessed from entry into the program through the age of 12 years, producing a barrage of studies assessing their development across a wide range of outcomes, including many that are not typically seen in the ECD literature. This review identified 11 studies, reporting a total of 49 outcomes over four domains that measured post-early childhood effects and were of sufficient quality to be included.

Physical Development

During the first 12 months of their placement, foster care children grew significantly more than their institutionalized peers in height and weight, although there was no detectable difference in head circumference or WAZ. After 12 months, they had height and weight scores in normal range, but the institutionalized group did not measurably improve (Johnson and others 2010).

However, physical gains appear to have ended after 12 months. No improvements were observed between 12–18 months (Johnson and others 2010), and none of the 19 physical outcomes in the post-early childhood period reported by studies in this review were significantly better for the foster child group.

Cognition Development

Improvement in cognitive abilities among children placed in foster care became apparent at an early age, and some gains in IQ were still observed in the post-early childhood period. When evaluated at 42 and 54 months, children in foster care performed significantly better on tests of cognitive ability. By age 8 years, these cognitive gains had translated into significantly higher full-scale IQ scores,[17] although there were no significant benefits in multiple measures of executive function.[11, 17]

Language Development

Although both groups learned language over time, the foster care children learned significantly more. By 30 months of age, foster care children showed some early gains in receptive language, but not in expressive language or their overall development quotients (DQs). By 42 months, however, they demonstrated significant improvements in both expressive and receptive language scores as measured by the developmental language scales (RDLS), though their DQs were still not measurably different (Windsor and others 2011).

By 8 years of age, all five of the unique language outcomes reported by studies in this review were significantly better in the foster care (stimulated) group.[17, 56] One of these measures—verbal comprehension—is a traditionally-reported language outcome in the ECD literature with a standardized measurement construct.

Socioemotional Development

Advantages in reduced socioemotional challenges benefits phase in and out through early childhood. Despite the absence of observable differences between the foster care and institutionalized children on multiple measures of socioemotional development at baseline, by 42 months of age foster care children were significantly better at paying attention and exhibited better positive affect (Ghera and others 2009). Twelve months later, foster care children were significantly less likely to have internalizing disorders such as anxiety, but there were no observable differences in externalizing disorders such as ADHD (Zeanah and others, 2009).

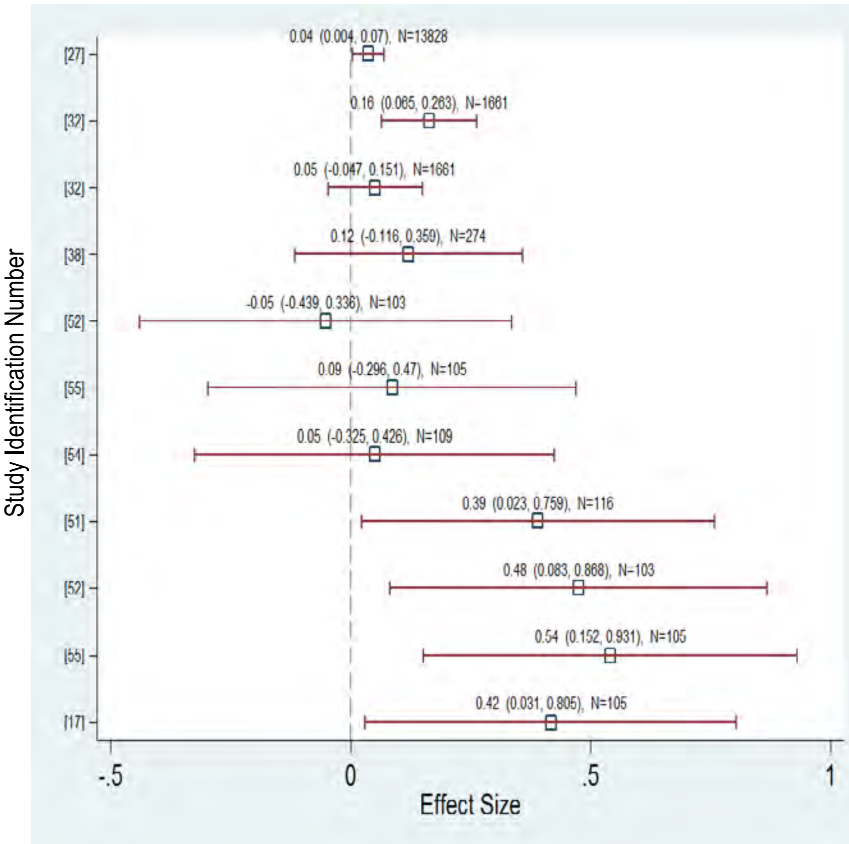
Improvements in socioemotional development solidified during early adolescence when children were 10 and 12 years old. The studies in this review reported 17 unique measurements of socioemotional outcomes at these ages, 11 of which were significant, including higher scores on the Social Communication Questionnaire at 10 years and decreased externalizing behavior[23] at 12 years.[30]

An additional 18 months of exposure to Mexico's Progresa (see box 5.1), which occurred while the children were still eligible for nutritional supplementation and were required to attend additional health checkups, significantly increased abbreviated verbal abilities scores among 7- to 11-year-old children.[8] However, a study that disentangled the effects of abiding by the conditionalities versus receiving the cash transfer found that only the latter component had a significant impact on abbreviated verbal abilities scores among children 8–10 years old.[16, 32]

Figure 3.1. Forest Plot for Verbal Abilities

Country	Intervention	Measurement	Average Age at Evaluation (years)
Belarus	Breastfeeding	WASI	6.5
Mexico[a]	CCT cash	WASI	9
Mexico[a]	CCT conditionality	WASI	9
Thailand	Nutrition (child, micronutrient)	WISC-III	9
Jamaica[a]	Nutrition (stunted children, SF)	WAIS	17.5
Jamaica[a]	Nutrition (stunted children, SF)	WAIS	22
Jamaica	Stimulation (LBW children)	WPPSI	6
Jamaica[b]	Stimulation (stunted children)	WISC-R	11.5
Jamaica[b]	Stimulation (stunted children)	WAIS	17.5
Jamaica[a]	Stimulation (stunted children)	WAIS	22
Romania	Stimulation (foster care)	WISC-IV	8

Study and Forest Plot



Note: The forest plot shows standard mean difference, 95 percent lower and upper bound confidence interval in parentheses, and sample size (N=number). The standard mean difference and confidence interval were calculated by Comprehensive Meta-Analysis software. Bracketed numbers correspond to numbered studies in References. All the results come from the verbal abilities score calculated within each test (WASI, WISC, WAIS, WPPSI). CCT = conditional cash transfer; WASI = Wechsler abbreviated scale of intelligence; WISC = Wechsler intelligence scale for children; WAIS = Wechsler adult intelligence scale; WPPSI = Wechsler preschool and primary scale of intelligence. LBW = Low birthweight. SF = Supplementary feeding.

a. Mexico study [8] is not included in this forest plot given that it looks at same average age at evaluation with [32].

b. For Jamaica studies [51, 52, 55] on stunted children, the stimulation compares “stimulation only + stimulation and supplementation” versus “no intervention + supplementation only.” Similarly, the supplementation compares “supplementation + supplementation + stimulation” versus “no intervention + stimulation.”

Reading and Literacy

Reading and literacy outcomes were improved by stimulation, sanitation, and governance programs, although there are only single studies of each of these intervention types. Nutritional interventions had mixed results, and social protection programs did not have a measurable effect on reading and literacy

Tests of reading abilities (for example, word reading, sentence completion, and context comprehension) are also likely to play a large role in determining educational achievements. However, supplementation did not consistently improve reading outcomes. Two studies that measured the effects of nutritional interventions on reading outcomes evaluated the Jamaica supplementation program and found that between the ages of 17 and 18 years old,[52] and again at age 22,[55] children who received supplementation did not have noticeably improved reading abilities compared to those who had not been given supplementation.

However, an assessment of the breastfeeding promotion program in Belarus found a marginally significant improvement in reading among 6.5-year-old children whose mothers had been encouraged to breastfeed (see figure 3.2).[27] In Guatemala, children who had participated in the supplementary feeding program of the Instituto de Nutrición de Centroamérica y Panamá demonstrated higher levels of reading comprehension between the ages of 25 and 42 years old.[31] It is difficult to determine, however, whether the positive effects found in Belarus and Guatemala are due to the specific nature of the intervention or the ages at which children received the intervention.

Stimulation also improved reading and literacy. The same two studies that reported the effects of the supplementation only arm in Jamaica also evaluated the stimulation component and found highly significant advantages in reading levels at both 17–18 years of age and 22 years of age.[52, 55] Interestingly, these studies allow for a direct comparison of the effects of supplementation versus stimulation on reading outcomes for the same participant group at the same ages, and suggest that stimulation is better able to improve post-early childhood reading outcomes (see figure 3.2). However, it must be noted that these findings are only applicable to a single program that was not implemented at scale and cannot be reliably generalized across contexts until further research has been done.

Three studies evaluated the effects of conditional cash transfers on reading comprehension. An assessment of the effects of an additional 18 months of exposure to Progresa in Mexico did not observe significant improvements when children were tested between the ages of 7 and 11 years.[8] Similarly, neither an unconditional cash transfer and income support program in South African nor a CCT in Honduras improved reading comprehension[14] or literacy[39] among 10-year-olds.

A single study was also found that assessed the effects of a sanitation intervention on language outcomes. In India, children living in areas where the Total Sanitation Campaign was implemented during the first year of their lives were exposed to more latrines than children born either in the same district in a different year or in a different district in the same year. At ages 6, 7, and 8 years, these children had marginally significantly higher literacy scores.[44]

One study assessed the impact of a political intervention in India on children's development outcomes. In Andhra Pradesh, local political seats were randomly reserved for women over several election cycles. The study measured learning outcomes among children who were exposed to the political reservation cycles during different periods of early childhood. The first cycle of reservations occurred five years prior to the birth of the first cohort of children and ended soon after their birth. Before being evaluated at age 8 years, the first cohort had thus received five years of the exposure to the treatment period and 8 years of exposure to post-treatment period in which improvements in norms and attitudes towards female political leadership and the issues they espoused may have persisted. A second cohort consisted of children who were born at the beginning of the next reservation cycle. These children lived in a treatment period for the first five years of their lives, but only had three years of exposure to the post-treatment period before being assessed at age eight years.

The two treatment cohorts were compared to a cohort of children who were six years old before seats were allocated for women in their districts. Although they experienced two years of exposure to the treatment period, this occurred after their entry to primary school, and they did not have any exposure to the post-treatment environment. Although no improvements in reading were observed among the second cohort, the first cohort of children did have significantly higher scores on an early grade reading assessment at age 8 years.[37] These results suggest that the long exposure to the post-treatment environment experienced by the first cohort, during which time some of the policies and norms established during the period when seats were allocated for women may have continued and so may have played a crucial role in affecting language outcomes beyond the early childhood period.

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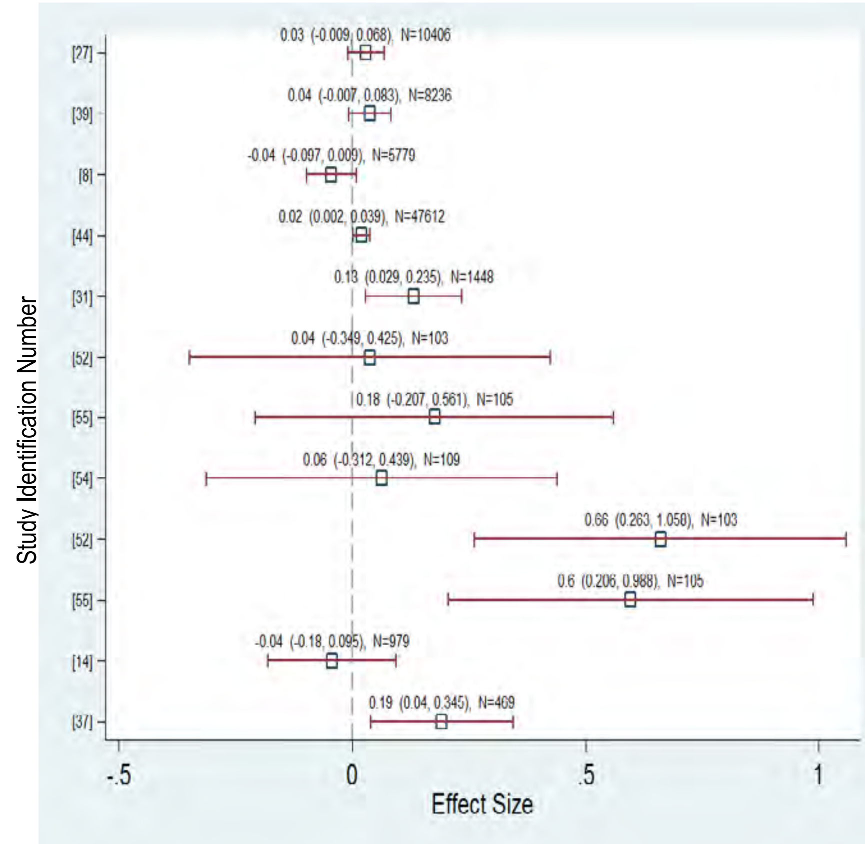
[1] Study [54], which provided stimulation to low birthweight Jamaican children, reported results for "verbal abilities," for six year olds, but no significant effects were observed.

Figure 3.2. Forest Plot for Reading and Literacy

Country	Intervention	Measurement	Average Age at Evaluation (years)
Belarus	Breastfeeding	Reading ability (TRAP)	9
Honduras	CCT	Literacy	14
Mexico	CCT	Ability to read	9
India	Sanitation	Recognizing letters	6
Guatemala	Nutrition (child, SF)	IARCT	32.3
Jamaica[a]	Nutrition (stunted children, SF)	Group reading test (RCC)	17.5
Jamaica[a]	Nutrition (stunted children, SF)	WRAT (Reading (log))	22
Jamaica	Stimulation (LBW children)	ERA (sqrt)	6
Jamaica[a]	Stimulation (stunted children)	Group reading test (RCC)	17.5
Jamaica[a]	Stimulation (stunted children)	WRAT (Reading (log))	22
South Africa[b]	UCT	Ability to read a story	10
India	Women's political reservation	EGRA	8

Study and Forest Plot



Note: The forest plot describes standard mean difference, 95 percent lower and upper bound confidence interval in parentheses, and sample size (N = number). The standard mean difference and confidence interval were calculated by Comprehensive Meta-Analysis software. Bracketed numbers correspond to the numbered studies in References. CCT = conditional cash transfer; UCT = unconditional cash transfer. TRAP = Teacher Ratings of Academic Performance. SF = Supplementary feeding. LBW = Low birthweight. IARCT = Inter-American reading and comprehension test. RCC = Reading context comprehension. WRAT = Wide Range Achievement Test. ERA = Early reading assessment. EGRA = Early grade reading assessment.

a. For Jamaica studies [52, 55] on stunted children, the stimulation compares "stimulation only + stimulation and supplementation" versus "no intervention + supplementation only." Similarly, the supplementation compares "supplementation + supplementation + stimulation" versus "no intervention + stimulation."

b. For South Africa study [14], the outcome is measured through the Early Grade Reading Assessment in which a child has to do a timed reading of letters and familiar words.

Vocabulary

The evidence of ECD interventions' effects on vocabulary capabilities is too thin and mixed to inform a general conclusion.

The evidence is inconsistent for measurements of vocabulary. Among nutritional interventions, the breastfeeding promotion program in Belarus resulted in improved reading among 6.5 year olds,[27] but The Gambia nutritional intervention did not produce detectable improvements in vocabulary between the ages of 16 and 22 years (see figure 3.3).[1]

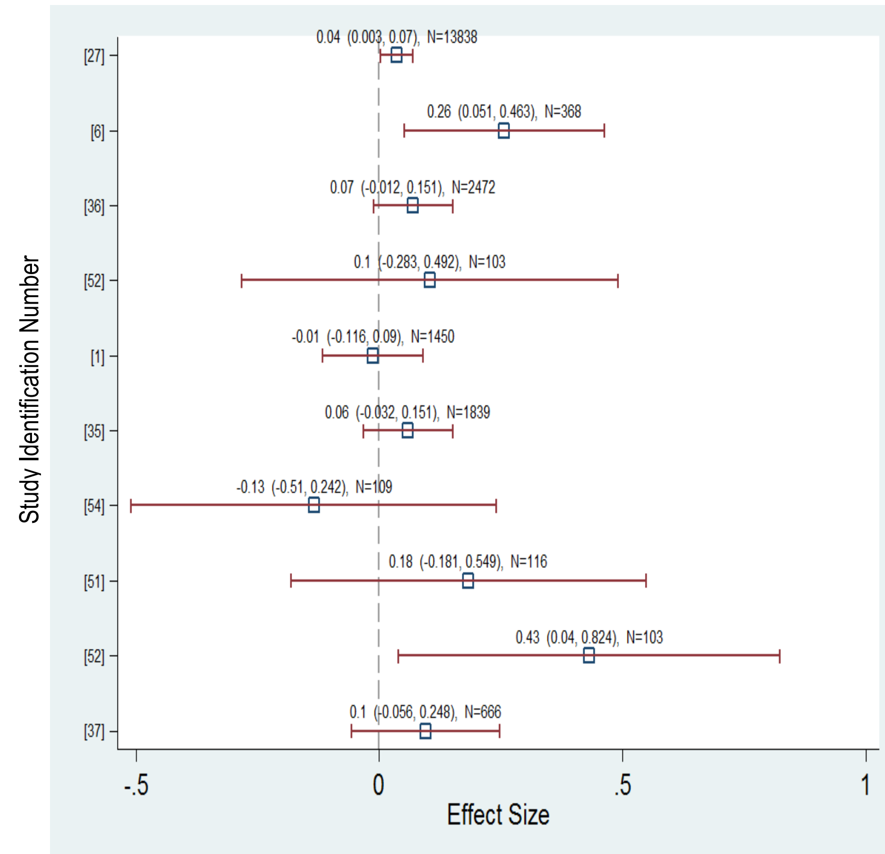
Programs promoting stimulation also had mixed effects. The preschool and mother training program in Mozambique did not noticeably improve vocabulary scores among participating children between the ages of five and nine years old,[35] while the Jamaica program that provided stimulation to stunted children did significantly improve vocabulary abilities at ages 11–12 years and age 17–18 years.[51, 52] The lack of density of evidence for these intervention types makes it difficult to form broad conclusions about what type of programs can successfully and consistently produce long-term improvements in vocabulary abilities.

Three intervention types' effect on vocabulary outcomes are represented by a single study each: social protection programs, disease prevention treatments, and governance interventions. An evaluation of Nicaragua's CCT program found significant improvements in vocabulary among 10-year-old boys whose families had been eligible for the program.[6] Siblings of children who had been part of a school deworming program had only a marginally significant improvement in vocabulary abilities at age 15 years.[36] In India, the random allocation of political seats to women did not produce measurable improvements in vocabulary for a cohort of children for which seat reservations occurred for five years prior to birth, or a cohort for which seats were allocated during the first five years of their lives, when compared to children who were not exposed to a reservation period until age six years.[37] Again, the absence of a dense evidence base for each of these intervention types limits the ability to draw reliable conclusions from these findings.

Figure 3.3. Forest Plot for Vocabulary

Country	Intervention	Measurement	Average Age at Evaluation (years)
Belarus	Breastfeeding promotion	WASI	6.5
Nicaragua[a]	CCT	TVIP[b] (boy)	10
Kenya	Deworming	PPVT	10
Jamaica[c]	Nutrition (stunted children, SF)	PPVT	17.5
Gambia, The	Nutrition (mother)	MHVT	19.6
Mozambique	QEC and PPP	TVIP[b]	7
Jamaica	Stimulation (LBW children)	PPVT	6
Jamaica[c]	Stimulation (stunted children)	PPVT	11.5
Jamaica[c]	Stimulation (stunted children)	PPVT	17.5
India	Women's political reservation	RV	8

Study and Forest Plot



Note: The forest plot describes standard mean difference, 95 percent lower and upper bound confidence interval in parentheses, and sample size (N = number). The standard mean difference and confidence interval were calculated by Comprehensive Meta-Analysis software. Study numbers in brackets correspond to the numbered studies in References. CCT = conditional cash transfer; PPVT = Peabody Picture Vocabulary Test; TVIP = Test de Vocabulario en Imagenes Peabody; WASI = Wechsler abbreviated scale of intelligence. SF = supplementary feeding. LBW = Low birthweight. MHVT = Mill Hill Vocabulary Test. RV = Receptive vocabulary. QEC = Quality early childhood. PPP = Pre-primary program.

a. Nicaragua study [6] only reports boy's outcome.

b. TVIP is a Spanish version of PPVT.

c. For Jamaica studies on stunted children, the stimulation compares "stimulation only + stimulation and supplementation" versus "no intervention + supplementation only." Similarly, the supplementation compares "supplementation + supplementation + stimulation" versus "no intervention + stimulation."

Language Summary

As with cognition, the evidence suggests that stimulation is better able to improve post-early childhood language outcomes than are micronutrient or macronutrient supplementation programs. This is in line with research that shows the quality of parent-child interactions (for example, how parents speak to and respond to infants and young children) is an important predictor of language development. The human brain develops in time-sensitive periods during which interaction with an individual's environment facilitates neuronal connections that are important for the development of cultural skills. Stimulation programs play a particularly important role in facilitating this process by encouraging caregivers to interact with children through a reciprocal relationship that establishes verbal and nonverbal communication skills (Black and Dewey 2014; Grantham-McGregor and others 2014; Wachs and others 2014).

There is solid rationale for expecting that various types of nutritional interventions to children at-risk for or suffering from deficiencies such as chronic malnutrition and iron deficiency could positively impact cognitive and language outcomes. However, the available evidence suggests that supplementation alone may not be enough to produce sustained effects on these abilities.

4. Socioemotional Development

Improvements in externalizing behavior do seem to manifest as participants age, and both conditional cash transfers (CCTs) and early stimulation may improve abbreviated measures of children's behavioral problems, but it appears harder to create a sustained change in internalizing behavior.

Socioemotional functioning refers to a broad range of intra- and interpersonal competencies. Intrapersonal competencies include, for example, how individuals view themselves, how they manage their feelings, how they approach and respond to problems or difficulties, and what their capacities are for self-motivation, perseverance, and attention. Interpersonal skills are concerned with how individuals establish and maintain relationships and how they interact with others. In the early years, the primary socioemotional tasks include forming loving and trusting relationships with adults, becoming independent, recognizing and learning how to control emotions and impulses, learning to read others' emotions, and developing empathy. Many of these skills are important for starting school ready to learn, and are believed to be necessary for succeeding in school, and subsequently, other aspects of life. Good early socioemotional development is also important in that it contributes to a person's ability to cope with anxiety and depression, maintain good self-esteem, and become self-sufficient. For this reason, socioemotional outcomes are important objectives of many early childhood development (ECD) interventions.

Children growing up in poor or adverse environments may be at increased risk for developing socioemotional responses or behaviors that can negatively impact not only their current functioning (Evans and others 2005; Kalil, Yoshikawa, and Ziol-Guest 2014), but also their future mental and physical well-being (Pechtel and Pizzagalli 2011; Shonkoff and others 2012a; Schilling, Aseltine and Gore 2007; Slopen, Koenen, and Kubzansky 2014). Prolonged exposure to abuse, neglect, violence, or other adversity can trigger a "toxic stress response" in a child, which can interfere with brain development and health organ functions, leading to stress-related diseases and cognitive impairment that can persist into adulthood (Shonkoff and others 2012a).

Longitudinal studies in developed countries have found low-income status associated with increases in externalizing[1] and internalizing[2] behaviors across childhood and adolescence (Bradley and Corwyn 2002; Brooks-Gunn and Duncan 1997; Evans, Li, and Whipple 2013), and there is evidence that these persist into adulthood (for example, Schilling, Aseltine and Gore 2007). There is also strong indication from developed nations that the effects of adversity early in life are apparent by the preschool years. For example, two large recent studies in the United States and United Kingdom found four-year-old children from the poorest homes showed more hyperactivity and problems with attention than did children from the wealthiest homes (Waldfogel and Washbrook 2011). In another national cohort study, English children who were raised in homes with high levels of cumulative adversity—including financial stress, maternal psychopathology, and neighborhood disadvantage—had more behavioral problems than children living in homes facing relatively little adversity (Slopen, Koenen, and Kubzansky 2014).

There is consensus in the literature from high-income countries that ECD programs can result in long-term improvements in an individual's social competence and psychological functioning (Ramey and Ramey 1998; Schweinhart, Barnes, and Weikart 1993; Schweinhart and others 2005; Gorey 2001; Camilli and others 2010; Yoshikawa 1994; Zigler and Styfco 1994; Zigler, Taussig, and Black 1992). For example, both in the short-term and up to 27 years after participating in preschool programs in the United States that were designed to improve cognitive and socioemotional functioning, participants experienced increases in social competence, defined as how well a child is able to interact in social situations (Anderson and others 2003).

Another robust effect found in the developed world is a decrease in behaviors such as crime. Evaluation of the Perry Preschool Project indicates fewer arrests among beneficiaries when followed up at age 40 years (Scweinhart and others 2005). Reynolds and others (2001) found that participants in Chicago's Child-Parent Centers, a program to help engage parents from low-income households in their children's preschool education, had lower arrest rates as young adults, while Donohue and Siegelman (1998) estimated that ECD programs can pay for themselves through reduced crime rates alone.

In low- and middle-income countries, one finds similar trends in regard to the association between adverse environments and poor socioemotional development (Kessler and others 2010). Reviews suggest that young children exposed to poverty and associated risks (that is, undernutrition, infectious disease, and insensitive parenting) exhibit more problematic behaviors (Walker and others 2007, 2011), and that these may continue into adulthood if there is no intervention to change their trajectory (Grantham-McGregor and others 2007).

As in high-income countries, however, evidence shows that a change in socioemotional outcomes is possible (Nores and Barnett 2010; Baker-Henningham and Lopez Boo 2010). For example, trials of parenting interventions to promote early stimulation through parent-child interactions have shown improvements in children's socioemotional outcomes (Engle and others 2011; Walker and others 2007; Walker and others 2011). Others have theorized that adequate early nutrition can also lead to socioemotional benefits (Black and others 2013; Engle and others 2007; Walker and others 2007).

A range of measures is used to estimate the effects of interventions on socioemotional outcomes, which are indicated in table 4.1. For younger children, many of these results are reported by parents or teachers, while measurements for older children and adults are often self-reported. The table details the 10 studies[3] in six countries that investigate socioemotional outcomes. There are seven different projects and six intervention types, identifying the specific indicators of both internalizing and externalizing behavior and the age of the individual at the time of evaluation.

Evaluations of programs in four different countries included estimates of externalizing behavior and distractibility during post-early childhood years. The effects from four unique interventions are shown in (figure 4.1).

Table 4.1. Impact Evaluations Investigating Socioemotional Development

	Study	Country (Project)	Average Age at Intervention (Years)	Average Length of Exposure (Years)[b]	Age at Evaluation (Years)	Evaluated Intervention	Reviewed Outcomes
Nutrition	Kramer and others 2008b [28]	Belarus (Promotion of Breastfeeding Intervention Trial [PROBIT])	0	1	6	breastfeeding promotion	strength and difficulties questionnaire (total difficulties)
Nutrition	Pongcharoen 2010 [38]	Thailand (micronutrient supplementation to children)	0.5	0.5	9	micronutrients and fortified food for children	Freedom from Distractibility Index
Nutrition	Walker and others 2011 [55][a]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	22	supplementary feeding	anxiety; depression; involved in a physical fight; involved in a violent crime; social inhibition; weapon use
Early Learning/Childcare	Walker and others 2010 [54]	Jamaica (stimulation and supplementation to stunted children)	0	2	6	stimulation	attention (map search, opposite-same (switching)); strength and difficulties questionnaire (total difficulties)**
Early Learning/Childcare	Humphreys and others 2015 [23]	Romania (Bucharest Early Intervention Project)	1.88	2.7	12	stimulation (foster care)	externalizing behavior**; hyperactivity; internalizing behavior
Early Learning/Childcare	Walker and others 2006 [53]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	17–18	stimulation	anxiety***; attention deficit**; depression**; hyperactivity; oppositional behavior*; self-esteem**
Early Learning/Childcare	Raine and others 2003 [41]	Mauritius (Child Health Project)	3	2	17	quality early childhood and preprimary program	anxiety; attention problem; hyperactivity**
Early Learning/Childcare	Gertler and others 2013 [18]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	22	stimulation	externalizing behavior factor; internalizing behavior factor**
Early Learning/Childcare	Walker and others 2011 [55][a]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	22	stimulation	anxiety; depression**; involved in a physical fight*; involved in a violent crime**; social inhibition*; weapon use

	Raine and others 2003 [41]	Mauritius (Child Health Project)	3	2	23	quality early childhood and preprimary program	court-reported criminal offenders*; self-reported criminal offenders**
Social Protection	Behrman and others 2008 [8]	Mexico (Progresa)	1.5	1.5 (DR)	7–11	CCT	strength and difficulties questionnaire**
Social Protection	Manley, Fernald, and Gertler 2012 [32]	Mexico (Progresa)	1	1.5 (DR)	8–10	CCT—conditionalities	strength and difficulties questionnaire**
						CCT—cash	strength and difficulties questionnaire

Note: Bracketed numbers correspond to numbered studies found in References. More details for each study are found in appendix A. CCT = conditional cash transfer; DR = dose response; INCAP = Instituto de Nutrición de Centroamérica y Panamá.

a. Jamaica [55] has a multiple intervention arm, and each intervention type has a separate row for this study.

b. DR in the length of exposure means intervention period in terms of the Dose Response. Specifically, DR here describes the dose response where early and late treatment effect is compared, and length of exposure is the difference of the intervention period between treatment and control group.
* Statistically significant at 10 percent.
** Statistically significant at 5 percent.
*** Statistically significant at 1 percent.

Box 4.1. Early Education and Health Enrichment in Mauritius Results in Improved Socioemotional Outcomes through Early Adulthood

The Mauritius Child Health Project, a two-year nursery school program for children between the ages of three to five, was started in 1972 based on recommendations by the World Health Organization (WHO) that countries focus on interventions that addressed malnutrition and poverty during the early childhood years. Although there are no estimates of effects during early childhood, beneficiaries were evaluated at three later points in time. One hundred three-year-old children, chosen from a population of 1,795, who were experimentally matched to a group of 100 comparison children based on similarity in psychophysiological baseline measures, gender, and ethnicity were evaluated at age 11.[40] Evaluations of the participants at ages 17 and 22 followed-up on 83 out of 100 treatment participants, and 355 individuals from the original population were matched on 10 variables (ethnicity, gender, age, nutritional status, cognitive ability, temperament, autonomic reactivity, parental social class, social adversity, and mother's age at birth) to construct a comparison group.

The intervention included preschool education, nutritional meals, educational programs, physical exercise, health assessments, and remediation for behavioral problems and learning disorders. Parental involvement was encouraged and home visits were also conducted. The children in the comparison groups also attended traditional community "petite écoles," but the teacher-pupil ratio was lower for students in the program (1:5.5 in the treatment group compared to 1:30 in the comparison group). Additionally, the food was of better quality and the health and educational curriculum better organized in the treatment group.[41]

Evaluations of the Child Health Project were the first to examine the effect of early education and health enrichment on psychophysiological functioning. The studies focused on measuring biological indicators of stress such as the level of a child's skin conductance, known as electrodermal activity, which reflect an individual's level of emotional stimulation and ability to pay attention and process information. These psychophysiological indicators were studied to understand the development of behavioral problems and antisocial behavior during early childhood. When children who were enrolled in the nursery program were tested between six and eight years after the intervention, at age 11, they showed signs of increased psychophysiological functioning—they were better able to process information and were more cognitively aroused than children of the same age who had not been exposed to the environmental enrichment program.[40]

Other studies were conducted to assess the effects of the program on adult outcomes of schizophrenia, conduct disorder, and criminal behavior. Results obtained through self-reported questionnaires and the Revised Behavior Problem Checklist suggested that at age 17 years participants showed fewer of schizophrenia and antisocial behavior, and at age 23 years were less likely to engage in criminal behavior. Interestingly, these positive outcomes were more pronounced among children who had been malnourished at age three years,[41] suggesting a catch-up effect.

The table below presents all of the outcomes reported by evaluations of the Mauritius Child Health Project. The lack of evaluations in five of the six outcome domains suggest that a significant research gap exists in the full understanding of the effects of early education and health enrichment on children's holistic development.

Outcome Domain by Age at Evaluation in the Mauritius Child Health Project

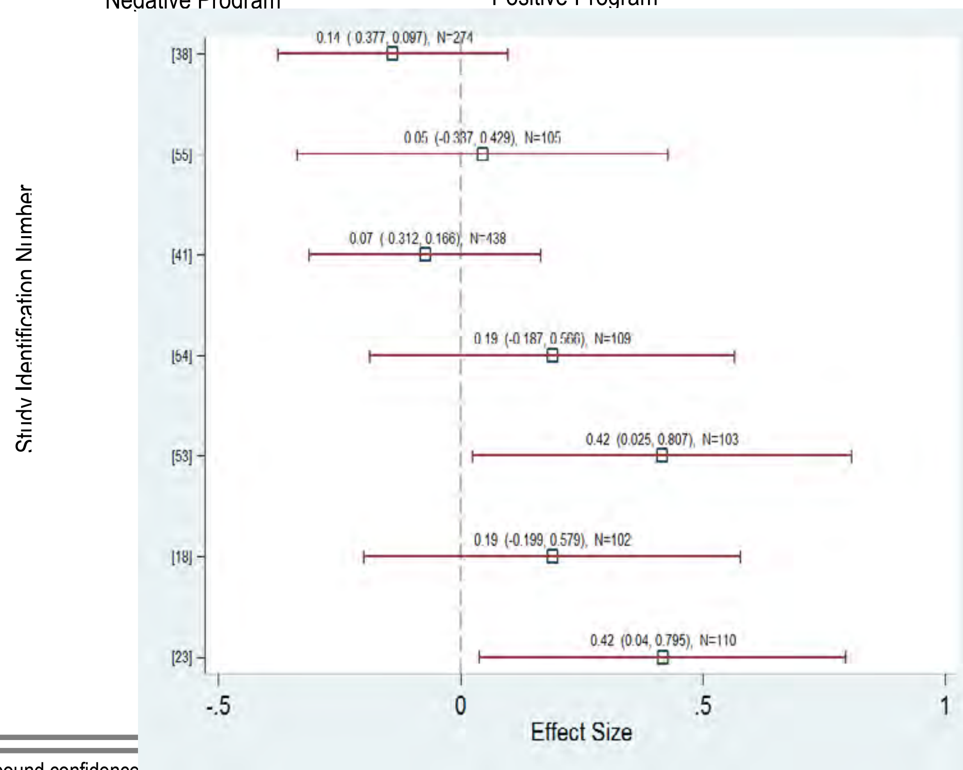
Age	Study	Physical Development	Cognitive Development	Language Development	Socioemotional Development	Schooling Outcomes	Employment and Labor Market Outcomes
11	[40]	4/7	-	-	-	-	-
17	[41]	-	-	-	5/8	-	-
23	[41]	-	-	-	1/6	-	-

Notes: To provide a more complete scope of these studies, this table includes all reported outcomes and not just those analyzed in the main body of this report (see box 1 in the Introduction for the decision rule for selecting outcomes for analysis). The numerator denotes statistically significant outcome at 10 percent level or better, and the denominator is the number of outcomes in the domain. The [bracketed] superscript number in the "Study" column is indicates study identifier (see References). No studies were found that produced causal estimates of the program during early childhood.

Figure 4.1. Forest Plot for Socioemotional Outcomes

Countr	Intervention	Measurement	Average Age at Evaluation (years)
Thailand	Nutrition (child micronutrient)	Freedom from DI[a]	9
Jamaica	Nutrition (stunted children, SF)	Social inhibition[b]	22
Mauritius	QEC and PPP	Attention	17
Jamaica	Stimulation (LBW	Attention (map search)[d]	6
Jamaica[e]	Stimulation (stunted children)	Attention deficit[f]	17.5
Jamaica[e]	Stimulation (stunted children)	Externalizing BF[g]	22
Romania	Stimulation (foster care)	Externalizing symptom	12

Study and Forest



Note: The forest plot describes standard mean difference and 95 percent lower and upper bound confidence ... size (N=number). Bracketed numbers correspond to numbered studies in References. Externalizing behavior scores in [28] were measured through supplemental behavior questions from the Canadian National Longitudinal Survey of Children and Youth, assessed by teachers but not included because details are lacking. Argentina's quality early childhood and preprimary program [9] is excluded because it measures attention using teacher assessment questionnaires ("How many of your students pay attention in class?") in administrative records of the National Education Ministry (i.e., National Education Assessment Operation). DI = Distractibility index. SF = supplementary feeding. LBW = Low birthweight. QEC = Quality early childhood. PPP = Pre-primary program. BF = Behavior factor.

a. Freedom from distractibility index in [38] is derived from arithmetic and digit span subtests.
b. Social inhibition in [55] is measured through 3 subscales from the inventory on Interpersonal Problems.
c. Attention problems in [41] is measured through Revised Behavior Problem Checklist, which is not comparable with other socioemotional outcomes.
d. Attention (Map Search) in [54] is measured through Test of Everyday Attention for Children.
e. For Jamaica studies [18, 53] on stunted children, the stimulation compares "stimulation only + stimulation and supplementation" versus "no intervention + supplementation only." Similarly, the supplementation compares "supplementation + supplementation + stimulation" versus "no intervention + stimulation."
f. Attention deficit in [53] is measured through Conners' Parent Rating Scale (short form).
g. Externalizing behavior factor in [18] is from the factor analysis of the WRAT math, WRAT reading comprehension, PPVT, verbal analogies, Raven matrices, and WAIS full scale intelligence tests.

Externalizing Behavior

Early childhood interventions appear to have a delayed effect on externalizing behavior, with no detectable effect on children but some improvements in teenagers and young adults.

Generally it appears that early childhood interventions have not demonstrated an effect on school-aged children's externalizing behavior (see figure 4.1). For example, the early stimulation intervention given to low birthweight infants in Jamaica had no detectable effect on a six-year-old's ability to pay attention.[1, 54] (Although similar to the psychosocial stimulation and nutritional supplementation interventions in Jamaica, this intervention was separate and started about a decade after the other.) In Thailand, a Freedom from Distractibility Index[2] was calculated for nine year olds who received iron or zinc supplements or both when they were infants. There was no discernable difference between the freedom from distractibility index scores of children who received the micronutrients and those who did not.[38]

Some evidence shows externalizing behavior could change in the teenage years and beyond as a result of interventions that occurred during the early childhood period. At 12 years old, Romanian children who were randomly assigned to foster care had significantly better externalizing behavior (comprised of oppositional defiant and conduct disorders) than did those who were raised in institutional homes. The different living environment did not influence hyperactivity rates, however.[23] At age 17, participants in the Child Health Project in Mauritius had significantly lower rates of motor excess, a measure of hyperactivity; there was no significant effect on attention problems.[41] Participants in the psychosocial stimulation intervention in Jamaica scored on average 3.44 points lower (out of a possible 36 points) at 17–18 years of age on the attention deficit questionnaire than did nonparticipants,[53] indicating better attention abilities. No significant difference was found in oppositional behavior or hyperactivity between the two groups.

A separate study looked at these same three external behaviors (hyperactivity, attention deficit, and oppositional behavior) when the participants were 22 years old, combining them into a factor score. Higher values indicate better functioning. The study found that stimulation had a positive, but ultimately nonsignificant, effect on reducing externalizing behavior for participants as a whole. Among women, however, it led to a significant 0.58 standard deviation improvement in their externalizing behavior factor score.[3, 18]

These same two programs—psychosocial stimulation in Jamaica and environmental enrichment in Mauritius—were also evaluated for their effect on violent behavior. In both cases there is evidence of benefits stemming from the interventions. At 23 years old, the number of self-reported criminal offenders in Mauritius was significantly lower among participants—23.6 percent versus 36.1 percent among the control group. There was also a marginally significant difference in court-reported criminal offenders, with only 3.6 percent of the enrichment group being reported as opposed to 9.9 percent of the control group.[41] In Jamaica, 22 year olds who participated in the psychosocial stimulation program were 36 percent as likely to be involved in or start a physical fight—although these results were only marginally significant—and 33 percent as likely to be involved in a violent crime.[4], [55] There was no effect, however, on weapon use.[5]

Internalizing Behavior

The evidence on post-early childhood internalizing behavior is too thin and inconsistent to draw conclusions.

Early stimulation in Jamaica had a sustained effect on internalizing behavior, but the Jamaican supplementation, Mauritian early enrichment, and Romanian foster care programs did not cause any detectable changes.[18, 23, 41, 53, 55] Jamaican 17 and 18 year olds who received early stimulation exhibited lower levels of anxiety and depression and greater self-esteem. Their anxiety score decreased by 2.81 points (out of a possible 28 points), their depression score decreased by 0.43 points (out of a possible 26 points), and their self-esteem score rose by 1.55 points (out of a possible 32 points).[53]

These improvements continued into adulthood. At age 20, a factor score[6] comprised of these three components showed a strong, positive effect overall—a 0.39 standard deviation increase—driven by improvements among women: the women's score improved by a highly significant 0.76 standard deviations, while the effect on men's scores was not significant.[18] Two of the same outcomes were reexamined two years later when participants were 22 years old, and while the effect on anxiety had disappeared, there was still a significant 0.35-point decrease on the depression scale.[55]

There was no detectable effect on anxiety among 17 year olds who participated in the Mauritius early enrichment program, nor among 22 year olds who had received the nutrition portion of the Jamaican intervention.[41, 55]

Strengths and Difficulties Questionnaire

When combining measures of externalizing and internalizing behavior, it appears that conditional cash transfers and early stimulation may be effective.

Four studies used the Strength and Difficulties Questionnaire (SDQ), a brief screening test of both prosocial (positive) and problematic behaviors for use with children three to 16 years of age, allowing direct comparison across findings. These impact evaluations (IEs) report on the total behavioral difficulties score from the SDQ, a composite score built from reports on both internalizing and externalizing behaviors.

Three of the IEs found that early childhood interventions can improve subsequent behavioral problems, while the fourth found no effect. In rural children in the early treatment group, who started Progresa 18 months before those in the later treatment group, had significantly better scores (that is, fewer behavioral problems) than those who started later.[8] There is evidence that this benefit may arise from the conditionalities imposed by the program rather than from the cash transfer itself. One study isolates the effect of the conditionalities and the cash separately for Progresa and finds that an additional 18 months of program participation during the early childhood period leads to significantly fewer behavioral problems, but there was no noticeable effect from the additional 18 months of cash transfers.[32]

In Jamaica, a cohort of low-birthweight babies was chosen to receive early stimulation through weekly home visits in which the mother was taught to converse and play with her child. This interaction led to a significant improvement in behavior at six years old, reducing the total difficulties score by 0.4 standard deviations.[54]

The only intervention that did not significantly affect children's behavior problem score was the breastfeeding promotion program in Belarus (see box 1.1). Both parents and teachers were asked to complete the SDQ, and neither reported significantly different behavioral difficulties for children who had benefited from breastfeeding promotion.[28]

Socioemotional Summary

While the evidence overall for the effect of early childhood interventions on later-life socioemotional outcomes is thin and at times inconsistent, the general trend did coincide in part with previous theoretical or early childhood IE work in the developing world. In particular, the programs that seem to be most effective are those that promote early stimulation and early learning (Engle and others 2011; Walker and others 2007, 2011). This is not always true, however, as shown by the Mauritian project's lack of effect on internalizing behavior. Furthermore, the theorized link between early nutrition and socioemotional development cannot be validated for later-life development as none of the three nutrition interventions found a significant post-early childhood effect (Black and others 2013; Engle and others 2007; Walker and others 2007). Interestingly, as in the

United States, these programs can have a lasting effect on violent behavior, reducing a person's likelihood to commit a crime.

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[1] Externalizing behaviors refer to behaviors such as hyperactivity, disruptive behavior, aggression, fighting, delinquency, and other unruly behavior.

[2] Internalizing behaviors refer to behaviors such as social withdrawal, inhibition, depression, anxiety, eating disorders.

[3] Study [41] contains two separate evaluations at ages 17 and 23 and so is listed twice.

[1] A preschool intervention in Argentina did have a significant and relatively large effect on third graders' attention, but this measure is not included in the main analysis because it is based on teachers' responses to the question, "How many of your students pays a lot of attention in class?" with little other information on the measure's validity.[9]

[2] This index is derived from the Arithmetic and Digit Span subscales of the Wechsler Intelligence Scale for Children III (Wechsler 1991) and reflect working memory, attention, and concentration abilities.

[3] A study of the breastfeeding promotion program, PROBIT, in Belarus also calculated externalizing and internalizing behavior factor scores, but the results are not included here because too little information was provided on the psychometrics of the outcomes to be able to determine their comparability to the other outcome measures. Neither score was significantly different between the treatment and control groups.[28]

[4] A violent crime was defined as a fight with a weapon, hurting someone with a weapon, carrying a gun in the past month, threatening someone with a gun, shooting someone with a gun, or being a gang member.

[5] Weapon use was defined as carrying a weapon within the past month or ever threatening someone with a weapon. The authors do not discuss how prevalent weapon use was among the respondents, so it is possible that the null effect is due to a power issue rather than a true lack of effect.

[6] In combining these three measures, the authors transformed the factor scores so that higher levels are more desirable.

5. Schooling Outcomes

Early stimulation, preschool, and conditional cash transfers (CCTs) seem most effective in improving schooling outcomes, while nutrition programs on average did not have an effect.

Schooling outcomes, which range from the number of years completed to academic performance, were some of the most widely studied in the evaluations of interventions from early childhood on later outcomes. There are a number of possible pathways through which early childhood interventions could affect schooling. For instance, improved cognitive development could result in increased scholastic achievement, while healthier children are better able to attend classes.

A 2003 systematic review of the effectiveness of comprehensive early childhood development (ECD) programs in the United States revealed significant improvements in school readiness, achievement, and retention rates among enrolled children (Anderson and others 2003). Additional long-term studies demonstrated that children who attend these programs were less likely to repeat a grade and more likely to graduate high school when compared with their peers who had not been enrolled (Schweinhart 2007). Two decades after children participated in Chicago's Child-Parent Centers, they demonstrated lower rates of grade retention, a lower likelihood of being enrolled in special education programs, and a higher percentage of high school completion (Reynolds and others 2001). At age 28, their schooling achievements translated to labor market gains and reduced arrest rates.

Early childhood development studies have also used theory, longitudinal data, and at times impact evaluations to try to establish which interventions work best in the developing world. As found in the United States, preschool is believed to produce later-life effects on schooling outcomes (Engle and others 2007, 2011) as are nutrition programs, presumably through better health and cognition (Black and others 2013; Bhutta and others 2013; Walker and others 2007; Engle and others 2007). Empirical evidence supporting the latter is mixed.

Table 5.1 maps the 21 studies that investigate schooling outcomes in 16 countries. There are 17 different projects and 13 intervention types, identifying the four specific indicators most commonly assessed and the age of the individual at the time of evaluation.

Table 5.1. Impact Evaluations Investigating Schooling Outcomes

		Study	Country (Project)	Average Age at Intervention (Years)	Average Length of Exposure (Years)[b]	Age at Evaluation (Years)	Evaluated Intervention	Reviewed Outcomes
Nutrition		Kramer and others 2008a [27]	Belarus (Promotion of Breastfeeding Intervention Trial [PROBIT])	0	1	6	breastfeeding promotion	math achievement; other subjects; reading**; writing**
		Pongcharoen 2010 [38]	Thailand (micronutrient supplementation to children)	0.5	0.5	9	micronutrients and fortified food for children (Iron and/or zinc supplementation)	English; math achievement; on-time primary school enrollment; science; Thai
		Alderman and others 2014 [1]	Gambia, The (Maternal Supplementation)	in utero	0.5 (DR1)	16–22	vitamins, micronutrients, or fortified food for pregnant women (protein biscuits)	school years completed
		Walker and others 2005 [52][a]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	17–18	supplementary feeding	math assessment
		Walker and others 2011 [55][a]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	22	supplementary feeding	general exams; math assessment; school years completed
		Maluccio and others 2009 [31]	Guatemala (INCAP supplementary feeding to children)	0	5.3	25–42	supplementary feeding	school years completed (men, women**)
Health		Cas 2012 [12]	Indonesia (Safe Motherhood program)	In utero	3	11–14	Access to obstetric and child health care	math assessment***; on-time primary school enrollment; school years completed**
Early Learning/Childcare		Martínez, Naudeau, and Pereira 2012 [35]	Mozambique (preschool)	3.45	1.5	5–9	quality early childhood and preprimary program	on-time primary school enrollment**
		Berlinski, Galiani, and Gertler 2009 [9]	Argentina (preprimary education)	4	1	8	quality early childhood and preprimary program	math achievement**; Spanish**

		Valdes 2011 [13]	Chile (Early Childhood Care and Education)	2.9	1.8	10	quality early childhood and preprimary program	math achievement***
		Berlinski, Galiani and Manacorda 2008 [11]	Uruguay (preschool)	4	1.5	7–15	quality early childhood and preprimary program	school years completed***
		Walker and others 2005 [52][a]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	17–18	stimulation	math assessment
		Gertler and others 2013 [18]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	22	stimulation	general exams*; probability of attending post-secondary school*; school years completed*
		Walker and others 2011 [55][a]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	22	stimulation	general exams*; math assessment**; school years completed**
Social Protection		Todd and Winters 2011 [47]	Mexico (Progresa)	2	2.8 (DR1)	6–9	CCT	on-time primary school enrollment*
		Secretariat of Social Development 2008 [8]	Mexico (Progresa)	1.5	1.5 (DR2)	7–11	CCT	school years completed
		Behrman, Parker, and Todd 2009 [7]	Mexico (Progresa)	1.5	1.5 (DR2)	6–14	CCT	on-time primary school enrollment (boys); on-time primary school enrollment (girls)*; school years completed***
		Rackstraw 2014 [39]	Honduras (Programa de Asignación Familiar)	1.5	2	13–15	CCT	school years completed***
		DSD, SASSA and UNICEF 2012 [14]	South Africa (Child Support Grant)	1	2.5	10	unconditional/targeted income support	numeracy; on-time primary school enrollment (boys); on-time primary school enrollment (girls)**; school years completed**
		Attanasio and Vera-	Colombia	3	1.2	8–17	childcare/daycare	probability of attending secondary

Child care		Hernández 2004 [4]	(Hogares Communitarios)					school**
Water and Sanitation		Spears and Lamba 2013 [44]	India (Total Sanitation Campaign)	0	continuous	6–8	adequate sanitation	numeracy (6 years old)**; numeracy (7–8 years old)
		Xu and Zhang 2014 [57]	China (rural drinking water program)	1	1	18–25	access to safe water	school years completed (exposed to 0–2 years)***; school years completed (exposed to 3–5 years)
Other		Pathak and Macours 2013 [37][c]	India (women's political reservation)	pre-birth birth	3 (DR1)	8	governance (women's political reservation)	numeracy

Note: Numbers in [brackets] correspond to the numbered studies in References. More details for each study are found in appendix A. CCT = conditional cash transfer; DR = dose response; INCAP = Instituto de Nutrición de Centroamérica y Panamá.

a. Jamaica [52, 55] each has a multiple intervention arm, and each intervention type has a separate row for these studies.

b. DR in the length of exposure means intervention period in terms of the Dose Response. DR is either randomized rotation (DR1) or phase-in (DR2). In terms of dose response, DR1 indicates the treatment and control group received the intervention for the same period of time but at different ages. DR2 describes the dose response where early and late treatment effect is compared, and length of exposure is the difference of the intervention period between treatment and control group.

c. India study [37] has multiple experimental arms. One treatment group is in utero when the political seats were randomized for women, and the other treatment group is between the ages of newborn and five years old during the reservation. The control group was children who were not exposed to reserved seats until six years and beyond.

* Statistically significant at 10 percent.

** Statistically significant at 5 percent.

*** Statistically significant at 1 percent.

On-Time Primary School Enrollment

Preschool programs and cash transfers appear effective in promoting on-time primary school enrollment.

Given this report's focus on children's development starting at entry into primary school, on-time primary school enrollment is one of the first possible educational outcomes that can be assessed. Evidence exists that early childhood interventions can successfully promote on-time enrollment. Of the five interventions evaluated, two of them had a significant beneficial effect, while the third had no overall effect but did decrease the probability of delayed enrollment among certain groups. The final two had no effect. In Mozambique, a preschool program significantly increased the probability that a child would enroll in primary school at age six by about 10.2 percentage points,[35] while the Mexican Progresa, led to a marginally significant 5 percent increase in the probability of enrolling at age six among children who were younger than three when they started the program.[47]

A second evaluation of Progresa examined the dose response of an additional 18 months of program participation and found that it significantly lowered the primary school starting age for 7- to 8-year-old girls but not for boys or for 9–11 year olds. The effect was fairly small (0.05 years), and the authors hypothesize that it might be due to better nutrition: the 7–8 year olds had been eligible for the nutritional supplementation, whereas the majority of the 9–11 year olds had not been.[7] The South African unconditional cash transfer also significantly improved on-time primary school enrollment for girls: there was a 26.5 percent reduction in the likelihood of delayed primary school enrollment for girls who starting receiving the Child Support Grants as birth rather than at 6 years old.[14] A similar effect was found for children whose mothers had less than 8 years of schooling, but there was no detectable effect for boys. No difference was found in the age at entry to primary school among the groups of Thai children who received iron, zinc, or both as compared to the placebo group or among Indonesian children whose villages had participated in a Safe Motherhood program.[38, 12]

Box 5.1. Mexico's Progresa Conditional Cash Transfer Program Improves Post-Early Childhood Schooling Outcomes

Progresa, a large-scale social assistance program in Mexico, was created to improve the lives of poor families through interventions in health, nutrition, and education. The program used conditional cash transfers to encourage healthy behavior and found significant effects on schooling outcomes throughout a child's life. Every two months, participating families received a cash transfer worth 20–30 percent of their household income. To qualify for the transfer, family members of all ages had to follow prescribed health interventions such as regular doctor visits and nutritional education programs. Several of the components aimed to improve early childhood development, including the requirement that children under two years old receive immunizations and take nutritional supplements. Mothers of children two to five years old had to attend health and hygiene information sessions, and children were required to have their nutrition monitored and take a nutritional supplement if they presented with signs of undernutrition (Gertler 2004).

Evaluations of Progresa revealed that the program had significant effects on children's anthropometric and physical outcomes during their early childhood years. Infants below the age of six months whose families lived in urban areas and were enrolled in the program grew significantly more in both height and weight than infants of the same age in nonparticipating families (Leroy and others 2008), and children up to three years old who were exposed to 24 months of the interventions were significantly taller and were less likely to be ill and anemic (Gertler 2004). When isolating the effect of the cash transfer from the program conditionalities, there were still significant, although relatively small, improvements in physical outcomes among 24- to 68-month-old children who had been enrolled in Progresa since birth (Fernald, Gertler, and Neufeld 2008).

Although these physical gains were not sustained in the primary school period, subsequent studies did identify longer-term schooling effects. Children who started Progresa when they were still young enough to receive the nutritional supplementation (less than five years old) were more likely to enroll in primary school at age six and less likely to miss school[47] than were children who enrolled in Progresa at age five or older. Seven to eight-year-old girls who were two young to receive educational scholarships but did benefit from the health interventions, entered primary school at a younger age than girls who had been exposed to the program for 18 fewer months. This trend that was also observed when comparing seven- to eight-year-old girls who had been enrolled in Progresa for five years to a matched sample of girls who had never participated in the program. In addition to entering primary school at a younger age, children who were old enough to qualify for the educational grants also increased the number of grades they completed by almost 9 percent.[7] Although it appears that data may be available to isolate the ECD effect by netting the combined effect from the school-only effect, this analysis has not been done to date.

In 2002, Progresa became known as Oportunidades (and was rebranded as Prospera in 2014), and school attendance of children age nine years and older in the household was introduced as a condition for cash transfers. The timing of this new component has made it difficult to separate the effects of the early childhood health interventions from the effects of increased school attendance due to the cash transfer, as some children may have received both during the time of evaluation. Since the transfer was given to families, it is also possible that children who were too young to qualify for the grant still benefited from cash the family received for an older sibling's school attendance. Despite the difficulty in disentangling causal pathways, the combined effect of both nutritional inputs and schooling indicates and prolonged, age-appropriate programs transitioning from early childhood into the schooling period can be effective in increasing schooling attendance. Several studies have also tried to assess the program's lasting impact on additional developmental indicators. The table below presents all of the outcomes reported by evaluations of Progresa included in this review and shows that lasting effects were also observed in the physical, cognitive, language, and socioemotional domains, although the evidence is not consistent.

Outcome Domain by Age at Evaluation in Mexico Progresa Study

Age	Study	Physical Development	Cognitive Development	Language Development	Socioemotional Development	Schooling Outcomes	Labor Market Outcomes
Below 5	Initial Studies	18/35	3/3	1/1			
6–9	[47]	-	-	-	-	2/2	-
7–11	[8]	0/4	0/1	1/2	1/1	0/2	-
8–10[2]	[32]	1/2	1/1	1/1	0/1	-	-
8–10[3]	[32]	0/2	0/1	0/1	1/1	-	-
6–14	[7]	-	-	-	-	8/10	-

Note: To provide a more complete scope of these studies, this table includes all reported outcomes and not just those analyzed in the main body of this report (see box 1 in the Introduction for the decision rule for selecting outcomes for analysis). The numerator denotes statistically significant outcome at 10 percent level or better, and the denominator is the number of outcomes in the domain. The [bracketed] superscript number in the "Study" column is indicates study identifier (see References).

a. Five "Initial Studies" were found that give estimates of program effects during early childhood: Barham (2011); Fernald, Gertler, and Neufeld (2008); Gertler (2004); Leroy and others (2008); and Rivera and others (2004).

Years of Schooling Completed

Given time, preschool, early stimulation, and cash transfers appear to increase schooling, but nutrition programs may not be effective.

The most widely studied educational outcome was years of schooling completed, and the evidences suggests that over time, various intervention types could positively affect this indicator. In a retrospective study in Uruguay, evaluators examined the effect of preschool on subsequent schooling and found that benefits grew with time. At seven years old, there was a significant decrease of 0.34 years of schooling among children who attended preschool, which the authors posit is from a delay in preschoolers starting primary school, but they give no evidence or explanation for this view. One explanation may be that preschool displaced early enrollment in primary school, as seen in a World Bank project in Cambodia (Bouguen and others 2013).

Despite the inauspicious beginning, former preschoolers eventually overtake their peers in schooling attainment. By age 11, those who attended preschool had 0.25 more years of schooling than those who did not, and the number grew to a highly significant 0.79 years by the time the participants were 15 years old, suggesting that preschool attendance, even if it delayed entry to primary school, prevented dropout or grade retention.[10] The increase was more pronounced among children whose mothers had lower levels of education, and those who lived outside of the capital city, Montevideo.

A Safe Motherhood program in Indonesia also led to a significant increase in years of school completed. In this program, the government deployed 54,000 newly graduated nurses to rural villages throughout the country in order to increase women's access to healthcare and safe delivery services. The nurses were expected to remain in the same village for three to six years, where they would provide public healthcare during regular business hours and could establish a private practice on the side. Eleven to 14-year-olds who were exposed to this program before they turned four years old had completed 0.17 more years of schooling than those who either received the program after they turned four years old or who lived in villages without the program. Interestingly, the effect is much larger and highly significant for those who are born in villages where the program was already established before they were born—ranging from 0.48 to 0.52 years, depending on whether the SMP nurse arrived one, two, or three years prior to the child's birth. The effect is still large if the nurse arrived at the year of birth (0.23 years) or within the first year after the child's birth (0.29 years), but by two years old, the effect has disappeared and remains insignificant if the nurse does not arrive until the child is three years of age.[12] This may indicate that for health programs to have an effect, they must be in place early in a child's life and have had sufficient time to develop, perhaps thereby creating a more generally healthy population in which the child can grow.

After five to six years of exposure, a dose-response assessment compared the early treatment group that received benefits when Progresa began in 1998 with the late treatment group incorporated 18 months later. There was no significant difference in grades of school completed between the two groups.[7, 8] However, one study also compared the early treatment group to a matched group of nonparticipants. While there was no effect on years of schooling completed for six to eight year olds, there was a highly significant increase in schooling among nine- to eleven-year-olds, with a particularly large return for both boys (0.4 years) and girls (0.27 years).[7]

Two other cash transfer programs also significantly increased schooling among participants. In Honduras, ten years later, children whose families had been eligible to receive the *Programa de Asignación Familiar* (PRAF) transfer from the birth of the child to age three had completed 0.11 more school years than their noneligible peers.[39] A similar effect was found in South Africa: at age ten, children whose families had enrolled in the Child Support Grant when the child was born had 0.14 years more of schooling than those whose families enrolled when the child was six.[14] While both of these results are significant, the effect size is fairly small and could indicate a difficulty in using years of schooling as an outcome at a young age. Differences in schooling accumulation may not be large enough to be detectable.

Overall, these findings are generally encouraging, but as shown in both Uruguay and Mexico, examining longer-term impacts for schooling outcomes is particularly helpful since it allows time for differences to grow. Fortunately, two studies of the same intervention conducted their follow-up analysis about 20 years after the conclusion of the intervention, when much of schooling would be completed. In Jamaica, 20-year follow-up studies to a psychosocial stimulation program for stunted children showed that beneficiaries had completed between 0.36 and 0.61 more years of education than those who did not.[18, 55] This improvement was sufficient to catch up to the nonstunted comparison group recruited at baseline, which while not randomly selected was subsequently shown to be similar in characteristics to the larger urban poor population in Jamaica.[18]

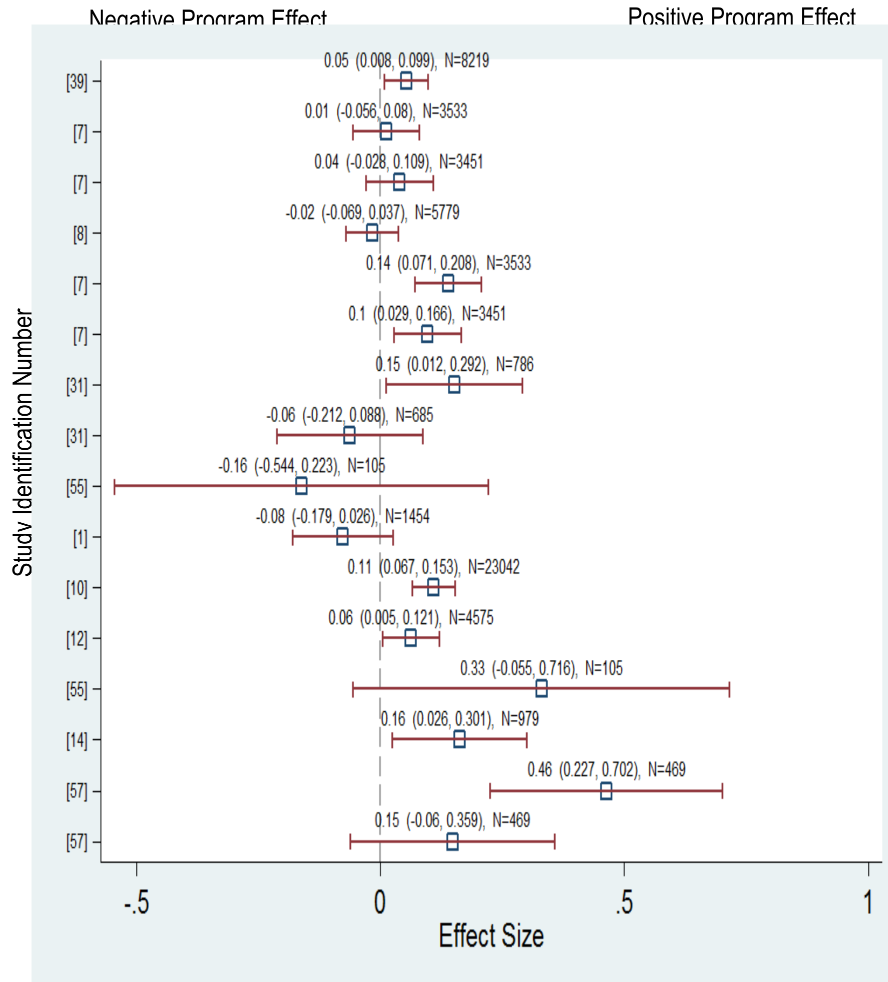
While it may be expected that cash transfers (many of which specifically promote education) and preschool programs would increase schooling among participants, the largest effect on schooling actually came from a clean water program in China.[57] Children whose villages had treated water by the time they were 0–2 years old had 1.7 more years of schooling than their nonexposed peers by the time they were 18–25 years old. There was no effect on children who were exposed when they were 3–5 years old, however, which may indicate that such interventions, which are likely to work through improved health, are more effective when started at very young ages.

The final type of intervention evaluated for its effect on years of schooling is nutrition. Despite some positive findings in Guatemala, it appears that nutrition programs may not be as effective in promoting increased schooling. Twenty-five years after Guatemala's INCAP program ended, women who had received atole, a protein-rich supplemental beverage, before they were 36 months old had completed 1.17 years more schooling than women who did not.[31] There was no corresponding effect among male participants. However, these results are likely capturing a catch-up effect: after starting from a lower average of accumulated schooling, females increased their years of school completed by a larger margin than males, resulting in greater equity across genders than in the previous generation.

This conclusion is supported by the lack of an effect in the other two nutrition interventions examined. In The Gambia, which examined the difference in timing between giving mothers protein-rich biscuits during gestation or postpartum, there was no effect on the highest grade achieved at ages 16–22 years by the children born during the intervention.[1] In Jamaica, 22 year olds who had received supplementation until they were two years old had not completed significantly more school than those who had not received the supplementation.[55]

Figure 5.1. Forest Plot for School Years Completed

Country	Intervention	Measurement	Average Age at Evaluation (years)	Study and Forest Plot
Honduras	CCT	Highest grade attained	14	
Mexico	CCT	Highest grade attained (girl)	7	
Mexico	CCT	Highest grade attained (boy)	7	
Mexico	CCT	School years completed	9	
Mexico	CCT	Highest grade attained (girl)	10	
Mexico	CCT	Highest grade attained (boy)	10	
Guatemala	Nutrition (child, SF)	Highest grade completed (boy)	32.3	
Guatemala	Nutrition (child, SF)	Highest grade completed (girl)	32.3	
Jamaica[a]	Nutrition (stunted children)	Highest grade level	22	
Gambia, The	Nutrition (mother)	Highest grade attained	19.6	
Uruguay	Pre-primary program	Years of schooling	15	
Indonesia	Safe motherhood program	School level attained	12.5	
Jamaica[a]	Stimulation (Stunted children)	Highest grade level	22	
South Africa	Unconditional cash transfer	Highest grade attained	10	
China	Water quality	Highest grade attained	19	
China	Water quality	Highest grade attained	22	



Note: The forest plot describes standardized mean difference, 95 percent lower and upper bound confidence interval in parentheses, and sample size (N = number). The standard mean difference and confidence interval were calculated by Comprehensive Meta-Analysis software. Bracketed numbers correspond to numbered studies in References. SF = Supplementary feeding.

a. For Jamaica study [55], the stimulation compares "stimulation only + stimulation and supplementation" and "no intervention + supplementation only."

Post-Primary Attendance

Participants of early stimulation programs appear more likely to attend post-primary school.

Two early childhood interventions were studied for their effect on another common schooling outcome, post-primary attendance, and both had a positive effect. In Colombia, Hogares Comunitarios established childcare centers where a madre comunitaria cared for children up to age six, providing nutritional meals and stimulation programs.[4] During high school, from ages 13 to 17, children who participated were 19.8 percent more likely to be in school than those who did not participate.[1] Additionally, those who received psychosocial stimulation as part of the Jamaican intervention were three times more likely than those who had not received early stimulation to have some college education, again catching up to the nonstunted comparison group.[18] However, this effect was only marginally significant.

School Performance

Interventions that provided early stimulation had a sustained effect on school performance, while those that focused on nutrition alone tended not to have an effect.

Attendance and completed schooling are important measures, but they do not necessarily indicate if students are learning. To assess real changes in human capital, a better metric may be performance at school. Of the six impact evaluations that assess achievement indicators, interventions providing early stimulation had positive effects in later periods of a child's life, and those that focused on nutrition alone tended not to have an effect. PROBIT in Belarus (box 1.1) did not significantly change primary students' performance in math and other subjects, but there was a significant, but economically small, positive effect on reading and writing.[27] In Thailand, primary-aged students who had received iron and zinc supplements as infants did not perform significantly better in math, science, or Thai or English language than those who did not.[38] Lastly, supplementation of children from 9–24 months old in Jamaica had no detectable effect on the number of secondary-level exams passed.[55] Although there are reports of implementation problems with the supplementation portion of the Jamaica intervention, the lack of effects in Belarus and Thailand reinforce doubts about the effectiveness of using nutrition to affect school performance.

Stimulation, whether through home visits or preschool, can positively affect children's academic performance. When assessing the early psychosocial stimulation program provided to children in Jamaica, researchers found a marginally significant increase in the percentage of participants who passed at least one Caribbean Examinations Council exam (a standardized exam taken at the end of 11th grade) but no effect on the percent of students who passed four or more.[18] There was also a significant, large increase in the number of students who passed at least one Caribbean Advanced Proficiency Examination, which is taken at the end of the 13th grade to prepare for college entry. No one in the either the control group or the supplementation-only group had passed, compared with 9 percent in the treatment group, comprised of those who had received early stimulation as well as stimulation and supplementation together.[2] In a second study of the same intervention, stimulation led to a marginally significant increase in the number of secondary-level exams passed.[55] In Argentina, a preschool program led to a significant increase of about 8 percent of the mean in both math and Spanish scores for eight-year-old children.[9]

In Chile, stimulation and nutrition were combined in the Early Childhood Care and Education program, in which children attended preschool, received school meals, and parents were encouraged to attend classroom activities and parenting workshops.[13] Using the Sistema de Medición de la Calidad de la Educación, a national standardized test, to evaluate fourth graders, researchers found that children who participated in preschool improved about 0.2 standard deviations in math, reading, and social science test scores. This effect was fairly constant whether the child started the program at two, three, or four years old, but it was largely driven by boys. For instance, in math, girls saw only a 4.9-point rise (.08 standard deviations) compared with the 11.5-point increase (0.2 standard deviations) among boys. The effects were largest for children in the second quintile, followed by those in the third and finally by those in the first.

Box 5.2. What Helps Numeracy and Maths?

Math skills are a particularly important piece of human capital accumulation. STEM education (Science, Technology, Engineering and Mathematics) skills are receiving increased attention in the curricula of high-, middle-, and low-income economies. When combined with results for numeracy (or early mathematics), the achievement scores seen in this section begin to tell an interesting story.

Interventions that stimulate the brain improve numeracy and mathematics. Twelve impact evaluations estimate effects on numeracy or math achievement. Of those, four estimates were of three interventions that were designed to challenge the brain prior to primary school, and three yielded significant results. The Argentine preschool program and the Chilean stimulation/nutrition early education program both made notable inroads towards improving math scores for eight- and ten-year olds, respectively.[9, 13] While the positive math assessment results for the Jamaica early stimulation program were not significant at age 17–18, they were by age 22.[52, 55]

Nutrition Interventions have yet to demonstrate lasting effects on math. None of the estimates coming from four studies of nutrition-related interventions produced improvements in math or numeracy scores: breastfeeding in Belarus at age 6.5,[27] micronutrients in Thailand at age nine,[38] or supplementation in Jamaica at ages 17–18 or 22.[52, 55]

Results from nonstandard ECD interventions are a thin, if mixed, bag. A governance intervention of reserving quotas of elected representatives' seats for women produced no differences in number recognition among eight-year-olds.[37] On the other hand, the IE of the Child Support Grant CCT in South Africa found that 10-year-olds who had received the cash transfer at the beginning of primary school at age six had a marginally significant advantage in an arithmetic assessment over those who had enjoyed the transfer from birth and throughout early childhood, even though it induced significant improvements in years of schooling completed—perhaps indicating an induced selection bias wherein the transfer was incentivizing on the capability margin.[14] Indonesia's Safe Motherhood program had a similar outcome, significantly increasing the years of schooling 11–14 year olds had completed while also making them highly significantly better at math than children who did not live in Safe Motherhood villages or whose village did not receive a nurse until the child was at least four years old.[12] Last, India's Total Sanitation Campaign produced a significant improvement in recognizing double-digit numbers for six-year-olds (but not for seven- or eight-year-olds, perhaps because the test was not sufficiently discriminatory).[44]

Schooling Summary

As shown, many different intervention types can positively affect schooling outcomes in low- and middle-income countries. In general, preschool, early stimulation, and cash transfers were the most successful programs, although the strong effect produced by the clean water program in China highlights the potential of nonstandard interventions The preschool finding is unsurprising given earlier work (Engle and others 2007, 2011), but the latter two interventions suggest a promising focus area. However, despite the widely held belief of an indirect effect of health and nutrition interventions on schooling outcomes (Black and others 2013; Bhutta and others 2013; Walker and others 2007; Engle and others 2007), little evidence was found. Only two of the five nutrition interventions produced significant results and then only in certain outcomes or for specific groups.

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[1] No significant effect was seen for primary school-aged children (8 to 12 years old).

[2] There were only 94 participants in the sample.

6. Employment and Labor Market Outcomes

Promising if yet thin evidence suggests early stimulation improves labor market outcomes.

Poor health during childhood, which can be prevented with prenatal and early childhood development (ECD) interventions, often translates into poor health and low occupational status during adulthood (Case and Paxson 2006). Studies from the United States show that early childhood services devoted to enriching an individual's environment by increasing inputs in education, health, and nutrition can determine future labor market outcomes (Smith 2009; Cunha and Heckman 2009). Long-term follow-up studies of participants in the Perry Preschool Program and Chicago's Child Parent Center program at ages 40 and 28, respectively, found significant labor market returns.[1] These gains in employment benefit both the individual in higher earnings and society through reduced welfare dependence (Barnett 1996).

Theoretical and observational literature suggests various pathways by which early childhood interventions may lead to improved labor market outcomes. Some have modeled the link from preschool and center-based programs to participants' wages, finding a positive relationship (Engle and others 2011), while others have theorized that health and nutrition interventions can improve health and cognition, which would in turn increase a person's economic productivity (Black and others 2013; Bhutta and others 2013; Black and others 2008). Finally, some authors posit that the path from early stimulation to better employment runs through improved cognitive and socioemotional outcomes (Engle and others 2007).

As yet there is still sparse experimental/quasi-experimental establishing the causality of these proposed links. Table 6.1 describes employment and labor market effects for the only early childhood intervention yet to be credibly impact evaluated on such outcomes. Despite the outcomes from this single study being well-identified, more high-quality evidence from developing economies is needed in order to establish whether the well-identified outcomes from this study and the observed developed country outcomes and hypothesized pathways hold for labor market outcomes for developing economies generally.

Table 6.1. Impact Evaluations Investigating Employment and Labor market Outcomes

	Study	Country (Project)	Average Age at Intervention (years)	Average Length of Exposure (years)	Age at Evaluation (years)	Evaluated Intervention	Reviewed Outcomes
Early Learning	Gertler and others 2013 [18] Gertler and others 2014 [19]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	22	stimulation	earnings***; migration*; employment

Note: Bracketed numbers correspond to numbered studies in References. More details for each study are found in appendix a. CCT = conditional cash transfer; DR = dose response; INCAP = Instituto de Nutrición de Centroamérica y Panamá.
* Statistically significant at 10 percent.
** Statistically significant at 5 percent.
*** Statistically significant at 1 percent.

A recent, well-regarded study of the early stimulation program for stunted children in Jamaica found positive long-term impacts on earnings and employment. The authors examined monthly earnings for first, last, and current jobs as well as average earnings overall, and found that 20 years after the intervention ended, children who received psychosocial stimulation had significantly higher earnings over their entire time in the labor market. Average monthly earnings were 30 percent higher when considering all jobs and 39 percent higher for full-time permanent jobs.[19]

This effect was more pronounced among women: average monthly earnings for full-time permanent jobs were 49 percent higher among female participants and 37 percent higher among male participants. The trend was also reflected at different periods in time, whether for the participant's first, last, or current job. For example, female participants earned 66 percent more per month in their current job than female nonparticipants, and there was no detectable effect for males.[19] These gains were sufficient for the intervention group to catch up to the earnings of a nonstunted comparison group identified at baseline. While this comparison group was chosen nonrandomly, it was similar in composition to the larger urban poor population in Jamaica.

Increased opportunities stemming from migration is one possible contributing factor to the higher salaries observed among participants. The authors found marginally significant evidence that psychosocial stimulation during childhood caused participants to be 10 percentage points more likely to have migrated to the United States or the United Kingdom by the time they were 22 years old.[18] As the authors noted, migration is an interesting outcome for a number of reasons, including its possible effect on human capital and earnings. They theorized that the early stimulation could have improved skills to a point that beneficiaries faced higher incentives to move abroad to take advantage of better education or labor market opportunities.

The authors acknowledge that their results could be due to censored data, since information on earnings is available only for those who are employed. To address this issue, they tested the relationship between early stimulation and employment and found that overall there was no detectable effect on employment. Of the four measures tested—employed, employed full time, being employed in a non-temporary job, or on looking for work—there was a marginally significant 12 percent increase in being employed, but there was no effect on the other three employment outcomes. .

Given extremely limited evidence available on employment, this chapter also considers studies that would have passed the quality screening but for high attrition rates. Accordingly, one additional piece of evidence is added. In a 19-year follow-up of the Turkish Early Enrichment Program (see box 9.1), children of mothers who participated in a training program to improve cognitive stimulation at home were no more likely to be well-employed than other children (Kagitcibasi and others 2009). This conclusion was based on the Occupational Status Index, which classifies jobs based on income level and prestige. However, a marginally significant increase was observed in beneficiaries' average age at gainful employment; the authors presented this as a positive indicator, citing a cost-benefit analysis from Turkey that suggests that an earlier starting age usually corresponds to less-qualified jobs and lower lifetime earnings. If true, this suggests that TEEP may induce better employment opportunities.

Employment and Labor Market Summary

Of all of the outcome domains examined in this report, employment has the least evidence from which to draw conclusions. Only one ECD project has reliable estimates of labor market effects, though a second, less robust, impact evaluation also estimated related outcomes. Both report positive findings. Also promising is that these interventions fall within the range of interventions thought to affect employment. Existing theories have linked early stimulation to improved economic outcomes (Engle and others 2007). Bolstered by the positive findings from the United States, these initial findings should spur evaluators to continue to add to this field to better determine the early childhood interventions and pathways that can promote employment and consequently economic growth. In the meantime, these findings are encouraging for policy makers—early stimulation holds promise to be able to improve labor markets and perhaps subsequent economic growth.

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[1] Schweinhart and others (2005) found that Perry Preschool participants at age 40 were more likely to be employed, had higher earnings, and relied less on external economic support. Reynolds and others (2001) observed higher earnings among former participants in Chicago's CPC program at age 28.