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Impacts of Interventions during Early Childhood on Later Outcomes

A Systematic Review

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Contents

Boxes

Tables

Figures

Evaluation Managers	
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Abbreviations

BMI	body mass index
BMIZ	BMI for age z score
CCT	conditional cash transfer
CPC	Child Parent Center
CSG	Child Support Grant
DIME	Development Impact Evaluation initiative
DQ	development quotient
EAP	East Asia and Pacific
ECA	Europe and Central Asia
ECCE	Early Childhood Care and Education
ECD	Early Childhood Development
HAZ	height-for-age z score
HC	Hogares Communitarios
IBRD	International Bank for Reconstruction and Development
IDA	International Development Assistance
IEG	Independent Evaluation Group
INCAP	Instituto de Nutrición de Centroamérica y Panamá
IQ	intelligence quotient
LAC	Latin America and Caribbean
MENA	Middle East and North Africa
MUAC	mid-upper-arm circumference
SIEF	Strategic Impact Evaluation Fund
PROBIT	Promotion of Breastfeeding Intervention Trial
RCT	randomized controlled trial
RPS	Red de Proteccion Social
SDQ	Strengths and Difficulties Questionnaire
SSA	Sub-Saharan Africa
TEEP	Turkish Early Enrichment Project
TVIP	Test de Vocabulario en Imagenes Peabody
UCT	unconditional cash transfer
UNICEF	United Nations Children's Fund
UNIT	Universal Nonverbal Intelligence Test
WAZ	weight-for-age z score
WAIS	Wechsler Adult Intelligence Scale
WASI	Wechsler Abbreviated Scale of Intelligence
WISC	Wechsler Intelligence Scale for Children
WPPSI	Wechsler Preschool and Primary Scale of Intelligence
WHZ	weight-for-height z score
WHO	World Health Organization

Glossary

Estimate	The empirical result of the application of an impact evaluation (IE) methodology to a set or subset of data for an intervention. Multiple estimates are possible for the same intervention and study if multiple IE methods are used.
Impact evaluation	A methodology of empirical analysis allowing causal inference through the use of a counterfactual. For the purposes of counting impact evaluations in this review, the number of impact evaluations within a study is the number of unique interventions within that study that reports an estimate for one of the included outcomes. Multiple arms are counted separately.
Intervention	The most disaggregated combination of policy or project components for which there is a unique impact evaluation estimate; an arm of a randomized control trial or pieces of an intervention whose effect can be separately estimated in a quasi-experimental IE.
Intervention family	The broadest categorization of interventions used for this review(see left side of figure 1).
Intervention type	The more specific categorization of interventions used for this review (see rows and boxes in figure 2).
Outcome	The construct measured by an estimate.
Project	The full bundle of interventions carried out for a population over a period of time.
Study	An article, working paper, or other publication that has at least one unique estimate for use in this systematic review. For counting purposes, a publication with several effectiveness for multiple arms of a project are still counted as a single study.

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Overview

Highlights

The economic rationale for investing in young children goes beyond improving quality of life during childhood. It hinges on the belief that the benefits of these investments persist into school age and beyond. This report is the first systematic review of causal evidence to investigate this belief, partly because an increasing number of early childhood development (ECD) studies have now matured to allow closer examination.

By collecting into one place those studies that provide high-quality causal estimates, the report takes an outcome-based approach to analyzing the post-early childhood effects of early childhood interventions. It serves three important functions. First, it provides analysis on early childhood interventions whose sustained effects have been evaluated across six areas of human development. Second, it examines impact evaluation evidence over time and its effect on shared prosperity through impacts on sub-populations. Finally, the review aims to improve the quality and coverage of ECD knowledge by discussing commonly observed evaluation challenges and identifying research gaps.

Four important findings derive from this effort:

1. Early childhood interventions can, but do not always, lead to benefits later in life in the areas of cognition, language, education, and the labor market. Evaluated interventions have not demonstrated consistent long-term advantages for physical development, although these outcomes are less salient to adult welfare.

2. Gender-neutrality dominates outcomes, but schooling does tend to improve for girls, the poor, and those who are in quality preschool and supplemental feeding programs for longer.

3. To take advantage of the window of opportunity from conception to the child's second birthday and achieve sustained effects beyond early childhood, nutrition interventions may need to be in place throughout and beyond these first 1,000 days.

4. Sizeable knowledge gaps persist but can be closed with careful planning and design.

Early childhood development holds considerable promise for making progress on the World Bank's dual objectives of reducing poverty and increasing shared prosperity while encouraging economic growth. More investment and evaluation are required to enable interventions, and the children they serve, to realize their potential.

In developed countries, well-documented evidence shows that interventions aimed at improving early childhood development (ECD) can play a major role in shaping young children's school performance and completion as well as earnings later in life. This evidence prompts many in the international development community—including the World Bank—to focus attention on the years before children enroll in primary school or attain the age of six as the first step in a sequenced strategy to build the skills needed for productivity and economic growth.

In developing countries, the ability of interventions to improve outcomes beyond early childhood is less well studied. Impact evaluations in middle- and low-income countries are scarce, and it may be problematic to embrace findings from other nations.

In an effort to bridge the evidence gap, the Independent Evaluation Group (IEG) prepared a systematic review that gathers and analyzes the available impact evaluation evidence in developing countries from 1990 to 2013 on whether early childhood interventions shape future outcomes. Its purpose is not to supplant existing evidence but rather to help practitioners understand how evidence from impact evaluations supports or challenges beliefs about interventions and can be used to inform development policy.

This review aims to answer two questions:

- What is the evidence of attributable effects on outcomes in primary school and beyond from interventions in low- and middle-income countries that occur during the early childhood period?
- How do the post-early childhood effects of early childhood interventions vary by socioeconomic status, gender, age at intervention, and age at evaluation, particularly during the first 1,000 days from conception to the child's second birthday and from age three to primary school enrollment at age five to six?

Methodology and Scope

Most systematic reviews are intervention based, that is, they track the outcomes from a narrow set of interventions. This report, on the other hand, reviews all interventions from developing countries that occur during early childhood for which impact evaluation estimates exist for effects observed at primary school age and older. From an initial search of thousands of studies, the search process—which included database searches, hand searches, and snowballing—identified more than 500 relevant impact evaluations written from 1990 to 2015. After excluding clinical trials and estimates of individuals or groups not wholly aged out of the early childhood period, 107 studies remained. From these, the team conducted a risk of bias analysis that included conducting a rigorous check of the credibility of the causal estimates, identifying assumptions, and assessing construct validity and representativeness. Studies were given a quality rating of A, AA, or AAA. Those with ratings of AA or AAA were selected for inclusion in the review.

Although this review contains all of the causally robust evaluations within its inclusion criteria, the evidence base for any given combination of interventions

and outcomes may still be thin. Furthermore, there are many reasons why a study may yield a null result besides the intervention having no impact, including challenges of statistical power, contamination, attrition, uptake, and implementation. Therefore, IEG's aim is to elucidate what is known about the long-term effects of early childhood interventions and identify the remaining research gaps.

Findings

This review covers six areas—or domains—of human development: physical development, cognitive development, language development, socioemotional development, schooling outcomes, and employment and labor market outcomes. These domains are commonly included in evaluations of early interventions targeting poor children because they are negatively affected by early poverty, can benefit from early intervention, and are important for overall well-being or adult productivity. Some outcomes can be measured repeatedly starting from early childhood (i.e., height and weight) while others are only measurable later in life (i.e., cognition, schooling, and employment and labor market status).

PHYSICAL DEVELOPMENT

Some improvement is seen in height but no effect is found on weight.

Physical health and nutrition in early childhood are important determinants of future well-being and development. Studies link them to mitigating future illness, boosting cognitive development, and achieving better schooling and labor market outcomes. Consequently, many of the outcomes included here, such as weight and height, are important not for their intrinsic value but rather as indicators of increased risk in these correlated areas. Although the evidence generally seems to point away from early childhood interventions having lasting effects on physical development, with the possible exception of height-related outcomes, this is less important if there are sustained effects to outcomes more closely tied to life prospects.

Despite the review of seven different intervention types in five geographical regions over a range of ages from six to 17 years old, not a single intervention had a lasting effect on weight.

The ability of early childhood interventions to change height may also be limited, although a few interventions were effective in specific contexts. Two of the effective interventions involved nutritional supplementation: one provided iron and zinc supplements to infants in Thailand, while the other gave pregnant Nepalese mothers folic acid, iron and zinc. However, the remaining eight nutrition interventions either negatively affected height or had no detectable effect.

Mexico's conditional cash transfer program, Progresa, and the family

planning and maternal and child health program in Matlab, Bangaldesh also improved beneficiaries' height, and female beneficiaries of the South African Child Support Grant were significantly taller. However, other evaluations of cash transfers, as well as early stimulation programs, found no effect, making it difficult to draw firm conclusions.

The third physical outcome—fine motor skills—has a particularly thin evidence base but was included for its intrinsic value as an increasingly popular measure of school readiness. In Mozambique, a significant improvement occurred in the fine motor skills of children who participated in preschool programs, but the Bucharest Early Intervention Program had no lasting effect on fine motor skills.

COGNITIVE DEVELOPMENT

Although stimulation interventions most consistently impacted outcomes over the spectrum of cognitive outcome measures, "general cognition" was improved by a wide range of interventions.

Cognitive ability reflects an individual's problem-solving and analytical skills, memory functions, general knowledge and ability to apply logic, and reactions to new situations. Cognitive outcomes are of particular interest in ECD research because of their influence on an individual's future productivity in areas such as schooling and the labor market.

Box 1. The Nutrition Enigma

Small-scale and near-term studies as well as others from high-income countries have shown that nutrition interventions can lead to significant improvements in child development, including better morbidity, mortality, and cognitive outcomes.

Longitudinal studies, including those in developing countries, indicate a strong correlation between early nutritional status and later-life outcomes. (See Bhutta and others 2013; Black and others 2013.)

Yet the later-life effects of nutrition interventions in developing countries are less well-established. Across human development domains, nutrition interventions had little impact on post-early childhood outcomes, although they sometimes led to improvements in height.

Rather than signal that nutrition is ineffective, these results show that more evaluative and intervention work is needed to determine how to sufficiently alter nutritional status so as to have effects lasting beyond early childhood.

Quantifying outcomes in cognition can be difficult because of the lack of a universal, standardized measurement of cognitive ability. Therefore, the reviewed studies report outcomes from a range of tests, from brief screening assessments to comprehensive full-scale intelligence tests. While it is inaccurate to compare results across different types of cognitive tests, the review groups results from similar assessment tools to compare outcomes across intervention types and contexts.

Improvements in both full-scale and abbreviated measures of general cognition were caused by four different intervention types and six separate programs: breastfeeding promotion in Belarus, stimulation-related interventions in Jamaica and Romania, CCTs in Mexico and Nicaragua, and a deworming program in Kenya.

The breastfeeding promotion program in Belarus improved IQ outcomes at age 6.5 years old, though the effects were only marginally significant. The stimulation component of the Jamaica program improved cognition scores for low birthweight children at age six and stunted children at the ages of 11–12, 17–18, and 22 years. In Romania, children who received greater stimulation by being randomly assigned to foster care had marginally higher full-scale IQ scores at age eight years than children who had remained in institutional care. The cash component of the Progresa CCT in Mexico produced a marginally significant effect on general cognition between the ages of 8 and 10, and Nicaragua's conditional cash transfer improved cognition in 10-year-old boys. Siblings of children who had participated in a deworming program in Kenya also had measurable improvements between the ages of eight and 15 years old.

While several interventions proved effective in improving nonverbal cognition, the evidence base in each is too thin to be more than suggestive. Only a single nutritional intervention, Guatemala's Instituto de Nutrición de Centroamérica y Panamá (INCAP) program, improved nonverbal cogntion in the post-early childhood period. Stunted children who participated in the stimulation component of the Jamaica program scored higher in nonverbal cognition at ages 11–12 and 17–18. Only one of two social protection interventions, the CCT in Nicaragua, improved nonverbal outcomes. The deworming program in Kenya also improved nonverbal cognition among siblings of children who participated in the intervention.

The evidence base is particularly thin for executive function, a measure of cognition which reflects how an individual responds to new or challenging situations. While stimulation for low birthweight babies in Jamaica improved short-term memory at age six years, related measures did not show improvement at age 11–12 (processing speed) or 17–18 years old (working memory). The Romanian foster care program did not result in noticeable improvements in executive function across a range of measurements assessed at eight years of age. The Nicaragua CCT program improved executive function in 10-year-old boys but not girls.

Despite a comparatively high level of study, there is underwhelming causal evidence that nutritional interventions produce lasting cognitive effects. Of the six supplementation programs that reported effects on cognition, only two

found significant improvements. On the other hand, both stimulation programs, Jamaica and Bucharest, improved four different cognitive outcomes.

LANGUAGE DEVELOPMENT

Early childhood interventions can improve language outcomes, although the evidence is mixed across intervention types.

During the second year of life (12–24 months), children experience a vocabulary explosion. As they enter the preschool years, vocabulary, spoken grammar, and sentence structure become more sophisticated, and children develop the ability to identify letters and, later, words. These skills are important for enabling them to read and do well in school.

Language outcomes were measured in three subdomains: verbal ability, reading and literacy, and vocabulary. The existing evidence suggests that stimulation, nutrition, and social protection programs can improve language. In addition, three non-traditional ECD interventions—deworming, sanitation, and governance—all improved language outcomes, although only one study was found for each type.

Two of the three stimulation programs included in this review improved long-term language outcomes. Verbal abilities seemed to be particularly sensitive to early stimulation programs: children who participated in the Romanian foster care program had significantly higher verbal abilities at age 8 years, and gains were also observed among participants of the Jamaican stimulation program at ages 11-12, 17-18, and 22 years. The stimulation component of the Jamaica program also produced lasting gains in reading and vocabulary. A second stimulation program in Mozambique, however, did not find measurable effects on beneficiaries' vocabulary.

Only two of the five nutritional interventions that measured long-term language outcomes found significant effects, although a single nutritional intervention—breastfeeding promotion in Belarus—improved outcomes for 6.5 year old children in all three language subdomains. A supplementation program in Guatemala also improved reading and literacy. However, the supplementation only arm of the Jamaica intervention did not have a measurable effect on reading, and a nutritional intervention in The Gambia did not significantly improve children's vocabulary.

Although there is solid rationale for expecting that various types of nutritional interventions aimed at children who are at risk for or suffering from deficiencies such as chronic malnutrition and iron deficiency could positively impact cognitive and language outcomes, the available evidence suggests that supplementation alone is often not enough to produce sustained effects.

The evidence suggests that social protection programs have inconsistent effects on language outcomes. Although Mexico's Progresa CCT increased verbal abilities among beneficiaries and a CCT in Nicaragua produced measurable gains in vocabulary among boys, none of the three social protection interventions that measured reading and literacy produced significant improvements.

Non-traditional ECD interventions also proved effective in improving language outcomes, although the evidence is thin and mixed. In India, both a sanitation intervention and a governance campaign improved reading and literacy. Although the governance campaign did not have measurable effects on children's vocabulary, a deworming program in Kenya did significantly improve vocabulary among 15 year olds.

SOCIOEMOTIONAL DEVELOPMENT SUMMARY

Delayed improvement occurs in externalizing behavior, but little improvement is seen in internalizing behavior.

Social and emotional functioning involves the acquisition of the skills and knowledge required by a person to understand and manage emotions, set and achieve goals, empathize with others, establish and maintain positive relationships, and make responsible decisions. It encompasses a broad range of internalizing and externalizing behaviors, which indicate how people view themselves and how they react to the world around them, respectively. These skills are important in learning to cope with difficulties and succeed in various endeavors.

Early childhood interventions appear to have a delayed effect on externalizing behavior; the review found no consistent effects on young children, but benefits from different early stimulation programs seem to show up more as children age into adolescence and beyond. Neither the psychosocial intervention in Jamaica nor a micronutrients intervention in Thailand had an effect on a child's ability to pay attention. But the Environmental Enrichment Program in Mauritius and the psychosocial stimulation program in Jamaica did have a positive effect on some elements of externalizing behavior for teenagers, including violent conduct.

The early stimulation program in Jamaica also had a sustained effect on internalizing behavior, while the nutrition arm of that intervention, foster care in Romania, and the early enrichment intervention in Mauritius did not. Those who benefited from early stimulation in Jamaica exhibited lower anxiety and depression and greater self-esteem at 17 years old, a finding that persisted at age 20, although by that time it was largely driven by improvements among women. When participants reached the age of 22 years, the effect on anxiety had disappeared, but there was still a significant decrease in depression among beneficiaries.

The Strength and Difficulties Questionnaire, which is a brief screening test, is an additional measure of both internalized and externalized socioemotional behavior. Its results can change due to early childhood interventions. Mexico's conditional cash transfer program, an early stimulation program for low birthweight infants in Jamaica, and the fostering and stimulation program in Romania significantly reduced post-early childhood behavior problems as measured by the questionnaire.

SCHOOLING OUTCOMES

Early stimulation, preschool, and cash transfers appear to be most effective.

Early childhood interventions could affect schooling through a number of possible pathways. For instance, improved cognitive development could result in increased scholastic achievement, while healthier children are better able to attend classes. Indeed, there is evidence that early childhood interventions can improve various educational outcomes.

Preschool programs and cash transfers appear effective in promoting on-time primary school enrollment. Of the four interventions evaluated, Mexico's Progresa and the Mozambican preschool program had a significant beneficial effect, while South Africa's Child Support Grant had no overall effect but did decrease the probability of delayed enrollment for girls and children whose mothers were less educated. A micronutrient supplementation program in Thailand, however, had no effect on on-time enrollment.

While the heterogeneity of interventions evaluated make it difficult to find a clear pattern in differences in years of schooling completed, some general trends emerge to suggest that early stimulation and cash transfers (though not nutrition programs) may be effective in promoting more education. For example, early stimulation in Jamaica and preschool attendance in Uruguay increased schooling among participants. Similar results were seen among some beneficiaries of the Honduran, Mexican, and South African cash transfer. For nutrition,the INCAP supplementary feeding program in Guatemala had a large effect, no effect was detectable from either the Jamaican supplementary feeding intervention or the maternal supplementation program in The Gambia. Remarkably, the largest improvement in schooling came from a clean water program in China.

Nutrition programs also did not have a detectable effect on school performance, but participants in early stimulation programs may be more likely to perform well and attend post-primary school. Only two programs were evaluated for their effect on post-primary attendance—Hogares Comunitarios in Colombia and the psychosocial stimulation intervention in Jamaica—both of which caused a large increase in the probability of attending.

Furthermore, the children who had received early stimulation through the same program in Jamaica, as well as the children who participated in a preschool program in Argentina and Chile's Early Childhood Care and Education programs, did significantly better on their subject matter and standardized achievement tests. Conversely, in three different nutrition interventions, participants' test scores were not significantly different than their peers.

EMPLOYMENT AND LABOR MARKET OUTCOMES

Early stimulation can help.

The goal of many early childhood interventions is to improve human capital, and labor market outcomes offer an important measure of its fulfillment. Early childhood services devoted to enriching an individual's environment by increasing inputs in education, health, and nutrition can determine the nature of these outcomes.

Indeed, there is evidence that early stimulation as well as good nutrition can positively influence participants' subsequent labor market outcomes. Psychosocial stimulation in Jamaica dramatically increased earnings, especially among women and people with full-time jobs. Interestingly, additional (though flawed) evidence of an early stimulation training provided to mothers through the Early Enrichment Program in Turkey did not cause its participants to be better employed but did delay the starting age of employment—commonly associated with lifetime earnings—likely because it also increased the probability of attending college.

Heterogeneous Effects

Later-life effects are generally gender-neutral, but girls and those from poor families or more educated parents do tend to have better schooling outcomes.

Evidence for heterogeneous effects, or differences in outcomes due to individual characteristics, is reported infrequently, with the largest evidence base for schooling outcomes and no more than four studies in other domains. Nevertheless, a few noteworthy trends can be observed.

Based on the available evidence, however, the later-life effects of early childhood intervention appear to be mostly gender-neutral, especially in the physical and socioemotional domains and for nutrition and early learning or childcare interventions; in other words, there is usually no significant difference in the benefits accrued to girls versus boys. However, girls are much more likely than not to benefit from interventions that affect schooling outcomes, and neither gender is likely to enjoy lasting physical benefits accruing to interventions occurring in early childhood.

Conversely, for socioeconomic status, there are some groups that are significantly more likely to benefit than others. Interventions affecting physical

outcomes appear to benefit the rich and the poor equally when they affect them at all, but the poor and those with better-educated parents benefit significantly more from interventions that improve schooling than do children from richer families or those with less-educated parents.

Time Effects

The persistence of effects over time varies by outcome domain, interventions lasting the full first 1,000 days may be needed, and additional exposure to some programs can be beneficial.

Three dimensions of time are evaluated for their effect on post-early childhood outcomes: temporal trajectories, age at exposure, and length of exposure. These elements are critical to consider when designing an intervention, but few studies examine these important elements, making it impossible to draw firm conclusions. Nevertheless, the preliminary findings drawn from the available evidence can help target future research.

In the first dimension—temporal trajectories—outcomes within a given intervention are traced across time to determine whether and how they change as a child ages. It appears that socioemotional benefits, particularly those that pertain to internalizing behavior, may fade over time, while cognitive benefits from an early psychosocial stimulation program in Jamaica not only remained significant from 11 to 22 years old, but actually increased in magnitude. The evidence regarding physical outcomes, however, is mixed. When estimates for height and weight are examined in five different interventions, half of the estimates disappear between the early childhood and post-early childhood periods. The other five remain constant, either causing significant benefits across time to those received the intervention or not.

To evaluate age at exposure, this review examines the first 1,000 days, a period that is believed to be critical for a child's development. Only one impact evaluation specifically isolated the effect of treatment during this period compared to later periods, and the only outcomes examined are stunting and height-for-age. In analyzing South Africa's unconditional cash transfer, the Child Support Grant, researchers compared children who began the program before two years old with those who began between two and five years old. At 10 years old, there was no significant difference in height-for-age or prevalence of stunting between these two groups.

Impact evaluations of six nutrition programs starting at various ages and lasting for various intervals—but always starting and ending during the first 1,000 days— demonstrated few later-life effects. However, a seventh program—providing supplemental feeding in Guatemala—concluded that continuous exposure from pregnancy

through the first two to three years of age was more important than at three to six years of age and caused larger and significant results for highest grade completed, reading comprehension, and nonverbal cognition. Taken together, this suggests that effective interventions may need to not only start early but also continue throughout the entire first 1,000 days.

In the final dimension—length of exposure—much of the evidence comes from dose response estimates for cash transfer programs or from evaluations of preschool interventions. Given how important length of exposure is to determining the optimal timing of an intervention, very little evidence is available to guide policy makers on the effect of longer participation in any given intervention. What evidence does exist, however, highlights two important areas in which longer exposure times may be helpful in producing benefits. For preschool or childcare programs, it appears that longer exposure can lead to higher school enrollment rates, while additional involvement in a cash transfer program during the early childhood period could help reduce behavioral problems through adolescence.

Knowledge Gaps

More casual evidence is needed to fill gaps and corroborate findings.

International attention around early childhood development is fairly new. Much of the scientific evidence supporting the need for ECD comes from work within the United States and other developed countries that has recently been able to thoroughly explore the post-early childhood outcomes of interventions. Many low- and middle-income countries, confronted by different development challenges, have focused their efforts primarily on child survival and growth, subsequently limiting their ability to invest in interventions such as preschool and other stimulation programs.

Although this picture is slowly changing, very little is known about the effectiveness of ECD programs across the full range of outcome domains in developing countries, particularly in the post-early childhood period. While many early studies in developing countries, such as the INCAP supplementary feeding program in Guatemala and the maternal biscuit intervention in The Gambia, made important discoveries about the short-term effects of nutritional interventions during the first 1,000 days, the ability of researchers to assess the longer-term effects of these programs is limited by the design of the initial studies, which was not intended for follow-up.

At the time these evaluations were implemented, it was not yet widely understood that early childhood interventions could have sustained effects on ECD outcome domains, and it

will be particularly important for future evaluations of ECD programs to facilitate long-term follow-up. The logistical difficulty of conducting long-term follow-up studies, particularly in the developing country context, has further contributed to a dearth of research.

Early childhood interventions can impact a variety of cognitive, linguistic, socioemotional, physical, educational, and employment outcomes; however, this review identified just 54 impact evaluations across all possible intervention types and outcome domains that passed the quality check. The evidence in several domains was particularly thin. For example, only one study measured the effects of ECD programs on employment outcomes, and only one intervention type—stimulation—had long-term effects measured in each of the six outcome domains. Future research should aim not only to provide more evidence across the full range of possible outcomes throughout an individual's lifespan, but also to expand the scope of interventions evaluated for their effects. One goal of this review is to further clarify the existing knowledge base of long-term effects of early childhood interventions and help inform future evaluations.

Challenges

Long-term follow-up evaluations face logistical challenges that contribute to the knowledge gap.

Early childhood development evaluations aiming to estimate impacts after a prolonged period face four challenges: confounding variables, attrition, designing for follow-up, and external validity. These challenges are not unique to ECD evaluations or longer-term evaluations, but they may be compounded here. In particular, issues of attrition and confounding variables are primarily responsible for the exclusion of more than half of the impact evaluation studies otherwise eligible for this review.

The evaluations that today constitute the evidence base of long-term effects of ECD interventions were often not designed with that objective. Many study designs were implemented prior to the existence of strong evidence of effects across a range of outcomes in the post-early childhood years and were not designed to track participants into adolescence and adulthood. Additionally, universal, standardized measurement across a range of outcomes over the lifespan—cognition and socioemotional development in particular—are not yet established, making it difficult to know how best to assess these constructs longitudinally. Although in some cases researchers are able to apply econometric methods based on analysis of past performance

to tease out lasting effects that can be attributed to the original intervention, the absence of prior planning for long-term follow-up at the implementation stage has complicated causal inference from these studies.

Finally, evaluations of all types, including impact evaluations, have challenges of external validity—the ability to apply results found in one study to a different scale, context, or time. Most of the interventions evaluated here are somewhat small; scaling up to a national level may present administrative or other challenges. Furthermore, the longer-term nature of the interventions means that interventions included here occurred in an era—sometimes 30 years ago—that may have influenced interactions with the project in very different ways than would be expected in the contemporary context, even if in the exact same location. Potential variation across location underscores the need to fill in regional gaps.

Implications

While much has been written on early childhood development and the near-term benefits to children selected to participate in interventions, few studies look at the sustained impacts of these programs. At this point in the development of the literature, this systematic review aims to contribute to the field's progress by collecting those studies that offer high-quality, causal estimates, providing analysis on interventions shown to have sustained effects across a range of outcomes, and identifying research gaps to help guide future studies.

Box 2. Design Challenges

Evaluation design is critical in yielding valid causal estimates. Design is a major determining factor in how similar the comparison group is to the treated group, which in turn is the basis for calculating attributable program effects. Unfortunately, problems in design can be exacerbated over time as they interact with other factors, compromising the comparability of the two groups.

Two well-known interventions, the program of the Instituto de Nutrición de Centroamérica y Panamá (INCAP) in Guatemala and the Turkish Early Enrichment Project, suffered from this problem. Because of weaknesses in the initial randomization, many of the INCAP studies rely on a comparison group that is not statistically equivalent to the treated group, while in Turkey, group comparability suffered from selection bias in one wing of the study and extremely high attrition rates overall. Such design challenges can undermine causal inference.

The results of this outcome-based systematic review imply that some domains may be easier to affect than others. In cognition, language, socioemotional, and employment domains, the evidence suggests that early stimulation interventions can result in sustained benefits to children, and various interventions were successful in improving subsequent

schooling outcomes. Conversely, there was little evidence of a strong post-early childhood effect in physical outcomes across the range of evaluated interventions.

Despite these promising results, much work remains to be able to draw firm conclusions on the post-early childhood effects of ECD interventions. With 54 impact evaluation studies on 24 projects of 20 intervention types across 21 countries, the results presented are still indicative rather than conclusive. High-quality evaluations of interventions that could significantly impact a child's development, including nontraditional interventions such as clean water and sanitation or agriculture, are hard to find but are necessary to determine the most effective method of intervening. Furthermore, evaluations across Regions are important to capture context-specific variables and improve general external validity. The analysis of heterogeneous effects, especially by gender and socioeconomic status, can improve intervention targeting.

ECD interventions, like the children they serve, have transformative potential if properly supported.

Introduction: Review Questions and Strategy

1. While the later-life effects of interventions during the early childhood period are generally well documented in the developed world, far less evidence exists in developing countries. To address this knowledge gap, the review uses a comprehensive search strategy and a rigorous screening method to compile the causally robust evidence on the post-early childhood effects of early childhood interventions in developing countries. The evidence is organized around six outcome domains to determine which intervention types can effectively and consistently produce sustained effects in particular areas of child development.

2. In the *World Development Report 2006: Equity and Development,* the World Bank singled out early childhood development (ECD) interventions as a promising policy area to achieve both equity and efficiency objectives (World Bank 2005). More recently, in the *World Development Report 2015: Mind, Society, and Behavior,* the Bank again chose child development as a key facet of inequality, noting that children from developing nations have systematically lower socioemotional and cognitive stimulation in their early years, which together with the high stress of growing up poor can impair decision-making and deliberative abilities (World Bank Group 2015).

3. These flagship reports perceive that ECD can play a key role in achieving the Bank's twin goals to reduce extreme poverty and promote shared prosperity while encouraging economic growth. The realization of these aims is predicated on the ability of countries to build "human capital and [expand] access to social services to produce a healthy, well educated, and productive labor force, as well as on the provision and access to infrastructure" (World Bank 2013a, 28). Programs targeted at ECD do just that—build human capital—by intervening during a critical period of development when it is suggested that interventions can improve both the starting point and trajectory of a child's life path and provide a longer time horizon over which the benefit stream is realized (Carneiro and Heckman 2003).

4. Early childhood development is an integrated construct influenced by many factors, such as nutrition, health, hygiene, early learning, and stimulation. For example, good nutrition during the first 1,000 days, from conception to the child's second birthday, is essential for normative linear growth (Victora and others 2008; Black and others 2013) and health brain formation (Couperus and Nelson 2006; Georgieff and Rao 1999). The plasticity of the young brain (i.e., its capacity to change) allows young children to benefit from positive inputs such as stimulation and nutrition but also makes them vulnerable to negative external shocks including deprivation and abuse (Shonkoff and others 2012a; Fox and others 2010). Cognitive, language, fine motor, and

socioemotional skills important for educational and social success emerge during these years (Heckman 2008; NRC and IOM 2000; Shonkoff 2011). Risk factors related to poverty (e.g., undernutrition, poor sanitation, insensitive parenting) in early childhood are associated with delays in these skills as well as in school progress (Georgieff 2007; Grantham-McGregor and others 2007; Walker and others 2007; Glewwe, Jacoby, and King 2001).

5. Experimental evidence suggests that nutrition, health, early learning, and other factors can play a major role in shaping young children's subsequent school attainment, performance, and earnings (Heckman 2008; Naudeau and others 2011; Barnett 2011; Duncan and others 2007). Indeed, the benefits of a variety of early childhood interventions are well documented in developed countries.[1] Long-term evaluations of children who received these interventions in the United States found positive life outcomes in education, health, fertility, risky behaviors, and the labor market (Smith 2009; Cunha and Heckman 2009; Schweinhart 2007; Campbell and others 2002; Camilli and others 2010; Reynolds and others 2007; Anderson and others 2003; Bitler, Hoynes, and Domina 2014; Olds, Sadler, and Kitzman 2007; Sweet and Appelbaum 2004). This evidence led many in the international development community—including the World Bank—to promote ECD and to focus on interventions as the first step in a sequenced strategy to build the skills needed for productivity and economic growth (World Bank 2010).

6. In developing countries, numerous studies and reviews establish that early childhood interventions can improve early childhood outcomes (Maternal and Child Nutrition Study Group 2013). Yet the ability of ECD interventions to improve later outcomes—those occurring after the early childhood period[2]—is less well studied. Impact evaluations (IEs) that examine the post-early childhood effects from early childhood interventions in middle- and low-income countries are scarce, and it may be problematic to extend the findings from the United States to developing countries. While the challenges of developing countries differ from place to place, on average they face challenges that Organisation for Economic Co-operation and Development countries do not, such as weaker institutions and lower economic development. It follows that interventions that are effective in wealthy nations may not have the same results in the resource-constrained contexts of low- and middle-income countries, especially given that basic needs in these countries are often less well met. The converse may also be true—interventions that are effective in developing countries may not yield the same results in wealthier contexts where basic needs are met.[3] This dynamic may explain differences in the set of evaluated interventions by national income.[4] Nevertheless, evidence from developed countries can help establish the physiological pathways between particular inputs and ECD outcomes. However, as was discovered in IEG's systematic review of maternal and child mortality (IEG 2013), even where what

to do is known (and even this is not always the case with ECD), knowing how to do it under such different circumstances is a persistent challenge.

7. This review by the Independent Evaluation Group (IEG) tries to addresses that challenge by gathering and analyzing the available impact evaluation evidence on the post-early childhood effects of interventions conducted during the early childhood years in the developing world. The purpose of doing so is not to supplant existing evidence, but rather to help practitioners understand how evidence from IEs supports or challenges beliefs about ECD interventions and how this evidence can be used to inform development policy. Impact evaluations aim to overcome confounding factors inherent in other forms of evaluation to determine the causal impact of an intervention. This highly rigorous form of evaluation is particularly well suited to evaluate the claims of lasting effects from early childhood interventions, considering the number and scope of confounding factors that arise over time.

8. By taking such a specific approach—focusing exclusively on the post-early childhood effects of any ECD intervention—this review goes beyond the work done in this field.[5] For instance, a 2011 review published in *The Lancet* series on ECD in low- and middle-income countries included some evidence on post-early childhood effects, but these outcomes were a relatively minor part of the review (Engle and others 2011). The present report differs from *The Lancet* piece in the breadth of the interventions and outcomes included, the specificity of the age at evaluation, and the types of studies accepted for inclusion. While Engle and others use an intervention-based approach to focus on psychosocial and educational interventions and the resulting range of outcomes, this review includes impact evaluations of any type of intervention occurring during the early childhood period and presents them through an outcome-based framework (Waddington and others 2012). Additionally, unlike *The Lancet* review which included outcomes measured during the early childhood period for both children and parents, this review only reports outcomes in the post-early childhood period for children. Finally, while *The Lancet* includes both efficacy[6] and effectiveness studies implemented using local or foreign capacity, this review is restricted to those interventions that use local capacity so as to provide evidence on interventions that could actually be replicated by low- and middle-income countries.

9. A systematic review published recently in the *Annals of the New York Academy of Sciences* examined the effect of integrated interventions (Grantham-McGregor and others 2014) in low- and middle-income countries, but again its scope differs in significant ways from this review. As with *The Lancet* review, Grantham-McGregor and others focused on a narrow group of interventions (stimulation and nutrition), included a broader range of outcomes and ages at evaluation (both parent and child outcomes measured during the early childhood period and after), and drew evidence from

interventions implemented using local or foreign capacity. It should also be noted that their use of evidence from the post-early childhood period was limited.

10. Despite having received relatively little attention, post-early childhood benefits are quite important as they comprise a major economic argument for investing in young children based on the assumption that returns continue over time. Budget and time constraints, together with the estimation challenges inherent in follow-up IEs, may be responsible for the relatively few IEs that address later-stage outcomes of early childhood interventions. However, it is important to take stock of the causal evidence that does exist. With that in mind, this review uses evidence from all impact evaluations with credible causal estimates for interventions occurring before primary school age on outcomes occurring at or after primary school enrollment. It aims to answer the following questions:

- What is the evidence of attributable effects on outcomes in primary school and beyond from interventions in low- and middle-income countries that occur during the early childhood period?
- How do the post-early childhood effects of early childhood interventions vary by socioeconomic status, gender, age at intervention, and age at evaluation, particularly during the first 1,000 days from conception to the child's second birthday and from age three to primary school enrollment at age five to six?

11. For the purposes of this review, the defined intervention period for early childhood runs from conception to primary school enrollment of the child. Accordingly, all early childhood interventions are considered that are either directly provided to the child or to the parent, caregiver, or pregnant or lactating mother. This includes a range of interventions such as preschool, conditional cash transfers, and behavior change interventions such as early stimulation by caregivers, promotion of exclusive breastfeeding, complementary feeding practices, and health and hygiene practices.

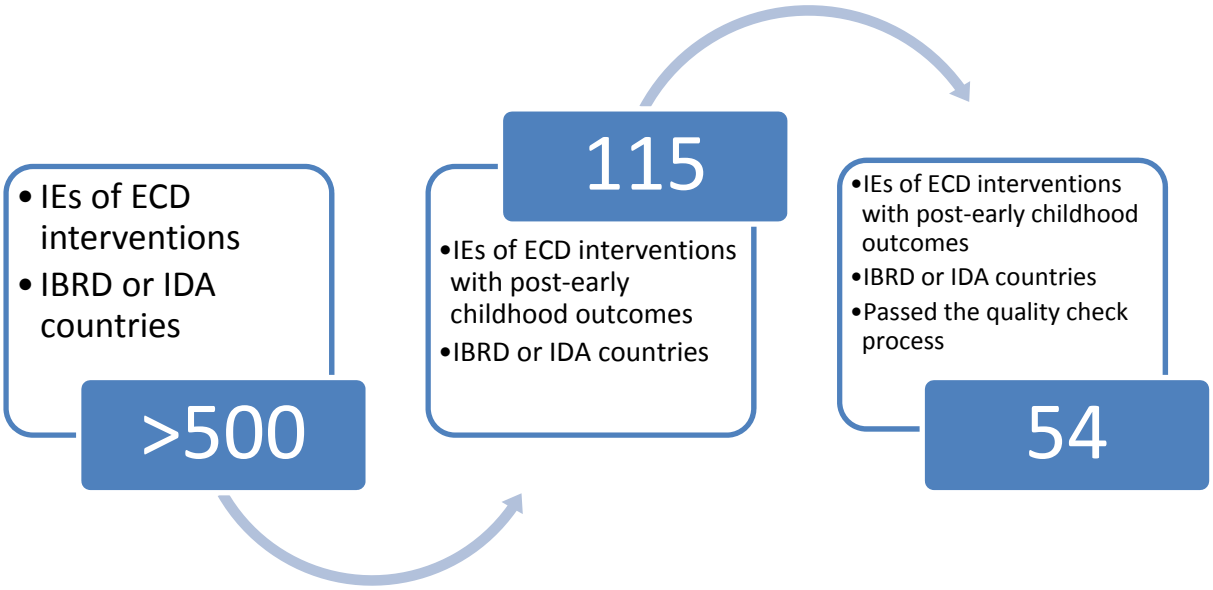
Search Strategy for Identification of Relevant Studies

12. Studies were identified through a detailed search strategy based on an approach used by a previous systematic review in IEG's Maternal and Child Health series (IEG 2013). Using search terms that encompassed the outcomes, methods, and the definition of low- and middle-income countries employed by the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA), studies between 1990 and 2014 were collected from relevant bibliographic databases and the World Bank's impact evaluation database. This was supplemented by searches of relevant institutions and a hand search of top ECD

authors, followed by the snowballing of references from included studies and related systematic reviews identified during the electronic search. The search included both published impact evaluations and unpublished grey literature, defined as working papers and studies soliciting review from the research community. (See appendix C for more information on the search process.)

13. Initial searches produced more than 500 potentially-relevant evaluations of ECD interventions in IBRD or IDA countries; 115 provided estimates for post-early childhood outcomes. A rigorous quality check against the inclusion criteria yielded 54 relevant studies of sufficient quality to include in the analysis (figure 1).

Figure 1. Flow of Search Results



Note: ECD = early childhood development; IBRD = International Bank for Reconstruction and Development; IDA = International Development Association; IEs = impact evaluations.

14. Despite this relatively thin evidence base, these 115 studies constitute the complete body of IE knowledge on the post-early childhood effects of ECD programs. The number is expected to grow. It should be remembered that the field of early childhood development is still relatively new, especially for developing country contexts. The pioneering IEs that offer evidence of later-life effects of early childhood development interventions were designed decades ago. Considerable evolution of both ECD theory and empirical standards and design has occurred since the initiation of some of the earliest studies reviewed (for example, the supplementary feeding program of the Instituto de Nutrición de Centroamérica y Panamá was begun in the 1970s), and most were not designed to serve as platforms for understanding long-term effects. This is not to critique the garden of child development evidence for being newly sown.

Rather, in light of this dynamic evidence base, this review seeks to take stock of what is known and point out where further cultivation might bear fruit.

Box 1. Analyzed Outcomes: The Rule of Three

This review reports outcomes across six different domains: physical development, cognitive development, language development, socioemotional development, schooling outcomes, and employment and labor market outcomes. Outcomes were selected for inclusion based on how often they were measured and reported and the extent to which they provided unique insight into measurements within the domain.

Outcomes that were reported in three or more independent studies were included. The high frequency of these outcomes was indicative of their usefulness in measuring and understanding early childhood development, and enabled comparison across contexts and intervention types.

In some cases, however, an outcome may have been reported in more than three studies, but was not included due to high overlap with other indicators. For example, both fat mass index and body mass index (BMI) were reported in many studies, but this review only included BMI measurements. Both indicators capture a similar measurement of a child's physical development, and including both would have provided little unique insight.

An exception to the "rule of three" was made for outcomes in employment and fine motor skills, both of which have high intrinsic value. Fine motor skills provide a useful measure of the development of an individual's executive function capabilities—an outcome domain in which little post-early childhood evidence exists. Similarly, given the focus on long-term outcomes in this review, employment outcomes are analyzed even though they are infrequently reported.

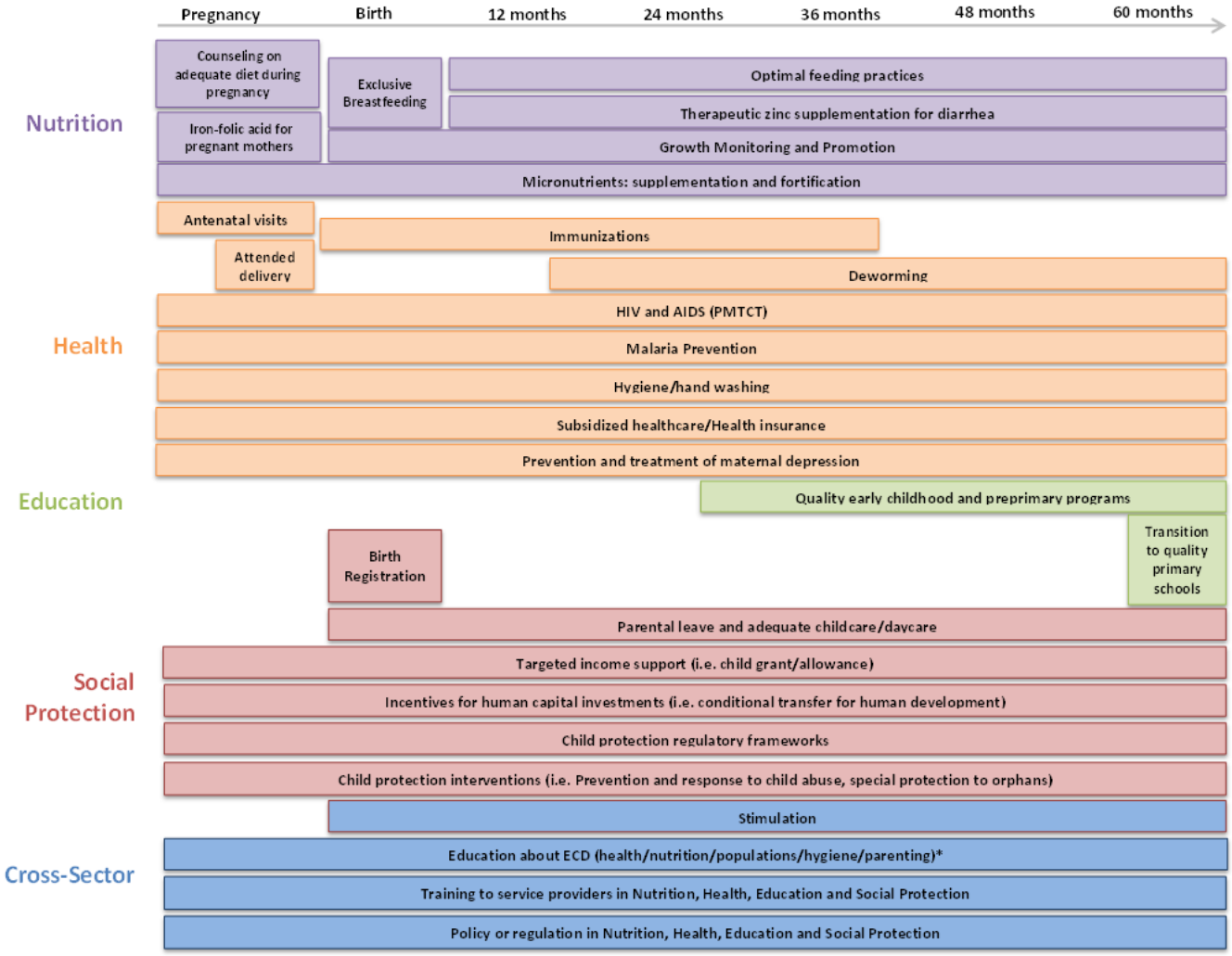
Criteria for Inclusion and Exclusion of Studies

15. The inclusion criteria required that the studies (i) employ a quantitative impact evaluation methodology using experimental or quasi-experimental identification strategies with a credible counterfactual[7] to identify causal attribution; (ii) assess post-early childhood outcomes of any intervention that occurred in the early childhood period;[8] (iii) evaluate any intervention occurring in a low or middle-income country that may have benefited a child before the age of entry into primary school;[9] (iv) be published between 1990 and the present and use endline data occurring no earlier than 1990; and (v) were peer reviewed. To reduce the risk of publication bias, grey literature was included for consideration if a full-text version is publicly available and the study passes other quality and inclusion criteria.

16. A taxonomy of ECD interventions is presented in figure 2, categorized by intervention type and the ideal age at intervention. To be included in this review, a study could be on any type of intervention, whether a typical ECD intervention or not, as long as it was implemented through local capacity channels (for example,

governments, nongovernmental organizations, or private sector firms) and would therefore be more easily replicated by local implementers.

Figure 2. Essential Interventions for Young Children and Families



Source: Denboba et al. (2014), adapted by IEG.
*Note: can be delivered voa home visists or Community Centers.

17. All included studies had a sample size of 50 or more and an attrition rate lower than 40 percent.[10] Studies excluded from this review use aggregated national or regional data, as in cross-country or national interrupted time series analyses with few observations over multiple periods. The unit of analysis could be at the individual, household, facility (e.g., school, center, or clinic), or community level.[11]

18. All studies meeting the inclusion criteria were subjected to a double-coded quality review that assessed the strength of the internal, external, and construct validity. The primary criteria for this assessment was the extent to which the identifying

assumptions of the identification strategy used were met, whether the data were representative of a definable and policy-relevant population, and whether the key indicators and outcomes in the report were measured in an unbiased and reliable way. (See appendix D for information about the rating and coding process.)

19. Based on these criteria, studies (or in some cases specific estimation strategies in a study) were assigned an overall quality rating: A, AA, or AAA. As in past IEG systematic reviews, only AA and AAA studies were included in the review. Studies with a AA rating have a credible counterfactual with identification assumptions plausibly fulfilled; those with a AAA rating have a credible counterfactual with identification assumptions clearly fulfilled. Studies graded A leave serious doubts about the validity of the counterfactual and the likelihood its identifying assumptions have been violated. This process identified 54 sufficiently high quality impact evaluations used for synthesis in this review. Challenges to the representativeness and interpretation of results remain that are inherent to systematic reviews, despite the rigorous standards applied in the search and coding process.

20. 20. Relatively few impact evaluations can answer the important questions about long-term effects of early childhood interventions posed by this review. Moreover, because the evidence that is available is spread across a broad range of intervention and outcome combinations, the evidence for any particular combination can be quite thin, or completely nonexistent. Thus, although the review contains all causally robust evaluations, results should be viewed as comprehensive but nascent and prone to change as new results are published.

21. In light of the challenges endemic to reviews (see box 2), rather than assuming that evidence gaps indicate interventions that do not work, this report focuses on interventions shown to be effective. One test of robustness of a review is whether the main messages would change if the cutoff date for inclusion were altered. As explained in Appendix C, this review completed an initial search and analysis ending in 2013 and then refreshed that search prior to publication to include material released in 2014. Although there was a substantial uptick in the number of studies from which to draw evidence, the conclusions remained almost entirely unchanged. This finding supports the view that the conclusions included here are likely to be broadly stable as still more evaluative, causal evidence is produced.

Box 2. Challenges and Cautions for Systematic Reviews

Notwithstanding the thoroughness of the search strategy, challenges remain to representativeness and interpretation of results that are common to all systematic reviews. This review meets or exceeds standard practice, such as it exists, in every instance.

Challenges to representativeness of the interventions arise from the fact that the process of selecting interventions to be evaluated by an impact evaluation is purposeful rather than random.

- Some types of projects are less amenable to impact evaluation methods and will be underrepresented.
- Interventions that report on intermediate rather than final outcomes are excluded.
- Importantly, the lack of existing impact evaluations for a family of interventions indicates a need for evaluations in that area, not that the interventions are ineffective.
- Challenges to representativeness of the impact evaluations are twofold.
- The review includes only concluded studies; it cannot use impact evaluations that are planned or in process.
- As with all reviews, the sample may suffer from file drawer bias or publication bias wherein studies that yield null results are not completed. Alternately, it has been hypothesized that only studies with experimental designs can be published with statistically insignificant results because of stronger internal validity; this may lead to a false conclusion that randomized trials are more likely to return null results.
- Challenges to interpretation of results imply a need for thoughtful application of findings.
- Impact evaluations of projects funded by foreign aid likely underestimate the true effect of the intervention because they measure partial (or local) equilibrium effects rather than the general equilibrium effects resulting from the fungibility of government budgets, which allows countries to reallocate health funding away from of the foreign-funded activities (Wagstaff 2011).
- Null results must be interpreted carefully: they do not necessarily mean there is no effect. They may occur where there is measurement error, insufficient sample size (power) to detect an effect, spillover from treatment to the control group, differential attrition, insufficient behavioral incentives, or implementation challenges. Distinguishing the causes of a null result is often untenable.
- External validity is a persistent challenge. Applicability of results to a different context—time, place, or scale—is likely a function of project complexity (Woolcock 2013, administrative capacity, political supportability, and alignment with the most important barriers of the target environment. The ideas and processes of an intervention may have greater external validity than the intervention itself.

22. Consensus analysis was carried out across the studies comparing statistical significance and magnitude in forest plots. Where sufficient numbers of studies exist with outcomes in a common construct, meta-analysis was conducted to explore the presence of an overall effect.

23. The report presents evidence for post-early childhood outcomes of early childhood-age interventions over six important domains: physical, cognitive, language, socioemotional, schooling, and employment and labor market outcomes. Chapter 7 breaks down heterogeneous effects and the differential outcomes observed both between subgroups and over time. Chapter 8 discusses the challenges of evaluating long-term effects of interventions conducted during the early childhood years, and chapter 10 identifies the remaining gaps in knowledge about the post-early childhood effects of ECD interventions.

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[1] In developing countries, preschool participation contributed to an increase in lifetime earnings by 5 to 10 percent (Engle and others 2007, 2011). Belfied and others (2000) computed the benefits of the Perry Preschool Program in the United States to be $150,000 (in 2000 dollars) per child through age 40 because of crime reduction.

[2] The post-early childhood period is determined to start on enrollment in primary school or, when that information is unavailable, at age six years.

[3] The effectiveness of a particular intervention is a function of, among other things, the complementary slackness of the constraint in the outcome's production function that that intervention is designed to address. For an example of a production function model of a range of inputs on a range of children's outcomes, see Tanner 2012 and Becker 1993.

[4] This presents a mechanism for the endogeneity of the evidence base by national income. For example, in contexts where a particular input (say nutrition) has a lower shadow price on the production of a particular output, the effect size of an intervention designed to alleviate that (nutritional) constraint will be low. Thus there may be comparatively fewer interventions of that input in that context, and so there may be fewer evaluations of that (nutrition) input.

[5] For a full review of the existing systematic review literature, see IEG 2015 (forthcoming).

[6] The World Bank's handbook, *Impact Evaluation in Practice* (World Bank 2011), defines efficacy trials as having "heavy technical involvement from the researchers during the implementation of the program" and which do not use "regular implementation channels." For the purposes of the inclusion criteria of this review, this is codified such that studies are excluded which do not rely on local capacity for implementation of the intervention

[7] Constructing a valid comparison group for use as a counterfactual—the outcome that would have been observed for a participant in the absence of the program—is the defining feature of impact evaluation methods.

[8] The early childhood period is defined as the time between conception and a child's entry to primary school. If age at the time of entry to primary school was not mentioned, 59 months was used as a cut off. Therefore, these impact evaluations must include outcomes measured after entry to primary school or age 6 years (post-early childhood) resulting from interventions that occurred before entry to primary school or age six years.

[9] Despite being recently classified as high-income countries by the World Bank in July 2013, studies from both Chile and Uruguay are both included in this review due to the fact that endline data for those studies was collected during the period when they were still categorized

as middle-income countries. All countries included in this report are currently World Bank client countries.

[10] In the professional judgment of the team, sample sizes below 50 engender serious doubts pertaining to their external validity; lower sample sizes are also more likely to be under-powered, complicating the interpretation of null results. There was one exception: a single outcome estimate from one of the studies of the Jamaica supplementation and stimulation project had a sample size of 48. Similarly, attrition rates over 40% (many would say 20% or even less) are judged to be seriously challenged by selection bias. See Chapter 9 for a more detailed discussion on challenges to follow-up impact evaluations, including problems of attrition.

[11] For example, if all students at a given primary school had participated in the intervention, attendance or school performance could be measured at the school level. In practice, almost all of the outcomes were measured on the individual level.

Part I: Effects by Outcome

The effects of interventions on six domains—physical development, cognitive development, language development, socioemotional development, schooling ourtcomes, 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 54 impact evaluations of 24 projects of 20 interventions types conducted in 21 countries.

The outcomes do not represent all that are reported. 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. Appendix A contains a brief description of an intervention, the relevant counterfactual, age at initiation, and age at evaluation.

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.

1.1 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).

1.2 Although undernutrition has long commanded the focus of maternal and child health experts, overweight and obesity have increasingly become problems in developing countries (Ebbeling and others 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 and others 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).

1.3 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.

1.4 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.

1.5 Table 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).

1.6 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).

1.7 Some studies used as outcomes the group differences in the actual value measured (e.g., PROBIT in Belarus[8228, 8187] and maternal supplementation study in The Gambia[8252, 8255] 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 Orgnaization (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. 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	Outcomes
Nutrition	Kramer and others 2007 [8228]	Belarus (Promotion of Breastfeeding Intervention Trial [PROBIT])	0	1	6	Breastfeeding promotion	BMI, height, MUAC, head circumference*
	Martin and others 2013 [8187]	Belarus (PROBIT)	0	1	11	Breastfeeding promotion	BMI, height, MUAC, head circumference
	Stewart and others 2009 [8256]	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)
	Stewart and others 2009 [8466]	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)
	Devacumar and others 2014 [8337]	Nepal (maternal multivitamin supplementation)	In utero	0.17	8.5	Vitamins, micronutrients, or fortified food for pregnant women (multivitamin supplement)	BMIZ, HAZ, WAZ, MUAC, head circumference, height, weight (z-scores based on WHO standards)
	Hawkesworth and others 2008 [8252]	Gambia, The (maternal supplementation)	In utero	0.5 (DR1)	11–17	Vitamins, micronutrients, or fortified food for pregnant women (protein biscuits)	Height,*** weight, BMI
	Hawkesworth and others 2011 [8254]	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 [8255]	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 [5549]	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 [5544][a]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	11–12	Supplementary feeding	BMI, HAZ (z-score based on NCHS standards)
	Pongcharoen 2010 [5117]	Thailand (micronutrient supplementation to children)	0.5	0.5	9	Micronutrients and fortified food for children (iron and/or zinc supplementation)	BMIZ, HAZ,* WAZ, MUAC (z-scores based on WHO standards)
Early Learning/Childcare	Martinez and others 2012 [8261]	Mozambique (preschool)	3.45	1.5	5–9	Quality early childhood and preprimary program	HAZ, WAZ, fine motor skills* (no information given on reference population used for calculating the z-score)
	Walker and others 1996 [5549][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 [8496]	Romania (Bucharest Early Intervention Project)	1.88	2.7	8	Stimulation (foster care)	Motor skills
	Walker and others 2000 [5544]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	11–12	Stimulation	BMI, HAZ (z-scores based on NCHS standards)
Health	Barham 2012 [8277][b]	Bangladesh (Matlab)	NA	Continuous	8–14	Well child visits	HAZ** (normalized using comparison areas means and standard deviation)
	Ozier 2013 [8251]	Kenya (primary school deworming project)	0	1	8–15	Deworming	HAZ, height (z-score based on WHO standards)
	Barham 2012 [8277][b]	Bangladesh (Matlab)	NA	Continuous	15–19	Family planning	HAZ (normalized using comparison areas means and standard deviation)
Social Protection	Behrman and others 2008 [8237]	Mexico (Progresa)	1.5	1.5 (DR2)	7–11	CCT	BMIZ, height (z-scores based on WHO standards)
	Manley and others 2012 [8274]	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 [8278]	Nicaragua (Red de Protección Social)	In utero	3 (DR2)	10 (boys)	CCT	HAZ, WAZ (no information given on reference population used for calculating the z-score)
	DSD, SASSA, and UNICEF 2012 [8222]	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: More details for each of the studies 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 appilcable; 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 [5544, 5549] studies have a multiple intervention arm, and each intervention type has a separate row for these studies.

b. Bangladesh Matlab study [8277] 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 3. Breastfeeding Intervention 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.[4692] 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 evaluations found virtually no group differences on various 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.[8190] The evaluations also did not find a detectable difference in dental health as recorded in routine dental exams conducted by a public health dentist.[8227] 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 cm in head circumference was marginally significant and a difference of 0.3 cm was significant for females.[8228] 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.[8187] No significant 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.[1383]

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 Develop-ment	Cognitive Develop-ment	Language Develop-ment	Socio-emotional Development	Schooling Outcome	Employment and Labor Market Outcomes
1	Anchor study	5/12	-	-	-	-	-
6	[8228, 4693, 1383]	2/13[8228]	1/4[4693]	3/3[4693]	0/16[1383]	1/4[4693]	-
11	[8187, 8344]	5/25	-	-	-	-	-

(Note 1) Numerator is statistically significant outcome at 10% level, and denominator is number of outcomes in the domain.
(Note 2) The superscript and number in "Study" column indicates study ID.
(Note 3) Anchor study is Karmer et al (2001) "Promotion of Breastfeeding Intervention Trial (PROBIT) A Randomized Trial in the Republic of Belarus" JAMA Vol 285, No. 4.
(Note 4) To provide a more complete scope of these studies, this table includes all of the outcomes reported in the studies and not just those analyzed in the main body of this report (see box 1 for the decision rule for selecting outcomes for analysis)

1.8 The most common anthropometrics found in the included studies are weight related (i.e., weight, BMI, BMIZ, WAZ, and WHZ) and height related (i.e., 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.

1.9 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.

1.10 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 (e.g., intervention type, timing, and duration of intervention) for doing so has not yet been established.

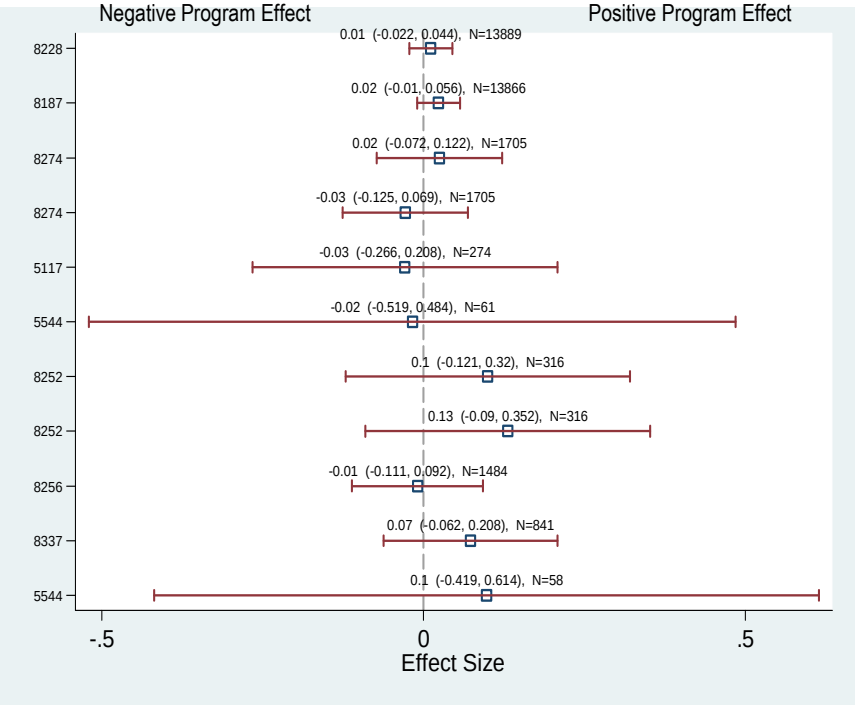
Weight

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

1.11 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 and 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 2).

Figure 3. Forest Plot for BMI and BMI for Age z-score

Country	Intervention	Measurement	Average Age at Evaluation (years)
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 (child, supplementary feeding) (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 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. Studies 5117 and 8274 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 8274, the conditional cash transfer effect is disentangled in cash and conditionality, and both estimates are reported in the forest plot. The Mexico 8237 study is not included in this forest plot given that it looks at the same average age at evaluation with 8274.

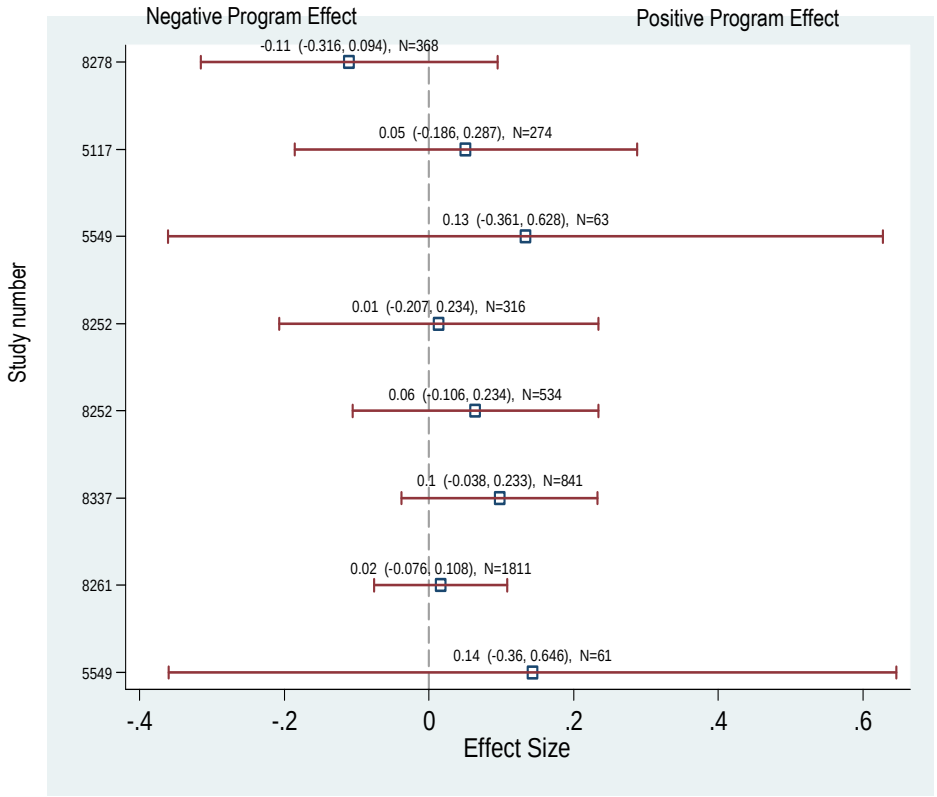
b. For Gambia study 8252, each gender estimate is included in the forest plot because the combined total estimate is not available.

c. For Jamaica study 5544, 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 8256, "multiple micronutrient" treatment group compared to the control group is used to compute the effect size.

Figure 4. Forest Plot for Weight and Weight-for-Age z-score

Country	Intervention	Measurement	Average Age at Evaluation (Years)
Nicaragua	CCT	Weight for age z-score (boy)	10
Thailand	Nutrition (child, micronutrient)	Weight for age z-score	9
Jamaica	Nutrition (child, supplementary feeding) (stunted children)	Weight for age z-score	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)	Weight for age z-score	8.5
Mozambique	Quality early childhood and pre-primary program	Weight for age z-score	7
Jamaica	Stimulation (stunted children)	Weight for age z-score	7.7



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. Study 5549 uses National Center for Health Statistics growth reference data to compute standardized z-score, and study 5117 uses WHO 2006 growth reference. Study 8261 and 8278 are not clear which growth reference data is used for computing the weight for age z-score, but given they are published relatively recently, they are likely to use WHO 2006 growth reference. CCT = conditional cash transfer.
a. For the Gambia study 8252, 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.

1.12 Evidence shows that it may also be difficult to produce post-early childhood effects on height (see figure 6). 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 (see figure 5).

1.13 When taken individually, only five of 20 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.

1.14 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 1st 1000 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).

1.15 The majority of these interventions (9 of 11) provided micronutrients either to pregnant mothers or to infants[8256, 8466, 8337, 8252, 8255, 5117]. 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 6 – 8-year-old Nepalese children whose mothers received folic acid, iron, and zinc while pregnant were .64 centimeters taller than those whose mothers did not receive micronutrients.[5117, 8466]

1.16 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.[i], [8252, 8255] There was no effect on height found from the other six micronutrient interventions. [8256, 8466, 8337, 5117]

1.17 The remaining two nutrition interventions were the Jamaican supplementary feeding and Belarussian breastfeeding promotion programs.[8228, 8187, 5549, 5544] Both were studied soon after early childhood (6-8 years old) and again a few years later (11-12 years old), and neither found a detectable effect on children's height.

1.18 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 9 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. [ii] 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.

1.19 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 the beginning of the program 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.[1], [8274, 8237]

1.20 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

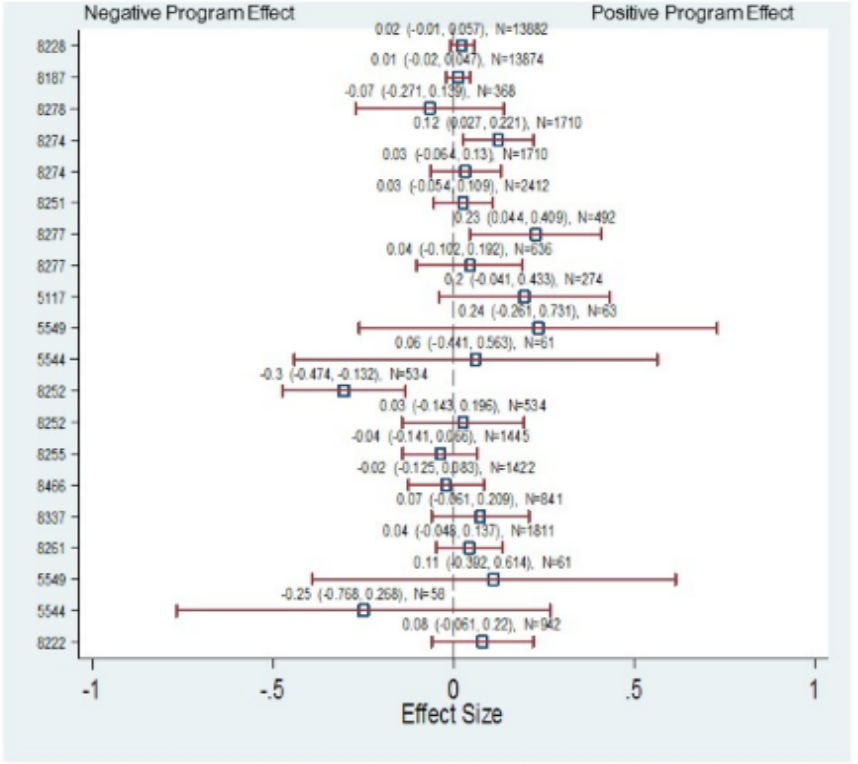
least be partially spent on improving health and nutrition for the child it was intended to support, but no condition required it.[8222] In this particular evaluation of the program, the authors target households with children who were age two years or younger when they received the grant and compares 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.[8278]

1.21 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.[5544, 8261]

1.22 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.[8277] 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 those who were too young to receive the treatment. Ten years later, there was no effect on height or height-for-age.[8251]

Figure 5. 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	CCT	Height for age z-score (Boy)	10
Mexico[c]	CCT cash	Height for age z-score	9
Mexico[c]	CCT conditionality	Height for age z-score	9
Kenya	Deworming	Height for age z-score	10
Bangladesh	Family planning & MCH	Height z-score	9
Bangladesh	Family planning & maternal health	Height z-score	9
Thailand	Nutrition (child, micronutrient)	Height for age z-score	9
Jamaica	Nutrition (child, supplementary feeding) (stunted children)	Height for age z-score	7.7
Jamaica[a]	Nutrition (child, supplementary feeding) (stunted children)	Height for age z-score	11.5
Gambia, The[b]	Nutrition (mother)	Height (girl, cm)	13.8
Gambia, The[b]	Nutrition (mother)	Height (boy, cm)	13.8
Gambia, The[b]	Nutrition (mother)	Height (cm)	19.6
Nepal[d]	Nutrition (mother)	Height (cm)	7
Nepal	Nutrition (mother)	Height for age z-score	8.5
Mozambique	Quality early childhood and pre-primary program	Height for age z-score	7
Jamaica	Stimulation (stunted children)	Height for age z-score	7.7
Jamaica	Stimulation (stunted children)	Height for age z-score	11.5
South Africa	Unconditional cash transfer	Height for age z-score	10



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. Study 5544, 5549 use National Center for Health Statistics growth reference data to compute standardized z-score, and study 5117, 8251, 8274 use WHO 2006 growth reference. Study 8222, 8261 and 8278 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 8277 height z-score is standardized by subtracting the comparison group mean and dividing by the comparison gr group standard deviation for people of the same age and gender. CCT = conditional cash transfer.

a. For Jamaica study 5544, 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".

b. For Gambia, The, study 8252, 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 8278.

c. For Mexico study 8237, it is not included in this forest plot because it looks at same average age at evaluation with 8274.

d. For Nepal study 8466, "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.

1.23 Three studies examined head circumference and MUAC. Two of the IEs looked at the effect of the PROBIT in Belarus on both measures.[8187, 8228] The third study to examine the effect on head circumference evaluated the food supplementation and home intervention in Colombia,[5425] and the third study to examine the effect on MUAC was the evaluation of the Thai iron and zinc intervention.[5117] 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.[8228] 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.

1.24 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.[8261] Conversely, a program that promoted early stimulation by placing Romanian orphans with foster care families rather than in insititutional homes had no detectable effect on the fine motor skills of 8-year-old foster care children.[8496] 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

1.25 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.

1.26 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.

1.27 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.[8228] There is some evidence that even that effect might disappear four years later.

1.28 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[5549, 5544] and the maternal supplementation project in The Gambia,[8252, 8254, 8255] also occurred during that time period but did not produce significant effects.

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[i] 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.

[ii] 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%) (Super and others 1990).

[1] 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.[8274] 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 2 of study 8274).

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.

2.1 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

2.2 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 (e.g., vocabulary and analogies) and nonverbal abilities (e.g., 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.

2.3 Widely used, brief cognitive assessments, like pattern completion tests such as the Raven's matrices, are designed to measure specific aspects of cognition (e.g., 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.

2.4 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

2.5 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).

2.6 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; Magnusen, 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.

2.7 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

2.8 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.

2.9 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 IEs and reviews that address this area.

2.10 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

2.11 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.

2.12 Table 2 maps the 15 unique studies in this review that investigate cognitive outcomes. The studies span 10 projects in 9 countries and include 7 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.

Table 2. Impact Evaluation Invsetigating Cognitive Development

	Study	Country (Project)	Average Age at Intervention (Years)	Average Length of Exposure (Years)[c]	Age at Evaluation (Years)	Evaluated Intervention	Outcomes
Nutrition	Kramer and others 2008 [4693]	Belarus (Promotion of Breastfeeding Intervention Trial)	0	1	6	Breastfeeding promotion	Abbreviated IQ (total score),* abbreviated performance IQ, nonverbal subscales
	Pongcharoen 2010 [5117]	Thailand (micronutrient supplementation to children)	0.5	0.5	9	Micronutrients and fortified food for children (Iron and/or zinc supplementation)	Full-scale IQ, performance IQ, nonverbal cognition (Raven's matrices), executive function (processing speed)
	Alderman and others 2014 [8255]	Gambia, The (maternal supplementation)	In utero	0.5 (DR1)	16–22	Vitamins, micronutrients, or fortified food for pregnant women (protein biscuits)	Nonverbal cognition (Raven's matrices), executive function (backward digit span)
	Walker and others 2005 [8198]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	17–18	Micronutrients and fortified food for children (supplementary feeding)	Full-scale IQ, performance IQ, nonverbal cognition (Raven's matrices)
	Walker and others 2011 [5602]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	22	Supplementary feeding	Full-scale IQ, performance IQ
	Maluccio and others 2009 [4845][a]	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 [5547]	Jamaica (stimulation to low birthweight infants)	0	2	6	Stimulation	Full-scale IQ, performance IQ,** executive function (short-term memory)***
	Fox and others 2011 [8490]	Romania (Bucharest Early Intervention Project)	1.88	2.7	8	Stimulation (foster care)	Full-scale IQ,* executive function (processing speed), executive function (working memory), perceptual organization
	Bos and others 2009 [8494]	Romania (Bucharest Early Intervention Project)	1.88	2.7	8	Stimulation (foster care)	Executive function (stockings of Cambridge), executive function (spatial working memory)
	Walker and others 2000 [5544][b]	Jamaica (stimulation and supplementation to	1.55	2	11–12	Stimulation	Full-scale IQ,** performance IQ,* nonverbal cognition (Raven's matrices),** executive function (processing speed)

		stunted children)					
	Walker and others 2005	Jamaica	1.55	2	17–18	Stimulation	Full-scale IQ,** performance IQ,* nonverbal cognition (Raven's matrices),* working memory
	[8198]	(stimulation and supplementation to stunted children)					
	Gertler and others 2013	Jamaica	1.55	2	22	Stimulation	Cognitive factor score***
	[1715]	(stimulation and supplementation to stunted children)					
	Walker and others 2011	Jamaica	1.55	2	22	Stimulation	Full-scale IQ,*** performance IQ***
	[5602]	(stimulation and supplementation to stunted children)					
Health	Ozier 2013	Kenya	0	1	8–15	Deworming	nonverbal cognition (Raven's matrices),*** cognitive factor score**
	[8251]	(primary school deworming project)					
Social Protection	Behrman and others 2008	Mexico	1.5	1.5 (DR2)	7–11	CCT	Abbreviated performance IQ
	[8237]	(Progresa)					
	Manley and others 2012	Mexico	1	1.5 (DR2)	8–10	CCT—conditionalities	Abbreviated cognitive performance IQ
	[8274]	(Progresa)				CCT—cash	Abbreviated cognitive performance IQ*
	Barham and others 2014	Nicaragua	In utero	3 (DR2)	10 (boys)	CCT	Cognitive factor score,*** nonverbal cognition (Raven's matrices),** executive function (processing speed)**
	[8278]	(Red de Protección Social)					

Note: More details for each of the studies are found in appendix A. Study 3941 is obviated by study 4845 and is not included. CCT = conditional cash transfer; DR = dose response; INCAP = Instituto de Nutrición de Centroamérica y Panamá; IQ = intelligence quotient.

a. 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.

b. Jamaica [5544] has a multiple intervention arm, and each intervention type has a separate row.

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 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.

* Statistically significant at 10 percent.

** Statistically significant at 5 percent.

*** Statistically significant at 1 percent.

Box 4. 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. [379, 1715, 5544, 5549, 5602, 8198, 8275]

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,[5549] 11–12 years,[5544] 17–18 years,[379, 8198] and 22 years,[1715, 5602] 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

result in significant differences[a] in children's development between the ages of seven and 22 years.[379, 5544, 5549, 5602, 8198]

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.[b, 5544] These cognitive advantages were again observed at 17 and 18 years of age.[8198] 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.[5602]

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.[379] 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.[1715, 8275] These results present a clear picture that psychcosocial 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.

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

a. The only detectable outcome that could be attributed to supplementation was a marginally significant decline in anxiety, measured as a 2.8 standard mean difference decrease on the questionnaire score.[5602]

b. Test scores of the stunted but stimulated nearly caught up with nonstunted children,[5544] suggesting that early stimulation may be able to mitigate some of the functional consequences of growth restriction in young children.

Outcome Domain by Age at Evaluation in the Jamaica Supplementation Project

Age	Study	Physical Development	Cognitive Development	Language Development	Socio-emotional Development	Schooling Outcomes	Employment and Labor Market Outcomes
Below 5 y	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[5549]	-	-	-	-	-
	Stimulation	0/8[5549]	-	-	-	-	-
	Both	0/8[5549]	-	-	-	-	-
11-12 y	Supplementation	0/5[5544]	0/8[5544]	1/4[5544]	-	-	-
	Stimulation	0/5[5544]	5/16[5544]	4/8[5544]	-	-	-
	Both	1/5[5544]	3/8[5544]	2/4[5544]	-	-	-
17-18 y	Supplementation	0/2[8198]	0/12[8198]	1/10[8198]	1/8[379]	0/2[8198]	-
	Stimulation	0/2[8198]	7/12[8198]	10/10[8198]	6/16[379]	0/2[8198]	-
	Both	0/2[8198]	2/6[8198]	4/5[8198]	1/8[379]	0/1[8198]	-
22 y	Supplementation	0/1[5602]	0/5[5602, 1715]	0/4[5602]	0/9[5602, 1715]	0/7[5602, 1715]	-
	Stimulation	0/1[5602]	5/6[5602, 1715]	4/4[5602]	4/11[5602, 1715]	10/16[5602, 1715]	5/8[1715, 8275]
	Both	0/1[5602]	3/3[5602, 1715]	1/2[5602]	2/3[5602, 1715]	1/4[5602, 1715]	-

Note: 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 means age at evaluation. The superscript number identifies the study (see References).
(Note 4) To provide a more complete scope of these studies, this table includes all of the outcomes reported in the studies and not just those analyzed in the main body of this report (see box 1 for the decision rule for selecting outcomes for analysis)

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.

2.13 Cognitive outcomes were reported for 10 early childhood programs (figure 6). However, only two of these programs, early stimulation and supplementation in Jamaica,[5544, 5602, 8198] and a conditional cash transfer in Mexico,[8274] report effects during 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 lifespan.

2.14 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.[5117] 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.[4693] The supplementation-only component of the Jamaica interventions did not have a significant effect on any measures of cognitive ability from age six through 22.[379, 1715, 5544, 5549, 5602, 8198, 8275] However, given that the Jamaica program provided supplementation to children who were already stunted, it may be that once stunting occurs, supplementation alone is not sufficient for producing measurable improvements in cognitive outcomes. This conclusion is supported by evidence suggesting that once stunting occurs, it is irremediable after the age of two or three years (Victora and others 2008). These findings further affirm the assumption 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.

2.15 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, [8198] and the gains became much larger and highly significant at age 22.[5602] Improvements in performance IQ were weakly significant for stunted children at ages 11–12[5544] and 17–18 years,[8198] 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.[5602] 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.[5547]

2.16 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. [8490]

2.17 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.[8237] However, a second study of the same

program was able to separate the effects of conditionalities versus 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.[8274] The evaluation of Red de Protección Social, a CCT in Nicaragua[8278] 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.[1] When evaluated at age 10, no significant effects were observed for girls, though boys whose families began to receive the program during the first 1,000 days of his life showed a highly significant improvement in the cognitive index measure over boys whose family began the program when the boy was two to five years old.

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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.

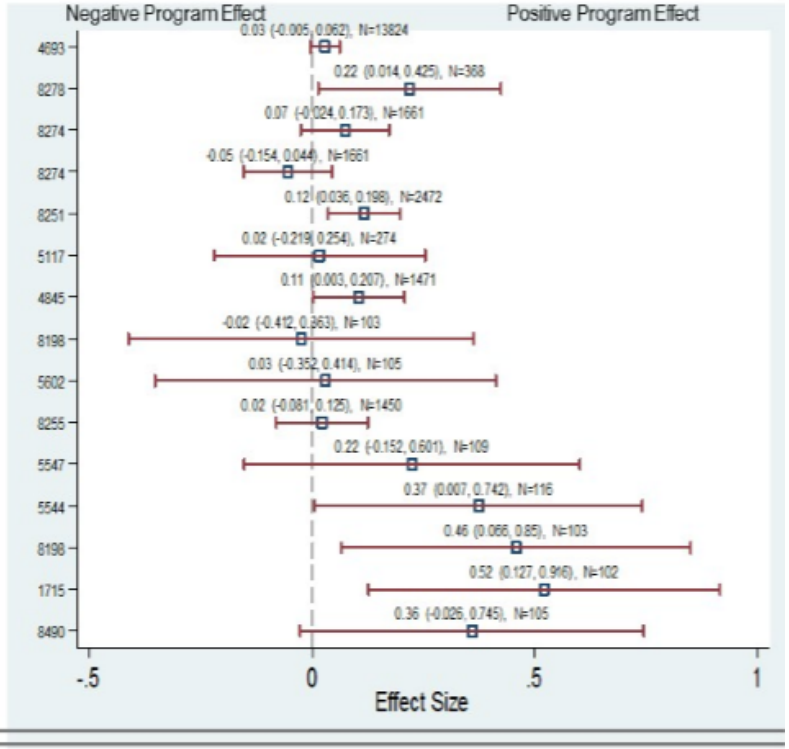
[3] For example, although randomized evaluations of the Head Start program detected cognitive gains among program participants between ages three and four (HHS 2005), nearly all of the gains disappeared by the start of first grade (HHS 2010).[3] Similarly, in the Early Childhood Longitudinal Study, Magnuson, Ruhm, and Waldfogel (2007) used non-experimental 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.

[1] 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.

Figure 6. Forest Plot for General Intelligence

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



Note: The forest plot describes standardized mean difference, 95 percent lower and upper bound confidence interval in parentheses, and sample size (N = number). The WASI, WISC, WAIS, 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.

a. For Mexico study 8237, it is not included in this forest plot because it looks at same average age at evaluation with 8274.

b. Nicaragua study 8278 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.

c. For Jamaica studies 5544, 5602, 8198, 1715 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".

d. Guatemala study 4845 uses first three of five scales in Raven's matrices as non-verbal cognitive ability outcome.

e. Jamaica study 1715 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.

2.18 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 common assessment of nonverbal cognition is Raven's Progressive Matrices, which require an individual to progress through increasingly difficult pattern recognitions.

2.19 Singular and multiple micronutrient supplementation interventions did not affect 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.[5117]

2.20 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.[8255] 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.[8198]

2.21 The only nutritional intervention to noticeably improve nonverbal cognitive outcomes was the supplementary feeding program of Guatemala's Instituto de Nutrición de Centroamérica y Panamá. Children who had received atole, a high-energy, high-protein supplement, between conception and three years old registered large and lasting improvements in fluid intelligence when tested between the ages of 25 and 42.[4845]The effects of stimulation on nonverbal cognition was only measured in two studies, both of which evaluated the supplementation and stimulation for stunted children program in Jamaica. The early stimulation component resulted in significant improvements in nonverbal cognition when children were between 11 and 12 years old.[5544] Those benefits were still marginally significant when children were again evaluated between 17 and 18 years of age.[8198]

2.22 Improvements were also observed in nonverbal cognition for the Red de Protección Social for 10-year-old boys in Nicaragua.[8278] 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.[8251] 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.

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.

2.23 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 probelm 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.

2.24 Two studies of nutritional programs reported effects on executive function measures, and neither the zinc and iron supplementation program in Thailand [5117] nor the maternal supplementation program in The Gambia [8255] noticeably improved executive function.

2.25 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 [5544] or working memory at ages 17–18.[8198] The Bucharest foster care program also did not measurably improve 8 year olds' executive function, as assessed by perceptual reasoning, working memory, processing speed,[8490] and visual and spacial working memory metrics.[8498]

2.26 Only a single study evaluated the effects of a CCT program on executive function. The assessment of Nicaragua's CCT program [8278] 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

2.27 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).

2.28 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 4). 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).

2.29 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 2012a).

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.

3.1 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.

3.2 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.

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

3.4 Table 3 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. 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. 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	Outcomes
Nutrition	Kramer and others 2008 [4693]	Belarus (Promotion of Breastfeeding Intervention Trial)	0	1	6	Breastfeeding promotion	Verbal abilities (abbreviated test)**, vocabulary**, reading ability*
	Pongcharoen 2010 [5117]	Thailand (micronutrient supplementation to children)	0.5	0.5	9	Micronutrients and fortified food for children (iron and zinc supplementation)	Verbal abilities
	Alderman and others 2014 [8255]	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)
	Walker and others 2000 [5544]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	11–12	Supplementary feeding	Verbal abilities, vocabulary, receptive vocabulary
	Walker and others 2005 [8198]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	17–18	Supplementary feeding	Reading abilities, verbal abilities, receptive vocabulary, verbal analogies
	Walker and others 2011 [5602]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	22	Supplementary feeding	Verbal abilities, reading abilities
	Maluccio and others 2009 [4845]	Guatemala (INCAP Supplementary Feeding to Children)	0	5.3	25–42	Supplementary feeding	Reading abilities**
Early Learning/Childcare	Martinez and others 2012 [8261]	Mozambique (Preschool)	3.45	1.5	5–9	Quality early childhood and preprimary program	Receptive vocabulary
	Walker and others 2010 [5547]	Jamaica (Early Stimulation to Low Birthweight Infants)	0	2	6	Stimulation	Verbal abilities, reading abilities, receptive vocabulary
	Fox and others 2011 [8490]	Romania (Bucharest Early Intervention Project)	1.88	2.7	8	Stimulation (foster care)	Verbal abilities**
	Walker and others 2000 [5544][a]	Jamaica (Stimulation and Supplementation to Stunted Children)	1.55	2	11–12	Stimulation	Verbal abilities**, vocabulary**, receptive vocabulary
	Walker and others 2005 [8198][a]	Jamaica (Stimulation and Supplementation to Stunted Children)	1.55	2	17–18	Stimulation	Reading**, verbal abilities**, receptive vocabulary**, verbal analogies**
	Walker and others 2011 [5602][a]	Jamaica (Stimulation and Supplementation to Stunted Children)	1.55	2	22	Stimulation	Verbal abilities***, reading abilities***
Health	Ozier 2013 [8251]	Kenya (Primary School Deworming Project)	0	1	8–15	Deworming	Receptive vocabulary*
Social Protection	Behrman and others 2008 [8237]	Mexico (Progresa)	1.5	1.5 (DR2)	7–11	CCT	Verbal abilities (abbreviated test)**, reading comprehension
	Manley and others 2012 [8274]	Mexico (Progresa)	1	1.5 (DR2)	8–10	CCT—conditionalities CCT—cash	Verbal abilities (abbreviated test) Verbal abilities (abbreviated test)***
	Barham and others 2014 [8278]	Nicaragua (Red de Protección Social)	In utero	3 (DR2)	10 (boys)	CCT	Receptive vocabulary**
	Rackstraw 2014 [8328]	Honduras (Programa de Asignación Familiar)	1.5	2	13–15	CCT	Reading abilities*
	DSD, SASSA and UNICEF 2012 [8222]	South Africa (Child Support Grant)	1	2.5	10	Unconditional or targeted income support	Reading abilities
Water	Spears and Lamba 2013 [8331]	India (Total Sanitation Campaign)	0	Continuous	6-8	Water and sanitation (latrine)	Reading*
Other	Pathak and Macours 2013 [8426][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

Note: More details for each of the studies are found in appendix A. CCT = conditional cash transfer; DR = dose response; INCAP = Instituto de Nutrición de Centroamérica y Panamá.

a. Jamaica [5544, 8198, 5602] 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, 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 program effect continues over time.

c. India study 8426 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 6 years and beyond.

* Statistically significant at 10 percent.

** Statistically significant at 5 percent.

*** Statistically significant at 1 percent.

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.

3.5 Verbal abilities is one component, together with performance IQ, that makes up full-scale IQ scores. As with other cognitive measurements, it 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 nine years,[5117] and an evaluation of Jamaica's supplementation programs did not find significant differences at ages 17–18 or 22 years of age.[8198, 5602] However, children whose mothers participated in Belarus's breastfeeding promotion program (PROBIT) had significantly better scores on an abbreviated measure of verbal abilities at six years of age compared to children's whose mothers had not participated (see figure 7).[4693]

3.6 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.[5544, 8198, 5602] An assessment of the BEIP foster care program in Romania (see box 5) 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.[8490]

Box 5. 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 III 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 instutionalized 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 evaluations, 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, [8490] although there were no significant benefits in multiple measures of executive function. [8490 and 8494]

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. [8353, 8490] One of these measures—verbal comprehension—is a traditionally-reported language outcome in the ECD literature with a standardized measurement construct.

Socioemotional Development

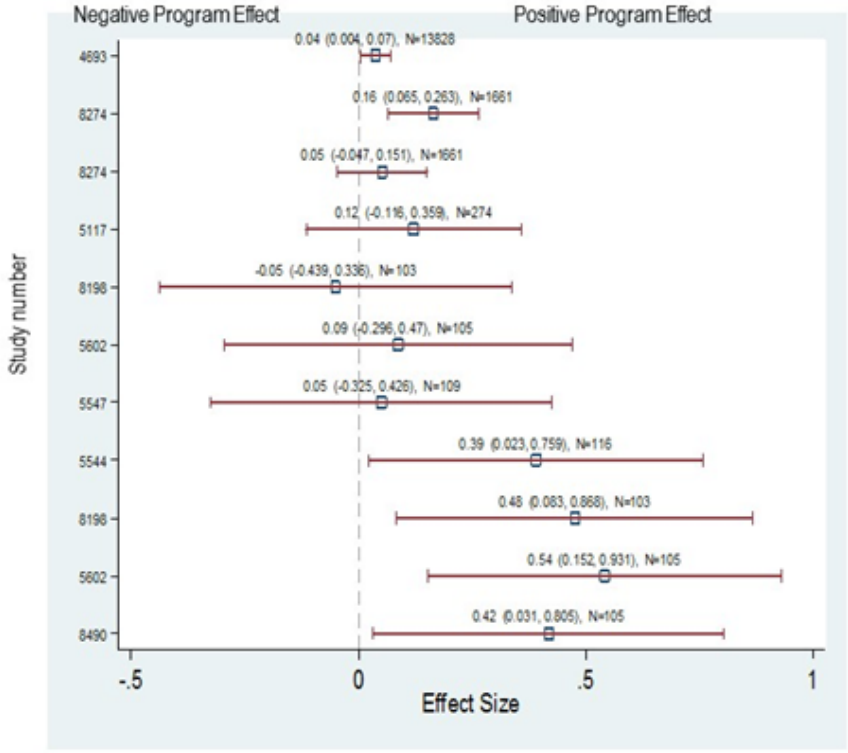
Advantages in reduced socioemotional challenges benefits phase in and out through early childhood. Despite the absence of observable differences between the foster care and institutionalized children on multiple measures of socioemotional development at baseline, by 42 months of age foster care children were significantly better at paying attention and exhibited better positive affect (Ghera and others 2008). 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 [8505] at 12 years. [8506]

3.7 An additional 18 months of exposure to Mexico's Progresa (see box 7), 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.[8237] 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.[4288, 8274]

Figure 7. Forest Plot for Verbal Abilities

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



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. 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.

a. For Jamaica studies 5544, 5602, 8198 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".

b. Mexico study 8237 is not included in this forest plot given that it looks at same average age at evaluation with 8274.

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.

3.8 Tests of reading abilities (e.g., 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,[8198] and again at age 22,[5602] children who received supplementation did not have noticeably improved reading abilities compared to those who had not been given supplementation.

3.9 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 8).[4693] 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.[4845] 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 were evaluated.

3.10 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.[8198, 5602] 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 8). 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.

3.11 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.[8237] Similarly, neither an unconditional cash

transfer and income support program in South African nor a CCT in Honduras improved reading comprehension [8222] or literacy [8328] among 10-year-olds.

3.12 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 signifanctly higher literacy scores. [8331]

3.13 One study assessed the impact of a political intervention in India on children's development outcomes. In Andra 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.

3.14 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 improvments 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.[8426] 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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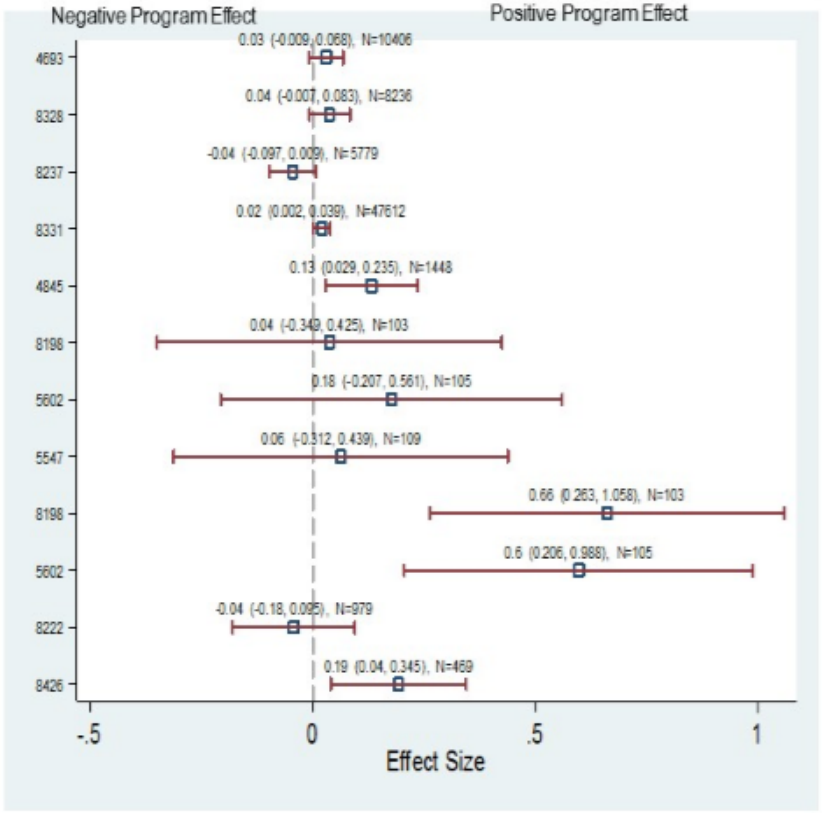
[1] Study 5547, which provided stimulation to low birthweight Jamaican children, reported results for "verbal abilities," for six year olds, but no significant effects were observed.

Figure 8. Forest Plot for Reading and Literacy

Country	Intervention	Measurement	Average Age at Evaluation (Years)
Belarus	Breastfeeding promotion	Reading ability (Teacher Ratings of Academic Performance)	9
Honduras	CCT	Literacy	14
Mexico	CCT	Ability to read	9
India	Sanitation	Recognizing letters	6
Guatemala	Nutrition (child, supplementary feeding)	Inter-American reading and comprehension test	32.3
Jamaica[a]	Nutrition (child, supplementary feeding) (stunted children)	Group reading test (Reading context comprehension)	17.5
Jamaica[a]	Nutrition (child, supplementary feeding) (stunted children)	Wide Range Achievement Test (Reading (log))	22
Jamaica	Stimulation (low birth weight children)	Early reading assessment (sqrt)	6
Jamaica[a]	Stimulation (stunted children)	Group reading test (Reading context comprehension)	17.5
Jamaica[a]	Stimulation (stunted children)	Wide Range Achievement Test (Reading (log))	22
South Africa[b]	Unconditional cash transfer (UCT)	Ability to read a story	10
India	Women's political reservation	Early grade reading assessment	8

Study and Forest Plot



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. Studies 5117, 8259, and 8274 use 2006 National Center for Health Statistics growth reference to compute standardized z-score. CCT = conditional cash transfer.

a. For Jamaica studies 5602 and 8198 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".

b. For South Africa study 8222, the outcome is measured through Early Grade Reading Assessment (EGRA) component 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.

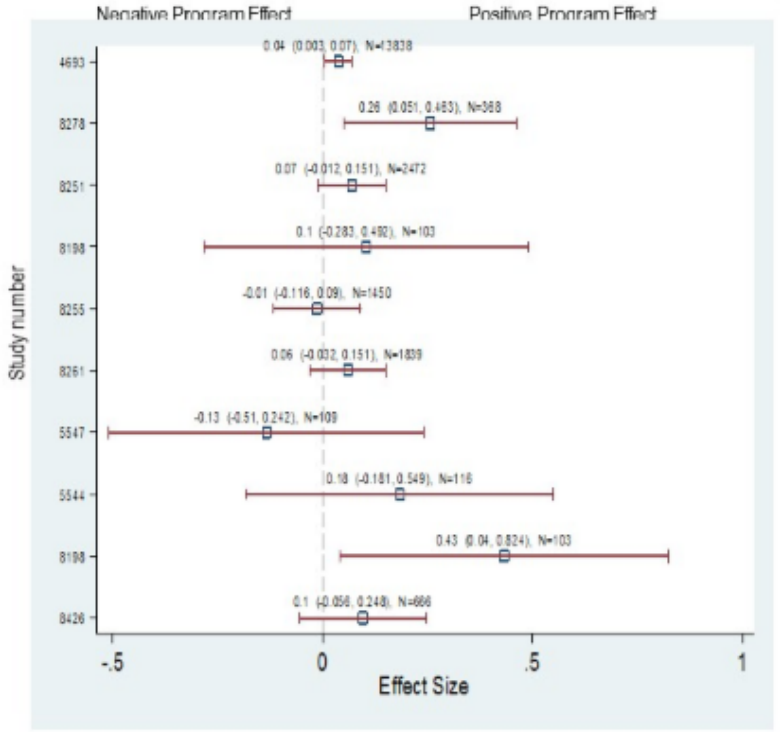
3.15 The evidence is inconsistent for measurements of vocabulary. Among nutritional interventions, the breastfeeding promotion program in Belarus resulted in improved reading among 6.5 year olds,[4693] but The Gambia nutritional intervention did not produce detectable improvements in vocabulary between the ages of 16 and 22 years (see figure 9).[8255]

3.16 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,[8261] 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.[5544, 8198] 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.

3.17 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.[8278] 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.[8251] 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 6 years. [8426] 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 9. Forest Plot for Vocabulary

Country	Intervention	Measurement	Average Age at Evaluation (Years)
Belarus	Breastfeeding promotion	WASI	6.5
Nicaragua[c]	CCT	TVIP[b] (boy)	10
Kenya	Deworming	PPVT	10
Jamaica[a]	Nutrition (child, supplementary feeding) (stunted children)	PPVT	17.5
Gambia, The	Nutrition (mother)	Mill Hill Vocabulary Test	19.6
Mozambique	Quality early childhood and pre-primary program	TVIP[b]	7
Jamaica	Stimulation (low birth weight children)	PPVT	6
Jamaica[a]	Stimulation (stunted children)	PPVT	11.5
Jamaica[a]	Stimulation (stunted children)	PPVT	17.5
India	Women's political reservation	Receptive vocabulary	8



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. Studies 5117, 8259, and 8274 use 2006 National Center for Health Statistics growth reference to compute standardized z-score. CCT = conditional cash transfer; WASI = Wechsler abbreviated scale of intelligence; PPVT = Peabody Picture Vocabulary Test; TVIP = Test de Vocabulario en Imagenes Peabody.

a. For Jamaica studies 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".

b. TVIP is a Spanish version of PPVT.

c. Nicaragua study 8278 only reports boy's outcome.

Language Summary

3.18 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 (e.g., 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).

3.19 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.

4.1 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.

4.2 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).

4.3 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 (e.g., 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).

4.4 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 and others 1993, 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).

4.5 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.

4.6 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 (i.e., 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).

4.7 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).

4.8 A range of measures is used to estimate the effects of interventions on socioemotional outcomes, which are indicated in the table below. For younger children, many of these results are reported by parents or teachers, while measurements for older children and adults are often self-reported. Table 4 maps the 10 studies (12 impact evaluations)[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.

4.9 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 10.

Table 4. 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	Outcomes
Nutrition	Kramer and others 2008 [1383]	Belarus (Promotion of Breastfeeding Intervention Trial)	0	1	6	Breastfeeding promotion	Strength and Difficulties Questionnaire (total difficulties)
	Pongcharoen 2010 [5117]	Thailand (Micronutrient Supplementation to Children)	0.5	0.5	9	Micronutrients and fortified food for children	Freedom from Distractibility index
	Walker and others 2011 [5602][a]	Jamaica (Early Stimulation and Supplementation to Stunted Children)	1.55	2	22	Supplementary feeding	Anxiety , Depression, Social Inhibition, Involved in a physical fight, Involved in a violent crime, Weapon use
Early Learning/Childcare	Walker and others 2010 [5547]	Jamaica (Early Stimulation to Low Birthweight Infants)	0	2	6	Stimulation	Attention (Map search, Opposite-same (switching)), Strength and Difficulties Questionnaire (total difficulties)**
	Humphreys and others 2015 [8505]	Romania (Bucharest Early Intervention Project)	1.88	2.7	12	Stimulation (foster care)	Externalizing behavior**, Internalizing behavior, Hyperactivity
	Walker and others 2006 [379][a]	Jamaica (Early Stimulation and Supplementation to Stunted Children)	1.55	2	17–18	Stimulation	Attention deficit**, Hyperactivity, Oppositional Behavior* Anxiety***, Depression**, Self-esteem**
	Raine and others 2003 [5839]	Mauritius (Child Health Project)	3	2	17	Quality early childhood and pre-primary program	Hyperactivity**, Attention problem, Anxiety
	Gertler and others 2013 [1715][a]	Jamaica (Early Stimulation and Supplementation to Stunted Children)	1.55	2	22	Stimulation	Externalizing behavior factor, Internalizing behavior factor**
	Walker and others 2011 [5602][a]	Jamaica (Early Stimulation and Supplementation to Stunted Children)	1.55	2	22	Stimulation	Anxiety, Depression**, Social Inhibition*, Involved in a physical fight*, Involved in a violent crime**, Weapon use
	Raine and others 2003 [5839]	Mauritius (Child Health Project)	3	2	23	Quality early childhood and pre-primary program	Self-reported criminal offenders**, Court-reported criminal offenders*
Social Protection	Behrman and others 2008 [8237]	Mexico (Progresa)	1.5	1.5 (DR)	7–11	Conditional (CCT)	Strength and Difficulties Questionnaire**
	Manley and others 2012 [8274]	Mexico (Progresa)	1	1.5 (DR)	8–10	Conditional (CCT)—Conditionalities Conditional (CCT)—Cash	Strength and Difficulties Questionnaire** Strength and Difficulties Questionnaire

Note: More details for each of the studies are found in appendix A. CCT = conditional cash transfer; DR = dose response; INCAP = Instituto de Nutrición de Centroamérica y Panamá.

a. Jamaica [379, 5602, 1715] 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. 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 6. 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. The project included 100 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 to evaluate the effect of the program at age 11.[5156] 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 ecoles," 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.[5839]

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.[5156]

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,[5839] 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.

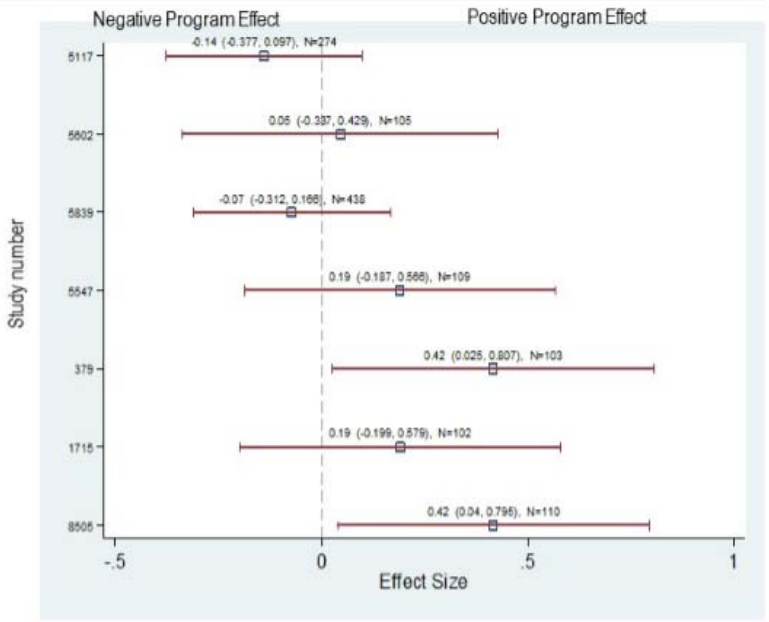
Outcome Domain by Age at Evaluation in the Mauritius Child Health Project

Age	Study	Physical Development	Cognitive Development	Language Development	Socioemotional Development	Schooling Outcomes	Employment and Labor Market Outcomes
11	[5156]	4/7	-	-	-	-	-
17	[5839]	-	-	-	5/8	-	-
23	[5839]	-	-	-	1/6	-	-

Notes: Numerator is statistically significant outcome at 10% level, and denominator is number of outcomes in the domain.
To provide a more complete scope of these studies, this table includes all of the outcomes reported in the studies and not just those analyzed in the main body of this report (see box 1 for the decision rule for selecting outcomes for analysis)

Figure 10. Forest Plot for Socioemotional Outcomes

Country	Intervention	Measurement	Average Age at Evaluation (Years)
Thailand	Nutrition (child, micronutrient)	Freedom from distractability index[a]	9
Jamaica	Nutrition (child, supplementary feeding) (stunted children)	Social inhibition[b]	22
Mauritius	Quality early childhood and pre-primary program	Attention problems[c]	17
Jamaica	Stimulation (low birth weight children)	Attention (map search)[d]	6
Jamaica[g]	Stimulation (stunted children)	Attention deficit[e]	17.5
Jamaica[g]	Stimulation (stunted children)	Externalizing behavior factor[f]	22
Romania	Stimulation (foster care)	Externalizing symptom	12



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. Externalizing behavior scores in 1383 were measured through supplemental behavior questions taken from Canadian National Longitudinal Survey of Children and Youth assessed by teachers, but this outcome is not included in the forest plot because the details of this measure is not provided in the paper. Argentina quality early childhood and pre-primary program (8197) has attention, but it is also not included in this forest plot because it is measured using teacher assessment questionnaires "How many of your students pay attention in class?" in the administrative records of the Argentine National Education Ministry, specifically "National Education Assessment Operation" (ONEE).

a. Freedom from distractibility index in 5117 is derived from arithmetic and digit span subtests.

b. Social inhibition in 5602 is measured through 3 subscales from the inventory on Interpersonal Problems.

c. Attention problems in 5839 is measured through Revised Behavior Problem Checklist, which is not comparable with other socioemotional outcomes.

d. Attention (Map Search) in 5547 is measured through Test of Everyday Attention for Children.

e. Attention deficit in 379 is measured through Conners' Parent Rating Scale (short form).

f. Externalizing behavior factor in 1715 is the result of the factor analysis of the (i) WRAT math, (ii) WRAT reading comprehension, (iii) PPVT, (iv) verbal analogies, (iv) Raven matrices, (v) WAIS full scale IQ tests.

g. For Jamaica studies 379 and 1715 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".

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.

4.10 Generally it appears that early childhood interventions have not demonstrated an effect on school-aged children's externalizing behavior (see figure 10). 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, 5547] (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.[5117]

4.11 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 insititutional homes. The different living environment did not influence hyperactivity rates, however.[8505] 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.[5839] 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,[379] indicating better attention abilities. No significant difference was found in oppositional behavior or hyperactivity between the two groups.

4.12 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, 1715]

4.13 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.[5839] 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, 5602] 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.

4.14 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.[5602, 8505, 379, 5839, 1715] 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).[379]

4.15 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.[1715] 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.[5602]

4.16 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.[5839, 5602]

Strengths and Difficulties Questionnaire

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

4.17 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 IEs report on the total behavioral difficulties score from the SDQ, a composite score built from reports on both internalizing and externalizing behaviors.

4.18 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 (i.e., fewer behavioral problems) than those who started later.[8237] 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.[8247]

4.19 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.[5547]

4.20 The only intervention that did not significantly affect children's behavior problem score was the breastfeeding promotion program in Belarus (see box 3). 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.[1383]

Socioemotional Summary

4.21 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 5839 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. [8197]

[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] An evaluation 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. [1383]

[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.

5.1 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.

5.2 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.

5.3 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.

5.4 Table 5 maps the 20 studies (23 impact evaluations) that investigate schooling outcomes in 15 countries. There are 16 different projects and 11 intervention types, identifying the four specific indicators most commonly assessed and the age of the individual at the time of evaluation.

Table 5. Impcat Eavluations Investigating Schooling Outcomes

	Study	Country (Project)	Average Age at Intervention (Years)	Average Length of Exposure (Years)[b]	Age at Evaluation (Years)	Evaluated Intervention	Outcomes
Nutrition	Kramer and others 2008 [4693]	Belarus (Promotion of Breastfeeding Intervention Trial)	0	1	6	Breastfeeding promotion	Math achievement, Writing**, Reading**, Other subjects
	Pongcharoen 2010 [5117]	Thailand (Micronutrient Supplementation to Children)	0.5	0.5	9	Micronutrients and fortified food for children (Iron and/or zinc supplementation)	Math achievement, Science, English, Thai, On-time primary school enrollment
	Alderman and others 2014 [8255]	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 [8198]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	17–18	Supplementary feeding	Math assessment
	Walker and others 2011 [5602]*	Jamaica (Stimulation and Supplementation to Stunted Children)	1.55	2	22	Supplementary feeding	School years completed, General exams, Math assessment
	Maluccio and others 2009 [4845]	Guatemala (INCAP Supplementary Feeding to Children)	0	5.3	25–42	Supplementary feeding	School years completed (women**, men)
Early Learning/Childcare	Martinez and others 2012 [8261]	Mozambique (Preschool)	3.45	1.5	5–9	Quality early childhood and pre-primary program	On-time primary school enrollment*
	Berlinski and others 2009 [8197]	Argentina (Pre-primary Education)	4	1	8	Quality early childhood and pre-primary program	Math achievement**, Spanish**
	Valdes 2011 [4138]	Chile (Early Childhood Care and Education)	2.9	1.8	10	Quality early childhood and pre-primary program	Math achievement***
	Berlinski and others 2008 [5850]	Uruguay (Preschool)	4	1.5	7–15	Quality early childhood and pre-primary program	School years completed***
	Walker and others 2005 [8198]	Jamaica (stimulation and supplementation to stunted children)	1.55	2	17–18	Stimulation	Math assessment
	Gertler and others 2013 [1715]*	Jamaica (Stimulation and Supplementation to Stunted Children)	1.55	2	22	Stimulation	Probability of attending post-secondary school*, School years completed*, General exams*
	Walker and others 2011 [5602]*	Jamaica (Stimulation and Supplementation to Stunted Children)	1.55	2	22	Stimulation	School years completed**, General exams*, Math assessment**
Social Protection	Todd and Winters 2011 [5538]	Mexico (Progresa)	2	2.8 (DR1)	6–9	Conditional (CCT)	On-time primary school enrollment*
	Behrman and others 2008 [8237]	Mexico (Progresa)	1.5	1.5 (DR2)	7–11	Conditional (CCT)	School years completed
	Behrman and others 2009 [8242]	Mexico (Progresa)	1.5	1.5 (DR2)	6–14	Conditional (CCT)	School years completed***, On-time primary school enrollment (girls)*, On-time primary school enrollment (boys)
	Rackstraw 2014 [8328]	Honduras (Programa de Asignación Familiar)	1.5	2	13–15	Conditional (CCT)	School years completed***
	DSD, SASSA and UNICEF 2012 [8222]	South Africa (Child Support Grant)	1	2.5	10	Unconditional/Targeted income support	School years completed**, On-time primary school enrollment (girls)**, On-time primary school enrollment (boys), numeracy
Child care	Attanasio and Hernandez 2004 [769]	Colombia (Hogares Comunitarios)	3	1.2	8–17	Childcare/Day care	Probability of attending secondary school**
Water and Sanitation	Spears and Lamba 2013 [8331]	India (Total Sanitation Campaign)	0	Continuous	6-8	Water and sanitation (latrine)	Numeracy (6 years old)**, numeracy (7-8 year old)
	Xu and Zhang 2014 [8415]	China (Rural Drinking Water Program)	1	1	18–25	Water and sanitation (water quality)	School years completed (exposed to 0-2 years)*** School years completed (exposed to 3-5 years)
Other	Pathak and Macours 2013 [8426][c]	India (Women's Political Reservation)	Pre-birth Birth	3 (DR1)	8	Governance (women's political reservation)	Numeracy

Note: More details for each of the studies are found in appendix A. CCT = conditional cash transfer, DR = dose response, INCAP = Instituto de Nutrición de Centroamérica y Panamá.

a. Jamaica [1715, 5602] 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.

* 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.

5.5 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 four 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 fourth—a micronutrient intervention—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,[8261] 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.[5538]

5.6 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 (.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.[8242] 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.[8222] 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.[5117]

Box 7. 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 [5538] 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.[8242] Although it appears that data may be avaialable to isolate the ECD effect by netting the combined effect from the school-only effect, this anlysis has not been done to date.

In 2002, Progresa became known as Oportunidades, 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 sociemotional 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	Socio-emotional Development	Schooling Outcomes	Employment and Labor Market Outcomes
Below 5	5 anchor studies	18/35	3/3	1/1			
6-9	[5538]	-	-	-	-	2/2	-
7-11	[8237]	0/4	0/1	1/2	1/1	0/2	-
8-10[2]	[8274]	1/2	1/1	1/1	0/1	-	-
8-10[3]	[8274]	0/2	0/1	0/1	1/1	-	-
6-14	[8242]	-	-	-	-	8/10	-

Note 1: Numerator is statistically significant outcome at 10% level, and denominator is number of outcomes in the domain.

Note 2: The effect of cash transfer.

Note 3: The effect of conditionality.

Note 4: To provide a more complete scope of these studies, this table includes all of the outcomes reported in the studies and not just those analyzed in the main body of this report (see box 1 for the decision rule for selecting outcomes for analysis)

Years of Schooling Completed

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

5.7 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).

5.8 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.[5850] The increase was more pronounced among children whose mothers had lower levels of education, and those who lived outside of the capital city, Montevideo.

5.9 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.[8237, 8242] 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).[8242]

5.10 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 Familiaf* (PRAF) transfer from the birth of the child to age three had completed 0.11 more school years than their non-eligible peers.[8328] 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.[8222] 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.

5.11 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.[1715, 5602] 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.[1715]

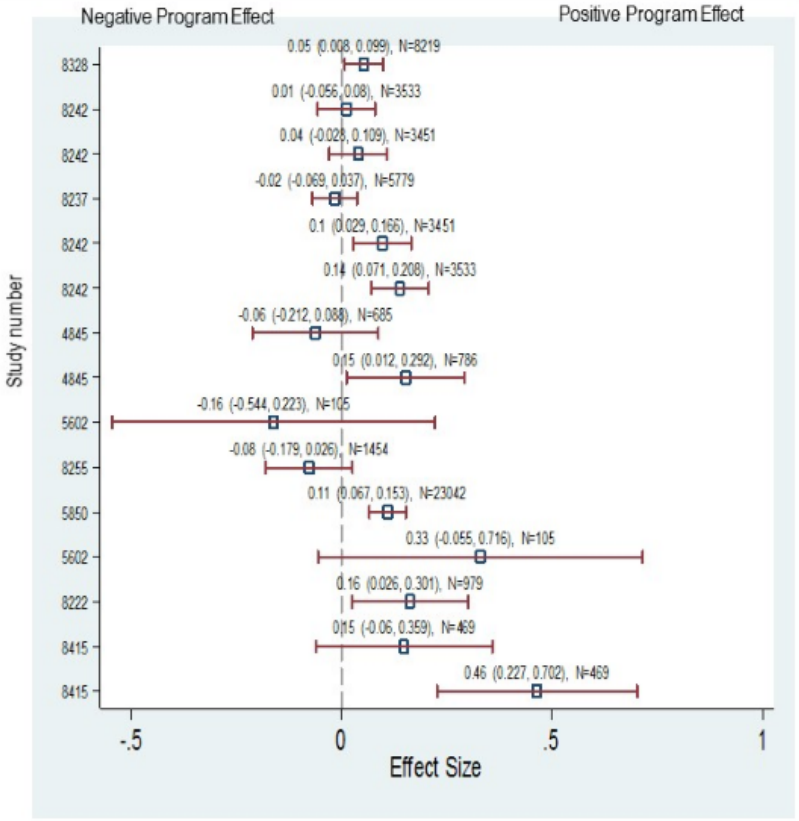
5.12 While it may be expected that cash transfers (many of which specifically promote education) and preschool programs would increase schooling among participants, the largest effect on schooling actually came from a clean water program in China.[8415] Children whose villages had treated water by the time they were 0 – 2 years old had 1.7 more years of schooling than their non-exposed 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.

5.13 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.[4845] 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.

5.14 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.[8255] 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.[5602]

Figure 11. Forest Plot for School Years Completed

Country	Intervention	Measurement	Average Age at Evaluation (Years)
Honduras	CCT	Highest grade attained	14
Mexico	CCT	Highest grade attained (girl)	7
Mexico	CCT	Highest grade attained (boy)	7
Mexico	CCT	Number of school years completed	9
Mexico	CCT	Highest grade attained (girl)	10
Mexico	CCT	Highest grade attained (boy)	10
Guatemala	Nutrition (child, supplementary feeding)	Highest grade completed (boy)	32.3
Guatemala	Nutrition (child, supplementary feeding)	Highest grade completed (girl)	32.3
Jamaica[a]	Nutrition (child, supplementary feeding) (stunted children)	Highest grade level	22
Gambia, The	Nutrition (mother)	Highest grade attained	19.6
Uruguay	Quality early childhood and pre-primary program	Years of schooling	15
Jamaica[a]	Stimulation (stunted children)	Highest grade level	22
South Africa	Unconditional cash transfer (UCT)	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.
a. For Jamaica study 5602, 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.

5.15 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 communitaria cared for children up to age six, providing nutritional meals and stimulation programs.[769] 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.[1715] 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.

5.16 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 3) 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.[4693] 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.[5117] Lastly, supplementation of children from 9–24 months old in Jamaica had no detectable effect on the number of secondary-level exams passed.[5602] 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.

5.17 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.[1715] 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.[5602] 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.[8197]

5.18 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.[4138] 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 8. 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[8197, 4138]. While the positive math assessment results for the Jamaica early stimulation program were not significant at age 17-18, they were by age 22[8198, 5602].

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[4693], micronutrients in Thailand at age nine[5117], or supplementation in Jamaica at ages 17-18 or 22[8198, 5602].

Results from non-standard 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 [8426]. 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 6 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.[8222] 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).

Schooling Summary

5.19 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 non-standard 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.

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

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

6. Employment and Labor Market Outcomes

Early stimulation appears to improve labor outcomes.

6.1 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).

6.2 Research linking early childhood development in developing countries to subsequent employment outcomes is well established. Some have tried to model the effects of preschool and center-based programs on 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 increase a person's economic productivity (Black and others 2013; Bhutta and others 2013; Black and others 2008). Finally, some authors believe that early stimulation can improve cognitive and socioemotional outcomes, leading to better employment (Engle and others 2007). More robust theories as well as causal evidence is needed to better understand the potential employment benefits of early childhood interventions.

6.3 Table 6 maps the single project in this review that investigates employment and labor market outcomes, identifying the specific indicators assessed and the age of the individual at the time of evaluation. Given the scarcity of high-quality evidence on employment outcomes, there is substantial need for more research to better understand the long-term effects of ECD interventions. While the identified evaluation seems to indicate positive employment outcomes, these conclusions are preliminary and more research is needed before they can be generalized.

Table 6. 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	Outcomes
Gertler and others 2013 [1715, 8275]	Jamaica (Early Stimulation and Supplementation to Stunted Children)	1.55	2	22	Stimulation	Earnigns***, Employed*, Unemployed, Migration*

Note: More details for each of the studies 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.

6.4 Only one intervention, the early stimulation program for stunted children in Jamaica, was evaluated for its long-term impact on employment. It appears to have had a positive impact on earnings and employment.

6.5 The authors examined monthly earnings for first, last, and current jobs as well as average earnings overall, and found 20 years later, 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.[8275] 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.[8275] 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, subsequent analysis indicates that it is similar in composition to the larger urban poor population in Jamaica.

6.6 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.[1715] 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.

6.7 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 the project caused a marginally significant 12 percent increase in employment, but no effect on being employed full time or on looking for work.

6.8 Given extremely limited evidence available on employment, this chapter also considers studies that would have passed the quality screening but for high attrition rates. Added is one additional pieces of evidence, which seems to support the finding that early stimulation may improve subsequent employment outcomes (Kagitcibasi and others 2009). In a 19-year follow-up of the Turkish Early Enrichment Program (see box 9), 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.

Employment and Labor Market Summary

6.9 Of all of the outcome domains examined in this report, employment has the least evidence from which to draw conclusions. Only two ECD projects were evaluated for their effect on labor market outcomes, and both have some 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 indicators should encourage future researchers to continue to add to this field to better determine which early childhood interventions can promote employment and consequently 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.

Part II: Factors Influencing Outcomes

Part I inspects the overall effects of early childhood interventions. Part II examines specific characteristics of beneficiaries and projects that can influence the effectiveness of the interventions. These characteristics are important not only to target interventions correctly, but also to determine the appropriate timing of interventions to avoid wasting finite resources.

Chapter 7 covers heterogeneous effects—whether interventions have different effects based on individual characteristics such as gender and socioeconomic status. Chapter 8 is motivated by a deeper look at one of the defining features of this review: time. Temporal effects are examined within the impact evaluation evidence for insights into the best age at intervention for sustained impacts—with particular attention on the first 1,000 days from conception to age two, benefits of longer program exposure, and whether program effects persist across time.

Chapter 7: Heterogeneous Effects—Girls, Boys, and the Poor— *While overall there appears to be gender neutrality in outcomes, girls and the poor (and children of better-educated parents) are much more likely than not to see improvements in schooling outcomes.*

Chapter 8: Time Effects—Longer, Later, Lasting?—*The literature is underdeveloped to answer important time questions. Evidence suggests that the persistence of effects over time varies by outcome domain, and longer exposure to some programs can be beneficial. More research is needed to determine whether interventions at a very early age achieve abiding benefits. The impact evaluation evidence to date suggests otherwise.*

7. Heterogeneous Effects—Girls, Boys, and the Poor

7.1 The second of the World Bank's "twin goals" is to improve shared prosperity. Beneficiary analysis of distributional impacts and heterogeneous effects can shed light on how to achieve this goal through the vehicle of early childhood development.

7.2 Important heterogeneous effects have been found in both developed and developing countries, and an analysis of these distributional differences can be used to inform more effective targeting of future programs. In the United States, there is evidence that women enjoy long-term significant benefits from preschool programs across a range of outcomes, while the long-term benefits for males are limited (Anderson 2008). When disaggregating by socioeconomic status, recent research has shown that the cognitive and noncognitive benefits of the Head Start program were largest for those individuals at the bottom of the achievement distribution. The authors hypothesize that the large effects of the Perry Preschool Program may also have been due to the low baseline abilities of the participating students (Bitler, Hoynes, and Domina 2014). Recently, Schady and others (2014) complemented this research, finding that a similar pattern exists in the developing world. In fact, even in relatively better-off regions, differences in cognitive development between socioeconomic groups are observed at a young age can persist past early childhood (Schady and others 2014). Therefore it is important that policy makers know which groups benefit the most from any given intervention and be able to identify the heterogeneous makeup of targeted intervention areas.

7.3 The impact evaluation (IE) evidence on heterogeneous effects used in this report covers a broad range of outcomes and interventions. Of the 54 studies in this review, 24 reported heterogeneous effects across all six outcome domain categories.[1] The interventions span combinations of 11 different intervention types: conditional cash transfers (CCTs), unconditional cash transfers (UCTs), parenting education, general disease prevention, childcare centers, micronutrients, early stimulation, supplementary feeding, breastfeeding promotion, preschool, and water and sanitation.

7.4 Using that evidence, this report focuses on heterogeneous effects by gender and socioeconomic status (SES). Although effects were reported across many different groups, these two were the domains with the largest evidence base. Furthermore, an evaluation of them can also contribute to meeting the World Bank's goal of shared prosperity as well as its renewed focus on gender equality.

7.5 This report discusses two different methods of reporting heterogenous effects. In the first, the authors tested the two groups against each other. For example, they analyzed whether girls were significantly more likely to benefit than were boys by comparing difference between beneficiary and non-beneficiary boys to the difference between beneficiary and non-beneficiary girls.

7.6 In the second, the authors used subgroup analysis to ascertain whether one group benefited or not, regardless of the effect size relative to the other group. That is, they tested whether girls in the treatment group were significantly different from girls in the control group, regardless of the boys' outcomes. The results from both of these methods are included in table 7 below and are discussed separately.

7.7 Notable is that various contextual factors could also be influencing the results presented here. For example, there are likely Regional differences in gender roles and norms that affect who participates in certain interventions as well as differences in measuring income or education. The time period in which the intervention took place could also affect a parent's perceptions of gender roles.

Effects by Gender

7.8 Twenty-five impact evaluations disaggregated the interventions' effects by gender. As show in Table 7, the majority of the outcomes measured were gender-neutral especially in the physical and socioemotional domains and for nutrition and early learning/childcare interventions. This indicates that there was not a statistically significant difference in the outcomes between genders, not that neither gender benefited, as can be seen in the Girls and Boys columns.

7.9 In examining the subgroup analyses, it can be determined whether a gender is more likely than not to benefit—for example, whether girl beneficiaries have better outcomes than girl non-beneficiaries. Girls are much more likely than not to benefit from interventions that affect schooling outcomes and slightly more likely than not to improve in socioemotional measures. It appears, however, that interventions affecting cognitive development are less likely to be effective for girls, and both girls and boys are much more likely not to see lasting benefits in physical outcomes than they are to see them. Furthermore, no interventions demonstrated improvements for boys in either linguistic or socioemotional development. In fact, the only domain in which boys were more likely than not to benefit was in cognition.

7.10 When broken down by intervention type, it once again appears that most interventions were gender-neutral. The only exception was for water which found that boys' cognitive and linguistic development was significantly more likely to benefit from

clean water than were girls, but the India Total Sanitation Campaign was the only water intervention to enter the review.[8331] Both girls and boys were more likely than not to see *no* effect from social protection programs and more likely than not to see an effect from early learning and childcare programs. Girls benefited in a slight majority of the measures evaluated for nutrition programs, while there was not a single reported later-life benefit for boys from nutrition.

7.11 Latin America and the Caribbean (LAC) and Europe and Central Asia (ECA) exhibit a fairly high degree of gender parity, a single measure from Sub-Saharan Africa (SSA) indicates that girls benefited significantly more than did boys, and there is some evidence of a greater effect for South Asian boys than for girls. Neither gender was more likely than not to benefit in LAC, SSA, or South Asia, but European and Central Asian girls did tend to see long-lasting effects. quality evidence emerges.

Table 7. Heterogeneous Effects by Gender

GENDER	Girls > Boys	Boys > Girls	Girls = Boys	Girls*	Boys*	# of Unique IEs
Domains						
Physical		2	25	5/14	1/14	10
Cognition		2	2	1/4	3/4	6
Language		1	2	2/4	0/4	5
Socioemotional	2	1	12	4/7	0/5	4
Schooling	3	1	8	17/21	10/22	10
Employment			1	0/1	1/1	1
Interventions						
Nutrition	2	2	29	7/13	0/11	8
Early Learning/ Childcare	1	2	14	14/20	11/20	9
Health				1/1	1/1	1
Social Protection	2		7	7/17	3/18	6
Water and Sanitation		3				1
Region						
LAC	2	2	27	2/5	0/3	11
ECA	2	2	18	17/26	12/27	5
SSA	1			5/11	3/11	3
South Asia		3	5	4/9	0/9	6

Note: See footnote 1 for the list of IEs that report heterogeneous effects by gender.
*The fraction represents the number of measures in that domain, intervention, or region that showed a significant effect for girls (boys) over the total number of measures that were evaluated specifically for girls (boys).

Effects by Socioeconomic Status

7.12 The two most-reported dimensions of socio-economic status for which the reviewed studies provided heterogeneous effects are household wealth and parents' education level. Even so, these important subgroup analyses are found in only eight studies—five for wealth and three for education. Results are given in Table 8.

Table 8. Heterogeneous Effects by Socioeconomic Status

INCOME	Poor > Rich	Rich > Poor	Poor = Rich	Poor*	Rich*	# of Unique IEs
DOMAINS						
Physical			3			1
Cognition			1			1
Language	1		1	1/1	1/1	1
Socioemotional			1			1
Schooling	5		1	5/7	1/7	4
Employment						0
INTERVENTIONS						
Early Learning/ Childcare	3		1	3/5	0/5	3
Social Protection	3		6	3/3	2/3	2
REGION						
LAC	4		7	4/6	2/6	4
SSA	2			2/2	0/2	1
EDUCATION	Less > More	More > Less	Less = More	Less*	More*	# of Unique IEs
DOMAINS						
Physical				0/4	3/4	1
Cognition						0
Language				0/2	0/2	1
Socioemotional						0
Schooling		2		1/5	4/7	3
Employment						0
INTERVENTIONS						
Early Learning/ Childcare		2		0/2	2/2	1
Social Protection				1/9	5/11	2
REGION						
LAC					2/2	1
SSA		2		1/11	5/11	2

Note: See footnote 1 for the list of IEs that reported heterogeneous effects by socio-economic status.
*The fraction represents the number of measures in that domain, intervention, or region that showed a significant effect for poorer/less educated (richer/better educated) groups over the total number of measures that were evaluated specifically for poorer/less educated (richer/better educated) groups.

7.13 Physical outcomes appear to benefit the rich and the poor equally, while the poor and those with better educated parents benefit significantly more from interventions that improve schooling than do children from richer families or those with better educated parents. In fact, the poor and those with better educated parents are more likely than not to see benefits from those interventions. Children with better educated parents were also more likely than not to see later-life benefits in physical development, but parents' education was not an important factor for contributing to language benefits from ECD interventions.

7.14 In approaching the analysis by intervention type, social protection programs did appear to benefit participants differentially by either dimension of socio-economic status, perhaps because there is likely less heterogeneity within these already-targeted interventions.

7.15 It appears that when there is a differential effect by SES, the poor and children of better educated parents benefit significantly more than the rich or children of less educated parents. While the effect for the poor is encouraging, the effect for the better educated is perhaps unsurprising: ECD programs can perpetuate schooling advantages. The interaction effect with parents' education indicates that children from better-educated homes able to take better advantage of ECD interventions in realizing gains to their own schooling.

7.16 By region, children from poorer families were more likely than not to benefit from early learning and childcare interventions and from interventions in LAC and SSA, while children from richer families were not. In SSA, neither children from more nor less educated parents were more likely than not to see later-life effects. It bears repeating, though that thus far there are only three studies that can credibly address distributional effects by education, and extrapolation from these to an entire region (or the developing world generally) should be done with appropriate caution.

Heterogeneous Effects Summary

7.17 Very few studies reported heterogeneous effects by either gender or socioeconomic status, making it difficult to draw strong conclusions as to which groups benefit more from early childhood interventions.

7.18 Based on the available evidene, however, the later-life effects of early childhood intervention appear to be mostly gender-neutral, especially in the physical and socioemotional domains and for nutrition and early learning/childcare interventions; there is usually no significant difference in the benefits accrued to girls versus boys.

However, there are specific domains, intervention types, and regions in which groups are more likely than not to see benefits. For examples, girls are much more likely than not to benefit from interventions that affect schooling outcomes, but both genders are much more likely *not* to enjoy lasting physical benefits outcomes than they are to see them.

7.19 Conversely, for socioeconomic status, there are some groups that are significantly more likely to benefit than others. Interventions affecting physical outcomes appear to benefit the rich and the poor equally, but the poor and those with better educated parents benefit significantly more from interventions that improve schooling than do children from richer families or those with less educated parents. These findings, although preliminary, are useful in helping to target future interventions to the intended beneficiaries.

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[1] Studies that gave heterogeneous effects by gender: 5538, 769, 1383, 1715, 4138, 4845, 5850, 8187, 8197, 8222, 8237, 8242, 8251, 8261, 8278, 8328, 8331, 8337, 8466, 8499, and 8505.

Studies that gave heterogeneous effects by SES: 4138, 4288, 5538, 8197, 8222, 8237, 8261, and 8328.

8510 and 8343 also present heterogeneous effects by gender or SES but the outcomes are not relevant for this analysis.

8. Time Effects—Longer, Later, and Lasting?

8.1 Because time has a central place in the report's scope and inclusion criteria, this chapter treats three additional dimensions of time as it relates to early childhood programs. The first is the temporal trajectory of benefits—that is, outcomes within a given project are traced over time to understand whether and how they change as a child ages. The second dimension discussed here is the child's age at the initiation of the intervention—in particular whether an intervention occurred during the first 1,000 days of a child's life, from conception to two years of age. The final dimension is how long a child is exposed to treatment.

Temporal Trajectories

8.2 Although there may be many valid arguments for early intervention, one of the less controversial ones is that intervening early in a person's life provides a longer time horizon over which benefits can be realized (Carneiro and Heckman 2003). However, implicit in this argument is the assumption that these benefits persist over time. The hope is that early intervention changes the trajectory of a child's development so that benefits continue to accrue as a child grows. Evidence from the preschool programs in the United States points to a "fade-out" effect wherein the benefits to cognition and schooling from early childhood development (ECD) interventions shrink over time (Magnuson, Ruhm, and Waldfogel 2007; Deming 2009; Barnett 1992; Berrueta-Clement and others 1984; Currie and Thomas 1998). Other reviews show the effects of early interventions persisting over time, suggesting the intervention itself may be important in determining long-term impacts (Camilli and others 2010; Reynolds and Temple 2008).

8.3 The time element of the inclusion criteria of this review allows interventions in lower- and middle-income countries can be assessed to see if program effects persist or fade out in these countries. Thirty-eight of the 54 studies included in this report examine the seven interventions, presenting evidence over time for these programs. However, given that these interventions had different objectives and were initiated at different points in time, not all of the evaluations of a given intervention focus on the same variables or even the same outcome domains across the interventions. Consequently, the evidence is still thin and is limited to the cognitive, linguistic, and socioemotional domains.

8.4 In addition to the information collected from impact evaluations used in this report (i.e., evaluations that included outcome estimates beyond early childhood), an

effort was made to identify evaluations that provided estimates during early childhood for the same programs and on the same outcomes that were included in this study (hereafter called anchor studies). The search process focused on interventions for which post-early childhood cognitive and physical outcomes were reported—schooling and employment outcomes being meaningless for children under six and socioemotional measures being perhaps less well developed for application to this young population.

8.5 Anchor study IEs underwent an informal quality check before being accepted and were found for five interventions. It must be noted, however, that this search process was not as exhaustive as that for post-early childhood studies was. There may be additional anchor studies on the 24 projects included in this review that estimate cognitive or physical outcomes but are not captured here. Nevertheless, this analysis provides useful preliminary evidence on the temporal trajectories of cognitive and physical outcomes that could be affected by early childhood interventions.

SOCIOEMOTIONAL DEVELOPMENT

8.6 There is some evidence that the socioemotional benefits of ECD interventions persist over time. Researchers in Jamaica focused on internalizing and externalizing behavior. Some of the outcomes measured in adolescence and early adulthood remained the same (e.g., anxiety, depression, and information on antisocial behavior including fighting) while others (e.g., parent ratings of attention, hyperactivity and oppositional behavior) were dropped, and new measures were added to be more age-appropriate. There is evidence of persistence for at least some internalizing behavior outcomes. Initially, at 17–18 years old, all three measures of internalizing behavior they included had improved.[379] Two of the three outcomes were re-examined at 22 years old, and one of them was still significant, although both had decreased in magnitude. A fourth measure of internalizing behavior was also measured at age 22 and showed a positive benefit.[5602]

8.7 It is harder to determine a pattern for externalizing behavior. In Bucharest, improvements in externalizing behavior appeared later but were still present during the most recent evaluation. At eight years old, foster children were not significantly more socially engaged than their peers who had grown up in institutional care. However, by 10 years old they had marginally significantly better reciprocal social interactions, and at 12 years old, they were significantly less likely to exhibit oppositional defiant disorder or conduct disorder.[8505, 8506, 8510]

8.8 In Jamaica, only a single relevant outcome was included in the study at 22 years old, which was different than the five outcomes reported in the previous study. In the earlier study, only one of the five measures show a significant improvement at ages 17–18,[379] and the single outcome reported in the later study found that stimulation

significantly improved the externalizing behavior of 22 year olds.[5602] In Mauritius, the goal of the preschool intervention was to reduce the prevalence of certain types of mental illness, and therefore the outcomes reported were for externalizing behavior and psychiatric disorders. At age 17, preschool helped improve all three of the psychiatric disorder outcomes as well as two of the four external behavior outcomes. By 23, however, neither of the psychiatric disorder outcomes was still significant, while one of the two external behavior measures remained significant.[5839]

8.9 The same study also examined whether nutritional status at the time of intervention interacted with the intervention to affect subsequent socioemotional outcomes, and the results were similarly nonconclusive. At age 17, three of the seven measures of externalizing behavior were significantly influenced by nutritional status—leading to larger improvements among the children who had been malnourished at baseline—while at 23 years old, only one of the six measures used varied significantly by nourishment status. Taken with the previous results as well as those from Jamaica, it is difficult to conclude whether there is a persistent effect on externalizing behavior.

COGNITIVE AND LANGUAGE DEVELOPMENT

8.10 Evaluations of the early psychosocial stimulation in Jamaica also looked at cognitive and language outcomes, which show no evidence of fade-out effects. Full-scale, performance and verbal abilities were already significantly improved by 11–12 years old, and remained significant at 17–18 and 22 years old.[5544, 5602, 8198] In fact, the magnitude of the effect increased between 17–18 and 22 years old. Similarly, two other language outcomes—measures of verbal abilities and vocabulary—actually improved. No significant difference was found at 11–12 years old, but there were significant improvements by 17–18 years old.

ANCHOR STUDIES

8.11 Anchor studies were found for five interventions: Mexico's Progresa, the Gambian maternal supplementation program, the Bucharest Early Intervention Program (BEIP), and the Jamaican early supplementation and stimulation programs. Four of the five interventions (all but BEIP) reported early measurements of height and weight, which can be compared to subsequent estimates.[1] Half of the estimates showed that the gains in early childhood faded over time, while the other half remained the same, either demonstrating continued significant benefits (one estimate) or continued null effects (three estimates).

8.12 When disaggregated by intervention type, there is either not enough evidence or else the evidence is too mixed to draw firm conclusions. The two nutrition interventions provided temporal trajectories for physical outcomes. Both found an early childhood effect on weight that disappeared by follow-up at 6 – 8 years old in Jamaica and by 11

years old in the Gambia. Similarly, supplemented children in Jamaica experienced an initial increase in height that disappeared by 6 – 8 years old, but there was no difference in birth length among Gambian children, which turned into a significance difference in height at 11 years old that disappeared by the final evaluation at 16 years old (Ceesay and others 1997; Walker and others 1991).[5544, 5549, 8252, 8255] For the only conditional cash transfer program—Progresa—its effect on both height and weight faded out over time (Fernald and others 2008),[8237, 8242] while the single early simulation intervention—Jamaica—found no effect either within the first 12 months of the intervention nor at 7–8 or 11–12 years old (Walker and others 1991).[5544, 5549]

8.13 Cognition outcomes within early childhood were only found for BEIP and for the Jamaica supplementation and stimulation project and both showed a consistent effect across time.

8.14 In Jamaica, Grantham-McGregor and others (1991) report increasing estimates of the composite development quotient (DQ) for the group receiving both supplementation and stimulation over the 24 months of project exposure (beginning at nine months of age, on average). For the stimulated-only and supplemented-only groups, there was an initial dip in the DQ at six months' exposure, followed by a consistent upward trend, with the stimulated group always outperforming the supplemented one. Estimates for the performance and the hearing and speech subcomponents of the DQ, roughly comparable to the verbal and performance elements of cognition discussed in this report, were both large and highly statistically significant at completion of the program for the stimulated group. This upward trajectory is consistent with the trend seen in verbal and performance IQ from ages 12 to 17 to 22 for the stimulation-related outcomes.

8.15 In Romania, 42- and 54-month-old children who were randomly assigned to foster care had a significantly higher DQ and full-scale IQ score than those who had randomly been chosen to stay in institutionalized care (Nelson and others 2007). When they were assessed again at 8 years old, there was still a marginally significant improvement in foster children's full-scale IQ. However, there is some evidence that the children from institutional care may catch up, as a separate analysis by the authors found that the institutional care children's IQ score had modestly increased between 54 months and 8 years old, while the foster children's IQ scores showed little change.[8490]

8.16 The evidence on temporal trajectories is thin because of a lack of repeated measures over time. There are at least two potential reasons for this. First, relevant measures of well-being change as an individual's age. For example, in Jamaica attention and oppositional behavior were rated by parents when children were 17, but parent ratings may not have been appropriate for the follow-up study of 22 year olds.

However, while the exact measure may change, there may still be elements of comparability for the underlying construct (e.g., internalizing or externalizing behavior), in which case more work needs to be done to map comparable age-appropriate measures to encourage careful longitudinal work. Second, there may be an implicit assumption among researchers or policy makers that outcomes are temporally static. However, the evidence reviewed here certainly refutes such a notion of time-invariant returns.

8.17 Rather than universal time-invariance, it appears that the consistency of the effects depends on the domain. The current body of evidence indicates that socioemotional benefits may fade over time. Physical outcomes seem to be somewhat erratic, and cognitive benefits persist and may even strengthen over time—in contrast to the fade-out effects found in the Head Start evidence in the United States. Clearly more work is needed to track outcomes over time to determine the temporal trajectories of impacts from early childhood interventions whether early benefits are indeed sustained.

Age at Intervention: The First 1,000 Days

8.18 Stemming from the 2008 *Lancet* series on nutrition, much has been written about the importance of the first 1,000 days of a child's life from conception to two years old for long-term development. Although a global consensus has formed in particular around the belief that nutrition during this time period can have a lasting effect on a person's growth and development, very little causal evidence exists on the later-life effects of intervening during this time period. What is known may indicate that a different approach than those evaluated may be necessary to take advantage of this important developmental stage.

8.19 Of the seven nutrition programs (encompassing 12 interventions) included in this review that began during the first 1,000 days, six suggest that neither early exposure nor exposure longer than one year is by itself sufficient to produce lasting effects. The seventh provides insights into potentially effective approaches.

8.20 The first four interventions—a breastfeeding promotion program in Belarus and three micronutrients interventions during the first six months after birth in Thailand—were of relatively short duration. With the exception of possible language benefits and a reduction in problematic eating attitudes from breastfeeding, these nutrition interventions demonstrate very little impact on later-life outcomes.[5117, 8228, 4693, 1383, 8187, 8343, 8344]

8.21 Supplemental feeding in Jamaica lasted much longer. It began when the children were nine months old and lasted 1.25 years until they were two years old. Although initial gains were seen in physical health and cognition as a result of this supplemental feeding, subsequent evaluations revealed that virtually all benefits had faded as the children aged.[5549, 5544, 5602, 8198, 1715]

8.22 Recent evidence indicates that stunting (and impacts on its functional correlates of cognition) may actually begin as early as conception (Prendergast and Humphrey 2014). It may be that the food supplementation intervention in Jamaica simply began too late. Indeed, of the three programs (encompassing six interventions) to provide micronutrients to pregnant women in the Gambia and Nepal, there was a marginally significant decrease in stunting resulting from two of the interventions. Overall, however, there was virtually no detectable effect on later-life outcomes in any of the domains studied in this report.[8252, 8253, 8254, 8255, 8256, 8466, 8337]

8.23 The seventh program, —Guatemala's Instituto de Nutrición de Centroamérica y Panamá (INCAP) supplementation program, may provide insight into the way forward. It encouraged pregnant mothers as well as women and their children under age six to go to feeding centers. By comparing the point estimates and patterns of statistical significance for those exposed to the intervention from conception to age three versus age three to age six, the impact evaluation concludes that improved nutrition during the first two to three years of life is more important than later years. [4845] Younger children had larger and significant results for highest grade completed, reading comprehension, and nonverbal cognition.

8.24 The results in Guatemala, while hardly conclusive, could indicate that effective nutrition interventions must not only start early but also last longer. An intervention in Colombia reinforces this idea. (High attrition precluded this IE from passing the initial quality check, but there are some indications that the groups are indeed balanced.) Families with pregnant mothers were chosen based on whether their unborn child was at risk for stunting (as determined by whether a majority of the older siblings were stunted). The families were then randomly assigned to nutrition or early stimulation interventions that lasted from pregnancy until the child was three years old. This led to a significant improvement in weight-for-age and height-for-age at six years old, but not in weight-for-height or two other physical measures (Super and others 1990).

8.25 Near-term impact evaluations and other evaluative evidence support the importance of the first 1,000 days for improving early childhood outcomes. To affect outcomes beyond the early childhood period, however, these nutrition interventions seem to indicate that not only is early intervention key, but sustaining the program throughout the entire first 1000 days may also be necessary.

8.26 Beyond nutrition, only two impact evaluations—that of South Africa's unconditional cash transfer, the Child Support Grant, and the clean water program in China—specifically isolated the effect of treatment during this period as compared to later periods. In South Africa, researchers compared children who began the program before two years old with those who began between two and five years old. At 10 years old, there was no significant difference in the height-for-age or prevalence of stunting between these two groups.[8222] In China, however, the effect of having access to clean water from 0 – 2 years old on years of schooling completed is almost three times as high receiving access from 6 – 25 years old. There is no effect for exposure from 3 – 5 years old.[8415]

8.27 One last piece of evidence regarding the importance of the first 1000 days comes from the Bucharest Early Intervention Program. Children were placed with foster families at any time between 9 – 33 months old, and four of the evaluations tried to determine when age at placement significantly affected subsequent outcomes. The results are inconclusive: while the foster care children had better electroencephalograms if the child was placed before 24 months and better social skills if placed before 20 months, time of placement was not a significant correlate for executive function or memory, and it was placement before 26 months rather than 24 that was correlated with a significant improvement in a child's processing speed—suggesting that the critical window may extend beyond age two.[8490, 8494, 8498, 8499]

8.28 With so few and so diverse non-nutrition intervention, it is difficult to draw conclusions on what the post-early childhood effect of intervening during this critical time period may be compared with later interventions.[2] Though the evidence and rationale prioritizing certain interventions during this time period is fairly new, it is hoped that ongoing and future studies can provide more information on the optimal age at intervention to achieve lasting impacts. The first 1,000 days is held to be particularly important for health and nutrition interventions, while exposure to stimulating environments and interactions throughout the early childhood years are important for cognitive and socioemotional development. Nevertheless, further research into the additional benefits of stimulation during the first 1,000 days is still warranted. A coherent research agenda that investigates the relative benefits of intervening at different periods for the standard portfolio of early childhood interventions would be tremendously valuable to developing effective ECD protocols.

Length of Exposure

8.29 Regardless of when an intervention begins, it is important to determine how long an intervention should run in order to be most effective. It may be that a longer

exposure period is needed in order to change participants' habits or fundamentally alter their health, in which case ending the intervention too soon would weaken the desired effects. Conversely, continuing an intervention past its optimal point could diminish its reach if scarce resources are spent over-exposing participants rather than expanding the scale of the intervention.

8.30 This concept is similar to dose-response but with a time dimension. Phased interventions, including randomized rollouts, can complicate the general interpretation of findings, but they are ideal for understanding the incremental value of additional exposure to an intervention. Unfortunately, few of the included interventions were implemented or evaluated in a manner conducive to determining the effect of varying intervention lengths.[3]

8.31 The two main types of interventions that were analyzed by length of exposure for differential impacts lasting beyond the early childhood period are cash transfers and preschool programs. The two cash transfer programs included are Mexico's Progresa and South Africa's Child Support Grant (CSG). For Progresa, the studies all examined the effect of an additional 18 months of program participation, usually when the child was younger than three, on outcomes when the children were 8–10 years old. The study on CSG looked at the differential effect on 10 year olds who enrolled at birth versus at age six. A nutritional supplementation program and a childcare program were also evaluated for length of exposure, but the evidence on these programs comes from a single study each.

8.32 The cash transfer programs examined a range of outcomes, while the preschool and childcare interventions were evaluated solely for their effect on schooling. It appears that additional exposure to cash transfers does not tend to improve children's cognitive, language, physical, or schooling outcomes, but it can have a positive effect on subsequent socioemotional development. The evidence from preschool and childcare programs, however, was mixed, with no clear indication as to why additional time in some programs was more beneficial than in others. It should be noted that, as with other areas of this report, the evidence is thin, and conclusions are suggestive rather than definitive.

8.33 Estimates from four preschool programs in four different countries—Chile, Colombia, Mozambique, and Uruguay—indicate no clear conclusion as to whether children's subsequent schooling outcomes benefit from longer enrollment in preschool. In all four of these studies there is a potential endogeneity problem as a parent's decision to enroll their child in more years of preschool is likely related to other characteristics that would affect subsequent schooling outcomes.[4]

SCHOOLING OUTCOMES

8.34 In Chile, children could attend preschool for one to three years, and while children's achievement test scores increased gradually with each additional year of preschool, the difference in the scores was not statistically significant.[4138] Similarly, while preschool attendance in Uruguay overall led to an increasing advantage over nonbeneficiaries in terms of years of schooling over time—a half year by age 12 and 0.8 years more schooling by age 15—there was not a statistically significant difference in years of school attended for those who had an additional year of preschool versus those who were in preschool one less year.[5850]

8.35 While attendance may not be affected by longer exposure to preschool, there is some evidence that enrollment is. For 5–9 year olds in Mozambique, each additional month that a child had been enrolled in preschool increased the probability of enrolling in primary school as well as the probability of on-time enrollment by about 1 percentage point. It did not, however, have a detectable effect on the probability of dropping out of school.[8261] Tenure in childcare also had a positive effect on school enrollment. In Colombia, how much longer a child participated in Hogares Comunitarios may not have affected outcomes for 8–12 year olds, but 13–17 year olds who spent longer in the program were more likely to enroll in school and to pass a grade. When these estimates were disaggregated by gender, it appears that the effect on enrollment was largely driven by boys, while the effect on grade progression was stronger for girls.[769]

8.36 Conversely, additional exposure to cash transfers does not appear to affect a child's subsequent schooling outcomes. The number of years of school completed was not significantly different for children who had spent an additional 18 months in Progresa, nor was their probability of progressing on time through school.[8237, 8242] One study found a strong effect of additional time in Progresa on absenteeism of 0.12 fewer days missed or 53.6 percent fewer absences, and it also reported a marginally significant increase in the probability of primary school enrollment at age six.[5538] However, a second study[5538] found no detectable effect on age at enrollment for seven- to eight-year-old boys and a marginally significant decrease in age at enrollment for seven- to eight-year-old girls.[8242] Despite the lack of significant findings, the effects on the education variables were all positive and of fair magnitude; the authors postulate that the analysis may have lacked statistical power to detect significant effects.

8.37 Finally, an evaluation of INCAP supplementary feeding program in Guatemala also tried to determine the added benefit of longer exposure periods. The results were not presented in full within the study, but the findings suggest that exposure for more than 12 months is important in order to change highest grade completed, reading comprehension and nonverbal cognition.[4845]

COGNITIVE AND LANGUAGE DEVELOPMENT

8.38 While the evidences is mixed, it appears that overall, additional exposure to cash transfers does not affect post-childhood cognitive and language abilities. Two Progresa studies looked at the effect of an additional 18 months of program participation before the child turned three years old on cognitive and language abilities when participants were 8–10 years old. Overall, the effects were not significant for nonverbal abilities and ability to read, but there was a significant increase in participant's language development.[8237] However, the null results may be masking an effect from the cash transfer itself. When the program effect was disaggregated to isolate the effect of the cash versus the conditionalities, the conditionalities continued to have a nonsignificant effect, but the cash caused a marginally significant increase in the cognitive assessment score and a highly significant increase in the verbal assessment score.[8274] The authors theorize that this difference could stem from various sources, including the parents' ability to provide a better learning environment and more nutritious food from the additional income. More evidence is needed, however, as an additional six years receiving the unconditional cash transfer—the Child Support Grant (CSG)—did not lead to any additional benefit to either a child's ability to read or their reading.[8222]

SOCIOEMOTIONAL DEVELOPMENT

8.39 Both Progresa studies that included socioemotional outcomes measured the change in a child's score on the Strengths and Difficulties Questionnaire, and unlike for cognition and language, it appears that additional time in the program does benefit the children's socioemotional development. Overall, there was a significant improvement in children's behavior problem score, which seems to be driven by the program's conditionalities rather than the cash transfers.[8237, 8274]

PHYSICAL DEVELOPMENT

8.40 Similar to the null trend found in the main analysis of physical outcomes, additional exposure to cash transfers on average did not affect physical outcomes. Both the overall program effect as well as the effect of the cash and conditionalities led to small and nonsignificant changes in body mass index.[8237, 8274] The same was true overall for height, although there was a highly significant.05 standard deviation increase in children's height-for-age caused by an additional 18 months of cash transfers.[8237, 8274] CSG was only analyzed for its effect on the probability of illness in the last 15 days and how long that illness lasted, neither of which was affected by an additional six years in the program.[8222]

8.41 The only intervention to address length of exposure that was not a cash transfer or preschool program was a national policy in India to increase female political participation. A 1992 law required that one-third of seats in local councils as well as

one-third of village-level leadership positions be reserved for women. In Andhra Pradesh, this was accomplished by randomly reserving one-third of the seats in each election cycle and rotating through by each 5-year cycle. The authors exploit this random allocation by identifying children who were born at the beginning of the second election and dividing them into three groups based on location: the first group of children were born into areas where women had been in power for the previous five years and there were eight years for any changes to continue to develop, the second group lived in areas where women were assigned seats in the second election cycle and so would be in power for the first five years of a child's life and then there would be three years for any changes to continue to develop, and the third group (the control group) was born into areas where women would not benefit from the reservations until the children were six years old.

8.42 At eight years old, the first group of children had significantly better reading and word recognition scores than the third group (although their math, reading and receptive vocabulary scores were not significantly different), while there was no detectable difference between the second and the third groups.[8426] This suggests that the longer period enjoyed by the first group, during which time policies could not only be influenced by female representation but also have time to create changes in the community, may be necessary to reap the benefits of female political participation.

8.43 In summary, given how important length of exposure is to determining the optimal timing of an intervention, little evidence is available at this time to guide policy makers on the effect of longer participation in any given intervention. What evidence does exist, however, highlights two important areas in which longer exposure times may be helpful in producing benefits. For preschool or childcare programs as well as supplemental feeding, it appears that longer exposure can lead to higher school enrollment and completion rates, while additional involvement in a cash transfer program during the early childhood period could help reduce behavioral problems.

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[1] While some of the earlier estimates are unstandardized, and so are imperfect comparisons to the latter standardized measures, most of the unstandardized estimates were done for groups with small enough variation in age that one would not expect the standardized measures to differ significantly.

[2] Multiple iterations of meta-regression were run to try to understand the effect of beginning the intervention during the first 1,000 days and age at intervention as moderators, but none returned robust significant results. However, it is quite possible that this result is an artifact of the small number of studies available for inclusion, resulting in the regressions being underpowered.

[3] A simple analysis was done to determine the minimum and average duration of projects that produced at least a marginally significant result in four of the outcome domains (physical

development and employment and labor market domains were not included due to the overall lack of results in physical development, and the fact that there was only a single impact evaluation with employment outcomes that passed the quality check). For cognition, language, and schooling, the minimum project exposure required for at least a marginally significant result was one year (the Promotion of Breastfeeding Intervention Trial in Belarus, deworming in Kenya, and preschool in Argentina), and the minimum for socioemotional was 1.5 years (Progresa dose-response). However, it should be noted that the average exposure time to produce at least a marginally significant change in any of the four domains was two years.

[4] In Chile, the author tries to address this problem by using propensity score matching, but for the other studies, the results should be taken as conditional correlations rather than causal impacts. Furthermore, the studies in Chile and Uruguay compare across treated individuals, while the children in Colombia and Mozambique are compared to children who did not receive the intervention. Consequently, the estimates from the former two studies may be viewed as the difference in longer versus shorter preschool enrollment (inframarginal effects), while the latter two studies should be interpreted as the difference between enrolling in preschool and not enrolling (extramarginal effects).

Part III: Improving Study Quality and Coverage

The previous chapters analyze the current body of evidence for the post-early childhood effects of early childhood interventions. Part I examines the results by outcome, while Part II tries to determine how effects varied by subgroup and by time.

Part III takes a different approach. Rather than analyzing what is available, its objective is to aid in strengthening and broadening the knowledge of the later-life effects of early childhood development (ECD) interventions.

Despite impressive and pioneering work done to begin the study of the later-life effects of early childhood development, much is left to do to create a comprehensive evidence base for future policy makers.

Chapter 10 is intended for evaluators of early childhood interventions. It engages in a more technical discussion of common challenges for conducting impact evaluations (IEs) that straddle a long time frame between the intervention and a follow-up evaluation. Standard estimation challenges of confounding characteristics, attrition, program design, and external validity are often compounded in IEs of the post-early childhood effects of early childhood interventions that cover so much time and several developmental phases as a child moves from early childhood through primary age to adolescence and finally into adulthood.

Chapter 11 highlights notable evidence gaps and provides guidance for future evaluation to move toward a more complete understanding of impacts from early childhood interventions on later outcomes..

Chapter 10: Improving Study Quality—*Given the longer evaluation period, IEs of later-life effects of early childhood interventions are particularly susceptible to various evaluation challenges that can compromise causal inference. Particular challenges include confounding characteristics, high attrition, initial program design, and poor external validity.*

Chapter 11: Knowledge Gaps to Fill—*Evaluations must expand to cover a broader range of intervention types both inside and out of the traditional ECD sector and should include key evaluation components such as analysis of complementary methods, cost efficiency, and heterogeneous effects. More evaluations are needed everywhere, but particularly in the Middle East and North Africa and East Asia and the Pacific Regions.*

9. Improving Study Quality

9.1 This chapter includes a more technical discussion of challenges to causal inference commonly found in impact evaluations that span phases of human development from early childhood through elementary age into adolescence and adulthood. Its intended audience is those working to generate empirical evidence on early childhood development (ECD).

9.2 Early childhood development evaluations aiming to estimate impacts after a prolonged period face four challenges: confounding, attrition, design allowing follow-up, and external validity.[1] These challenges are not unique to ECD evaluations or longer-term evaluations, but they may be compounded here. In particular, issues of attrition and confoundedness are primarily responsible for excluding more than half of the impact evaluations otherwise eligible for this review. These are much higher rates of noninclusion on the grounds of quality than found in previous systematic reviews by the Independent Evaluation Group (IEG), indicating these issues may be a particular challenge for ECD impact evaluations with a longitudinal element. Only three impact evaluations of the 54 used in this review were rated AAA and are believed to be confidently free of these challenges and have a low risk of bias—two from Jamaica[1715, 8275] and one from Uruguay.[5850] The other 51 AA evaluations included were deemed plausibly free of these challenges with a moderate risk of bias.

9.3 This is not to denigrate the impact evaluation work on longitudinal ECD interventions that were necessarily designed a decade ago or more, and often without inclination to become a vehicle to study later-life effects. Indeed, many of the studies considered for review were groundbreaking in their examination of various interventions on immediate and long-term outcomes, and current perspectives on ECD have undoubtedly been influenced by this work. It is hoped that highlighting these challenges can inform and improve designs of future evaluative work.

Confounding Characteristics

9.4 Confounding factors, such as baseline differences between treatment and control groups or changing circumstances over time, can affect the developmental trajectories of the recipient population and therefore influence later outcomes. This risk grows with time as more opportunities for intervening events occur as well as longer periods in which baseline differences can cause nonnegligible changes in the groups. Before-after, interrupted time series, or simple ex post comparisons, are unlikely to be free of confounding factors other than the intervention that may explain observed changes or

differences for beneficiaries. Many of the impact evaluations discovered during the search did not meet the minimum standard criteria for inclusion principally on "risk of bias" grounds because they lacked a credible counterfactual.

9.5 For example, the search uncovered 12 potential impact evaluations on the supplementary feeding program of Guatemala's Instituto de Nutrición de Centroamérica y Panamá (INCAP), yet the identification of effects for most of evaluations is based on a matched-randomized strategy that is flawed and unrealiable (see box 9).[2] Consequently, there were systematic differences between the treatment and comparision groups at baseline. This is of particular concern in long-term follow-up studies since the passage of time allows for confounding factors to interact with and magnify these initial differences. Because 10 of the INCAP evaluations do nothing to correct for these differences, the studies' risk of bias exceeds the standards set by this review, and they are not included.

Box 9. Identifying Challenges of Follow-up Evaluations of ECD Interventions: Confounding Characteristics in the Instituto de Nutrición de Centroamérica y Panamá Program in Guatemala

In Guatemala, the Instituto de Nutrición de Centroamérica y Panamá (INCAP) began a series of studies to assess the impact of nutritional deficiencies on children's ability to learn. Between 1969 and 1997, INCAP administered two supplements to preschool-aged children in four Guatemalan villages: atole, a high-protein energy drink, and fresco, a fruity drink that lacked substantive nutrition.[4845]

The benefits from this intervention manifested early and persisted over time, suggesting that early childhood nutritional interventions can influence human capital accumulation throughout adulthood. The first study of the effects of the program was carried out on children who were between infancy and three years old when they received the supplements. The evaluation found that the greater nutritional intake from atole resulted in better physical development (Martorell, Klein, and Delgado 1980). Twenty-five years later, children who received the atole supplement between the ages of 0 and 7 years had higher scores in nonverbal cognitive skills and reading comprehension, and girls had completed an average of 1.2 more years of schooling, though this advantage was not found for boys.[4845]

Despite these promising results, much of the potential impact of this program remains unknown because of challenges in the initial evaluation design that were not corrected for in subsequent studies. From a pair of large villages and a pair of small villages, the design randomly selected one village from each pair to receive the intervention, resulting in one large and one small village being in the treatment group with the other large and small village being assigned to the control.[3] Although the sample size is large (more than 1,000 children), there are too few units of randomization (the four villages in this case) to rely on the Law of Large Numbers to generate treatment and comparison groups that are statistically equivalent. The randomization process allowed only four possible permutations of groupings.

As a result, the validity of the counterfactual relies on the strength of the prerandomization matching exercise, which used only size and geography to match the large and small villages.

There again, though, the small number of matching variables is not sufficiently large for matching to be credible over all relevant observed and unobserved characteristics. Early authors indicate systematic baseline differences between the treatment and control group over other important characteristics (e.g., Pollitt and others 1993).[4]

Only a single evaluation of the later-life effects of this program corrected for these problems (Maluccio and others 2009). However, given the initial positive findings and the importance of nutrition to early childhood development, it may be a worthwhile exercise to re-estimate program effects from previously generated INCAP data using these methods.

9.6 Similarly, the series of studies carried out on the Matlab family planning intervention in Bangladesh are frequently cited for their effects on fertility and related maternal and child livelihood outcomes. Despite the fact that these outcomes are often interpreted as resulting from the random assignment of treatment and control groups, the villages were not chosen randomly. The two sample populations differed along several baseline characteristics. Of the five Matlab studies identified as relevant in the search phase,[8284, 8285, 8280, 8279, 8277] only one[8277] adequately addressed these differences and passed the quality rating criteria, the others being assigned an A rating.

9.7 While this issue of quality control was particularly problematic for these well-known interventions, similar challenges in the violation of identifying assumptions of impact evaluation methodologies afflict nearly all of the nonincluded A-rated studies.

Attrition

9.8 If the participants who leave the study are systematically different from those who stay, or if assignment to the treatment group is correlated with attrition, then the remaining sample will produce biased estimates. The time lag between intervention and evaluation for long-term studies also results in the risk of high attrition rates. The likelihood of attrition increases as individuals transition into adulthood and establish their own households. Studies that were not originally designed as longitudinal evaluations often lack sufficient protocols for maintaining contact information for participants. The difficulty in tracking down individuals may be exacerbated in low- and middle-income countries, where movement and migration may be responses to urbanization, poverty, civil unrest, or the effects of natural disasters. There is also the possibility that participants who benefitted most from an early intervention—in terms of health, cognition, social behavior—were more motivated to seek educational or employment opportunities far from the study's origins, as seemed to be the case in the Jamaica studies,[1715] making follow-up more challenging. Some attrition may also result from refusals by individuals who are not willing to undergo the physical or

psychological assessments, perhaps because of the time required to do so or their perceived discomfort in participating in such tests.

9.9 Recognizing the heightened potential for attrition for this type of research, greater allowance was made for higher attrition rates in this review of longer-term impacts than in past IEG systematic reviews. Even so, the potential for bias created by differential attrition remains a concern. Therefore, IEG's criteria for inclusion in this systematic review required no study have an attrition rate higher than 40 percent, and if a study had an attrition rate higher than 20 percent, that study needed to demonstrate no differences in baseline characteristics between those who attrite and those who do not and demonstrate that the likelihood of attrition was not related to assignment to the intervention or comparison group. Findings of differential or selected attrition would disqualify a study from inclusion, regardless of the attrition rate.

9.10 Even where authors explore for differential attrition, there are some concerns about the methods being used. All of the analyses for attrition bias in studies in this systematic review use Type II statistical tests—that is, the null hypothesis is that there is no difference between those who leave the program and those who do not. The burden is on the data to prove there is no difference. Failure to reject the null of "no difference" is taken to be acceptance of the null, even though failure to reject can be a mere statistical artifact of a lack of power or underlying dispersion in the data. Type I tests would seem more appropriate—a null hypothesis that assumes those who leave and those who do not are different unless the data demonstrate otherwise. If Type II tests are used and the null is not rejected, authors could at least include a calculation of the sample size required to make the observed differences in the test significant at the 95 percent level. Alternately, authors could indicate the size of difference that their analytic sample would detect. If that difference is greater than, say, 20 percent of the baseline value for that characteristic, then authors should be wary that the failure to reject the null is more likely due to having a low-powered test than because there is no differential attrition.

9.11 Attrition levels can become extremely high—50 percent or more in some cases[5]. Three programs had impact evaluations with attrition rates between 40 and 45 percent and several more had attrition rates even higher. For transparency, we decribe briefly these three studies that were barely excluded for reasons of attrition but otherwise passed the quality review for risk of bias:

- An iron supplementation program for non-stunted infants in Chile resulted in worse scores on every measured outcome at 10 years old (significant for spatial memory and visual-motor integration and suggestive for IQ, arithmetic, visual perception and motor coordination). This perverse result was either due to

differential attrition in the the 43 percent dropout rate, or iron poisoning as those who stayed in the trial were generally healthy and had higher socio-economic status and developmental scores (Lozoff and others 2012).

- Food supplementation and home visits for cognitive stimulation for Colombian infants produced taller children by age three, but the effect was halved and only marginally significant by age six. The 43 percent attrition rate was found to be "non-random with regard to several background factors" in one of three sets of attrition tests (Super and others 1990).
- Vitamin A supplementation was offered to women in Nepal before and during pregnancy, and outcomes were measured when the children were 10-13 years old. At that point there were no differences in cognition or motor development between those children born in the (randomly assigned) treatment villages and placebo villages. Attrition ranged from 40-50 percent (Buckley and others, 2014).

9.12 In spite of high attrition, some interventions become quite well-known and are studied over several rounds of surveys. The evaluations of the Turkish Early Enrichment Project (TEEP) intervention in Turkey are an example. Because attrition was nearly 50 percent, results from this series of studies was excluded from the main results of this review (see box 10).

Box 10. Identifying Challenges of Long-Term Evaluations of Interventions and Outcome Matrix: Identifying the Gaps Attrition in the Turkish Early Enrichment Project

Between 1983 and 1985, the Turkish Early Enrichment Project (TEEP) tracked a group of 255 children between the ages of four and six from low-income areas of Istanbul as they progressed through a variety of preschool environments. The children attended daycare at either an educational or a custodial center or stayed at home, depending on their mothers' occupation. From each type of daycare group, half of the mothers were randomly assigned to training on cognitive stimulation and structured activities to facilitate engagement with their children.

Although long-term follow-up evaluations of TEEP suggest a generally positive trend of cognitive and social growth for participants, the evidence base for these claims is critically weakened by endogenous selection into care facilities and high rates of attrition. These issues challenge the internal validity of the TEEP studies, and their results should be carefully examined before wider lessons can be drawn about the effectiveness of the training curriculum or preschool options.

Nonrandom assignment into treatment groups can confound results. The evaluations of the TEEP program are based on a 3 x 2 matrix comparing outcomes of the children who participated in the three different preschool environ-ments and whose mothers either received training or did not. However, only assignment of the mother training treatment was random. Children were already enrolled in a particular daycare environment based on their mothers' occupation and location. The only valid comparison of outcomes is, therefore, between the children whose mothers received training and those who did not. However, even this comparison may be confounded by the high degree of variability within the groups, since

participation in a particular daycare is endogenous.

The loss of participants over time often undermines the ability to confidently attribute effects observed throughout an individual's lifetime to an intervention early in their childhood. One of the most substantial threats to the validity of the TEEP study is the high rate of attrition in the 19-year follow-up. The sample size of 131 reflects a 49 percent attrition rate. Although the authors try to confirm the randomness of attrition, loss of nearly half of the study sample significantly reduces the ability of the evaluation to detect small effect sizes and impairs the external validity of any results. High rates of attrition is one of the most common challenges faced by long-term evaluations, and ECD interventions may be particularly affected if attrition from post-early childhood samples is correlated with the gains achieved throughout childhood and adolescence.

Challenges in Design Allowing for Follow-Up

9.13 As noted in the attrition discussion, the evaluations which today constitute the evidence base of long-term effects of ECD interventions were often not designed with that objective. Many evaluation designs were implemented before strong evidence of effects existed across a range of outcomes in the post-early childhood years and were therefore not designed to track participants into adolescence and adulthood. Additionally, universal, standardized measurement across a range of outcomes over the lifespan—cognition and socioemotional development, in particular—are not yet established, making it difficult to know how best to assess these constructs longitudinally. Although in some cases researchers are able to apply econometric methods ex post to tease out lasting effects that can be attributed to the original intervention, the absence of ex ante planning for long-term follow-up at the implementation stage has complicated causal inference from these studies.

9.14 For example, the large-scale, locally administered maternal protein-biscuit supplementation program in The Gambia is the only study to investigate the independent effects of maternal supplementation in utero.[6] [8252, 8253, 8254, 8255] Similar to the patterns seen with the long-term effects of U.S. preschool programs, females tended to show benefits more frequently than males when there is a gender differential at all. But the most common finding was that the effects were not notably different between genders. Providing the comparison group with access to the intervention undermined the ability to understand any long-term effects of receiving supplementation in utero; subsequent studies would essentially be measuring a dose response comparing the effects of receiving the biscuits for 20 weeks in utero versus 20 weeks during lactation.

9.15 However, the authors of follow-up studies have used previous research in The Gambia to convincingly argue that postnatal protein-energy supplementation did not affect the quantity and quality of breast milk (Prentice and others 1983). It is impossible

to test this hypothesis for this group of mothers, but if true the integrity of the control group would be preserved for making comparisons of dichotomous treatment. This assumption enabled researchers to measure the longer-term effects of the program when the children were between the ages of 11–17 and 16–22.[8252, 8255] Although these evaluations were able to provide some insight into possible longer-term effects of maternal supplementation, a gap remains during the preschool and primary school years, which could highlight the lifecycle or fadeout effects of supplementation benefits (table 9).

Table 9. Outcome Domain by Age at Evaluation in The Gambia Study

Age	Study	Physical Development	Cognitive Development	Language Development	Socioemotional Development	Schooling Outcomes	Employment and Labor Market Outcomes
11-17	[8252, 8254]	2/22	-	-	-	-	-
16-22	[8255]	0/1	0/3	0/1	-	0/1	-

Note: Numerator is statistically significant outcome at 10% level, and denominator is number of outcomes in the domain.

External Validity

9.16 Finally, all evaluations—impact evaluations or otherwise—have challenges of external validity—the ability to apply results found in one study to a different scale, context, or time. Scale elements of external validity are particularly challenging for the selection of impact evaluations reviewed here. Most of the evaluated interventions are somewhat small, and scaling up to a national level may present administrative or other challenges, even if those interventions are not resource intensive. For example, the Jamaica supplementation and psychosocial stimulation project was administered to 90 children. Implementation capacity, monitoring, and quality control are clearly larger challenges if a similar program were to be implemented at the national level.

9.17 Impact evaluations, like any other type of evaluative method, can establish credible in-context external validity through appropriate sampling methods. Results found from a random sample of a well-designed sampling frame are externally valid to that frame. Unfortunately, very few of the impact evaluations in this review can claim this type of external validity because the original sample was not a representative, random selection of a larger group.[7] Beyond sample validity, which can take care of some elements of external validity to a specific context (the one from which the sample was drawn), all evaluations have challenges out-of-sample external validity. Evaluative methods of all stripes, impact evaluation and otherwise, are still working out how to apply results from one area to another.

9.18 Individual evaluations can offer little on external validity over a prolonged period of time. The interventions included here occurred at a particular point in time—sometimes 30 years ago—and those same contexts are now very different places. There is no guarantee the same results would be observed if the same intervention was implemented in the same context today. Moreover, advances in knowledge, methodology, and measurement in various fields suggest that the same studies would not be implemented in the same way today.

9.19 Even so, this systematic review tries to increase understanding of temporal trajectories—how effect sizes may change over time. These streams of impacts can be traced for the six impact evaluations that have longitudinal information. For example, the cognitive advantage of the early stimulation beneficiaries in Jamaica seems to become more apparent over time, as measured by various outcomes (schooling, employment, and earnings). The effects over the range of socioemotional outcomes were not measured consistently (with the same tools),[8] but it is noted that lower scores on the depression scales were sustained from adolescence to early adulthood. Across most measures of socioemotional outcomes, however, advantages were found for the stimulation group at both time points.

9.20 While evaluative methods are still working out how to apply results from one scale, context, or time to another, the fact that some of the results described here are consistent across these elements implies a level of robustness in external validity.

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[1] It should be noted that in addition to the four challenges noted above, many of the evaluations included interventions that were of long duration that required substantial financial investment. Moreover, many of the outcome measures employed in those studies and reviewed in this report—especially those that relied on direct measurements of people—are expensive, time-consuming, and necessitate fairly extensive training to complete. Thus, investigators may have had to compromise on some aspects of study design to carry out and evaluate the intervention. Ffor example, see Martorell, Habicht, and Rivera (1995) for discussion of some of the difficulties relating to design of the supplementary feeding study of Guatemala's Instituto de Nutrición de Centroamérica y Panamá (INCAP). Subsequent evaluations were often based on the same problematic study designs as the original study without correcting pre-existing differences between the treatment and comparison groups. None of this is unique to follow-up evaluations of early childhood development, but these challenges are worth noting. For sound work to be done, significant time and financial investments are required.

[2] Although study 3941 uses a double difference estimator and instrumental variables, issues of validity resulted in it being excluded from the report.

[3] In Martorell, Habicht, and Rivera (1995), the original study designers indicate that the delivery modality of the food supplementation intervention called for twice daily distribution from central feeding stations, precluding the possibility of randomizing at the individual or

household levels. Furthermore, budget constraints resulted in the exclusion of two additional control villages and logistical constraints influenced the selection of the village pool.

[4] Pollitt and others (1993) is an example of a study that fell just outside of the inclusion cutoff on methodology grounds. While the authors do control for important differences using covariates, included data are not matched based on those differences, and multivariate regression is not an included impact evaluation method.

[5] High attrition often seems to afflict evaluations of highly relevant interventions. For example, the only evaluation of a malaria intervention has an attrition rate of 51.6 percent—quite high, especially considering the high-mortality nature of malaria. However, the IE asserts that 17-year old children who had received malaria prophylaxis for two or three seasons when they were under five years old had better cognitive scores than those who received it for just one season or who had received a placebo. While school enrollment was similar between those receiving any prophylaxis and those receiving the placebo, those in the treatment had about a half year more of schooling achievement. (Jukes and others, 2006)

[6] While Guatemala's INCAP supplementary feeding program was available to gravid and lactating mothers, the study design did not allow isolation of the in-utero effects.

[7] Note that impact evaluations using matching methods or data trimming are likely to lose claims of external validity as they drop off-support data.

[8] This may be because the types of socioemotional factors important to measure at various ages change over time.

10. Knowledge Gaps to Fill

10.1 The evidence surrounding post-early childhood effects of early childhood interventions is often thin. Between all of the outcome domains across all possible interventions types in all low- and middle-income countries, only 54 studies were of sufficient quality for inclusion. Given the diverse range of early childhood interventions and the impact they can have across physical, cognitive, linguistic, socioemotional, educational, and employment domains throughout an individual's lifespan, there is room for far more evaluation not only on the lasting effectiveness of known programs, but also on the potential synergistic gains from bundling interventions. While the gaps are such that any effort to add high-quality impact evaluation evidence to the existing base would be useful, particular areas have greater need than others. The gaps presented here highlight those areas of concern in an effort to guide future research.

10.2 Gaps in the evidence of later-life effects from early childhood intervention exist for various reasons, many of which are factors of the types of interventions being studied or the long time horizon. First, some intervention types are less amenable to impacrt evaluation methods than others. For example, it can be much more difficult to quantify the physical or cognitive effects of social protection programs (e.g. regulatory frameworks, birth registration, and child protection interventions) than to identify the human development effects of a direct micronutrient supplementation program. Secondly, attrition is particularly high in follow-up studies of early childhood interventions as individuals often move, especially as children reach adolescence and early adulthood. Tracking down and re-evaluating participants at multiple stages in their lives can therefore be difficult and costly, if not impossible. A third factor is that long-term funding is often difficult to secure, and funders (and researchers and journals) often implicitly assume that returns are temporally static, such that follow-up work is not needed.

10.3 Regardless of the reason, the existence of gaps is a testament to the magnitude of the work still needed to understand the later-life effects of early childhood interventions. It is hoped that identifying these gaps will attract greater interest and resources from researchers, journals, and funders.

Gaps in Outcomes by Intervention Type

Significant research gaps across both the intervention space and outcome domains remain. Even where evidence of an intervention's effect is available, that evidence is typically thin. For instance, as depicted in Figure 12, only 1 of the 20 identified

intervention types—stimulation—has long-term effects measured in each of the six outcome domains. Furthermore, this report identified only two studies that assessed the impact of sanitation interventions on development outcomes, and not a single evaluation was found of the long-term effects of agricultural or food security programs—both interventions that are likely to affect children's development in lasting ways. The determination of effective interventions thus requires both a more densely populated evidence base and a more expansive evaluation of relevant intervention types and outcome indicators.

10.4 As seen in Figure 12, many intervention types have very little evidence documenting their effects beyond the early childhood period. For example, only a single study measured both the cognitive and language outcomes of a quality early childhood and pre-primary program, and just two measured the impact on socioemotional and physical development. Although four studies report schooling outcomes of a quality pre-primary program, the lack of evaluation of other outcome domains presents a significant gap in the understanding of why and how these these schooling improvements are being achieved.

10.5 In the health category, of the six identified types of pregnancy, prenatal, and postnatal interventions, only one—a family planning program[8277]—had effects reported across any outcomes. Similarly, only one of the five types of disease treatment programs, deworming, was evaluated for post-early childhood effects in any outcome domain.[8251] Other notable gaps include a complete lack of evidence for teacher and caregiver training programs, and educational media.

10.6 In certain outcome domains, very little evidence was found for programs in which one would expect a link between the intervention and the indicator. For example, only a single study measured socioemotional outcomes for a breastfeeding promotion intervention, and it did not detect any significant results.[1383] The lack of evidence on the relationship between a child's socioemotional development and an intervention that increases the interaction between mother and infant, such as breastfeeding, is troubling and challenges preconceptions of effective ECD strategies. While it could be the case that there is a socioemotional effect from breastfeeding, the single impact evaluation identified by this report, though its sample size is the largest among the 54 impact evaluations, does not support that conclusion. More research is needed before any causal conclusions can be reliably drawn.

10.7 The most commonly reported outcome across intervention types was physical: 27 unique studies measured physical effects in the post-early childhood period. The majority of the evidence comes from evaluations of nutritional programs for mothers and children. However, the lack of evidence on the effects of other health programs is

surprising. For example, only a single study exists in both the pregnancy, delivery, and postnatal interventions category (family planning)[8277] and disease treatment category (deworming).[8251]

10.8 In addition to needing more evidence in established ECD outcome domains, as evidence of the post-early childhood effects of early childhood interventions continues to emerge, the range of possible outcomes measured must expand to create a comprehensive picture of the impacts at each stage in an individual's life. For instance, despite the clear cognitive and educational gains among children exposed to ECD interventions, which would normally be associated with improved employment possibilities, only one study[1715] investigates employment outcomes in adulthood.

10.9 While more evidence is needed across the range of possible outcomes, the scope of interventions considered relevant to early childhood development (ECD) must also be expanded. Perhaps the biggest gap is the dearth of evaluations of the post-early childhood effects of programs from outside the traditional ECD sector. For instance, only a single evaluation was found for disease treatment interventions[8251] and governance programs, [8426] and only two studies[8331, 8415] assess the development outcomes of sanitation programs. Given the generally positive impacts found by the limited evidence, much could be learned about effective ECD programming if future research included a more expansive range of relevant intervention types.

10.10 Given the prevalence of ECD programs that combine multiple interventions, evaluations that can tease out the causal pathways of the combined treatments will provide valuable information about the complex interactions of ECD interventions throughout the post-early childhood timeline. For example, a study of Progresa in Mexico disaggregated effects by both the cash and conditionality components of the program,[8274] providing important insight into causal mechanisms. Although bundling of interventions within a program means that evaluations cannot always cleanly attribute impacts to a particular treatment, understanding the beneficial synergies and the most advantageous combinations can constructively influence ECD policy.

Figure 12. Intervention and Outcome Matrix

Intervention Type			Intervention Categories	Outcome Domains: Cognitive Development	Language Development	Socioemotional Development	Physical Development	Schooling Outcome	Employment and Labor Market Outcome	Number of Unique Studies
	Nutrition	Mother	Vitamins, micronutrients, or fortified food for pregnant women	2	1		8	2		8
			Exclusive breastfeeding	1	1	1	5	1		8
		Children	Micronutrients and fortified food for children	1	1		1	1		1
			Optimal feeding practices/complementary feeding	2	3	2	2	4		5
			Supplementary feeding (preschool, center-base and/or take home rations)	3	3	3	3	4		10
	Education	Early Learning/Childcare	Quality early childhood and pre-primary program	1	1	2	2	4		6
			Pre-school Infrastructure	1	1	1	1	2		2
	Health	Pregnancy, delivery and postnatal	Family planning	1			1	1		1
			Well child visits, screening for developmental delays	3	4	2	3	4		6
		Disease Prevention	Immunization	1			1	1		1
			Hygiene and hand-washing			1	1			2
		Disease Treatment	Deworming	1	1		1			1
	Social Protection	Cash Transfers (Incentives for human capital investments)	Conditional	3	4	2	3	4		6
			Unconditional/targeted income support (child grants, etc)	1	1		1	1		1
		Child protection		2	1	6	4			10
		Childcare/daycare						1		1
	Multi-sector	Parent support program		2	2		2	2		3
		Stimulation		7	6	10	6	2	1	18
	Other	Water and sanitation		1	1			1		2
		Governance (Women's political reservation)		1	1					1
			Number of Unique Studies	20	19	15	27	18	1	54

NOTE: Shown is the density of impact evaluations for any given intervention and outcome domain pair. It is based on the intervention types outlined in figure 2, but only the intervention types that had at least one impact evaluation of sufficient quality are included.

Gaps by Evaluation Components

10.11 Impact evaluations on ECD generally, and in particular those cited in this review, offer tremendous value. The systematic review by the Independent Evaluation Group identifies four major gaps in evaluation components of the impact evaluations

reviewed here: issues related to time, complementary methods, cost efficiency, and heterogeneous effects.

10.12 Three dimensions of time may be critical components to program effectiveness. First is the child's age at exposure. Interventions occurring before or after particular developmental milestones could have very different effects. Because the age of exposure is hypothesized to be an important factor in long-term program effectiveness, it would be useful for studies to explicitly test this hypothesis of critical treatment periods (e.g., the "first thousand days"). Second, the length of exposure to the intervention may or may not cause differences in outcomes, as it could be difficult to determine if some null findings could actually be an artifact of too little exposure to an intervention. Finally, increasing and varying the range of ages at the time of evaluation will continue to contribute to the knowledge of post-early childhood effects of interventions during early childhood and can be used to create a trajectory of an individual's development throughout their lifespan.

10.13 Very few impact evaluations are able to report on differential effects along these time dimensions—age at exposure, length of exposure, and age at evaluation. The evaluations collected in this report address some of these, but all can be improved in answering these questions. Adding to the body of knowledge of time-varying effects for ECD could greatly benefit the effectiveness of the sector. Each of these dimensions can be tested through multiple treatment arms.

10.14 Consistency of analysis across outcome domains of ECD interventions over time is critical to fully understand how effects may change throughout an individual's lifespan. For example, although numerous studies report on the effects of the maternal supplementation program in The Gambia, outcomes were only measured during the first year of life and again when the children were between the ages of 11 and 22.[8252, 8253, 8254, 8255] The lack of evidence during younger ages represents a significant gap in the knowledge of how micronutrients received in utero can affect children's development during the primary school years, making it difficult to determine whether the null results at later ages were due to the lack of an effect or to a fadeout of earlier benefits.

10.15 Six of the programs identified in this review—the Promotion of Breastfeeding Intervention Trial in Belarus, maternal supplementation in The Gambia, Jamaica's supplementation and stimulation program, the Mauritius Child Health Project, Mexico's Progresa, and the Bucharest foster care program[1]—were evaluated at different points in time to look at a range of outcomes as children aged. However, the majority of the interventions included in this review are only evaluated at a single point in time. Yet the posited value of early childhood development interventions is their ability to influence an individual's development trajectory throughout the post-early childhood

timeframe. A comprehensive illustration of the effects of early childhood interventions on the accumulation of human capital throughout a child's life can help researchers and policy makers create and target future programs, and future evaluations should aim to contribute to this knowledge.

10.16 Greater use of mixed methods should supplement rigorous econometric modeling of the differential impacts of early childhood interventions over time. Process evaluation, focus groups, and other qualitative methods can help unpack the mechanisms at work in the causal pathways and provide valuable insight into issues surrounding contextual components or implementation. None of the 54 impact evaluations reported both extensive qualitative evaluation and quantitative impact evaluation. Mixed methods can be particularly useful in understanding or eliminating possible reasons for the many null results found in this review and which, if taken at face value, may challenge prior assumptions about the effects of early childhood interventions.

10.17 Early childhood interventions may be one of the most cost-effective development strategies available to policy makers (e.g., Carneiro and Heckman 2003), yet few studies report cost analysis of any kind. Where they do report these assessments, the quality is generally poor, amounting to back-of-the-envelope calculations, and estimates are rarely comparable due to different methods of calculation. However, research indicates that the period of time before a child enters primary school is the best window of opportunity for interventions to break the intergenerational transmission of poverty (World Bank 2005), and ECD interventions are generally believed to have large equilibrium effects on equity and efficiency. Therefore, it would be beneficial to policy makers if future evaluations provided more comprehensive cost assessments to accurately illustrate the gains of ECD interventions.

Gaps by Region

10.18 The 54 unique impact evaluations identified in this report span 5 World Bank Regions and 21 different countries Figure 13 shows the locations of the ECD programs that had medium- or high-quality impact evaluation (AA or AAA) evidence on post-early childhood outcomes, as determined by this report's rating system; figure 14 depicts the location of every ECD program for which an impact evaluation of any quality measured post-early childhood outcomes.

10.19 The most robust evidence base was found in the Europe and Central Asia and the Latin America and Caribbean Regions, with 19 and 18 evaluations, respectively. These regions enjoy more evidence individually than the remaining four Regions

combined: 9 in the Sub-Saharan Africa, 6 in South Asia, and just 2 from East Asia and the Pacific. Not a single robust evaluation of the long-term effects of early childhood interventions was identified from the Middle East and North Africa region. When the studies that did not pass the quality check are added to the count, the number of represented countries increases by only 8, to 29. The relative densities, however, remain approximately the same across Regions, with high relative representation in Europe and Central Asia and the Latin America and the Caribbean Region, low representation from most of the rest of the Regions, and still no studies from the Middle East and North Africa Region (see figure 14).

10.20 The distribution of evidence across income level was similarly skewed, with 72 percent (39 out of 54) of the medium and high quality studies coming from upper middle income countries. Of the remaining studies, 10 evaluated programs in low income countries, and only 5 reported results for the lower middle income countries. The dearth of evidence in lower middle income countries, which may be poised to make significant investments in ECD, highlights an area where more work is urgently needed.

10.21 The inequitable distribution of evidence on the long-term effects of early childhood interventions by region and income level is surprising. The lack of evidence in the regions most in need of investment in early childhood development is inconsistent for organizations like the World Bank, with its twin goals of ending poverty and increasing shared prosperity.

Figure 13. Locations of ECD Programs with Medium- or High-Quality Impact Evaluations

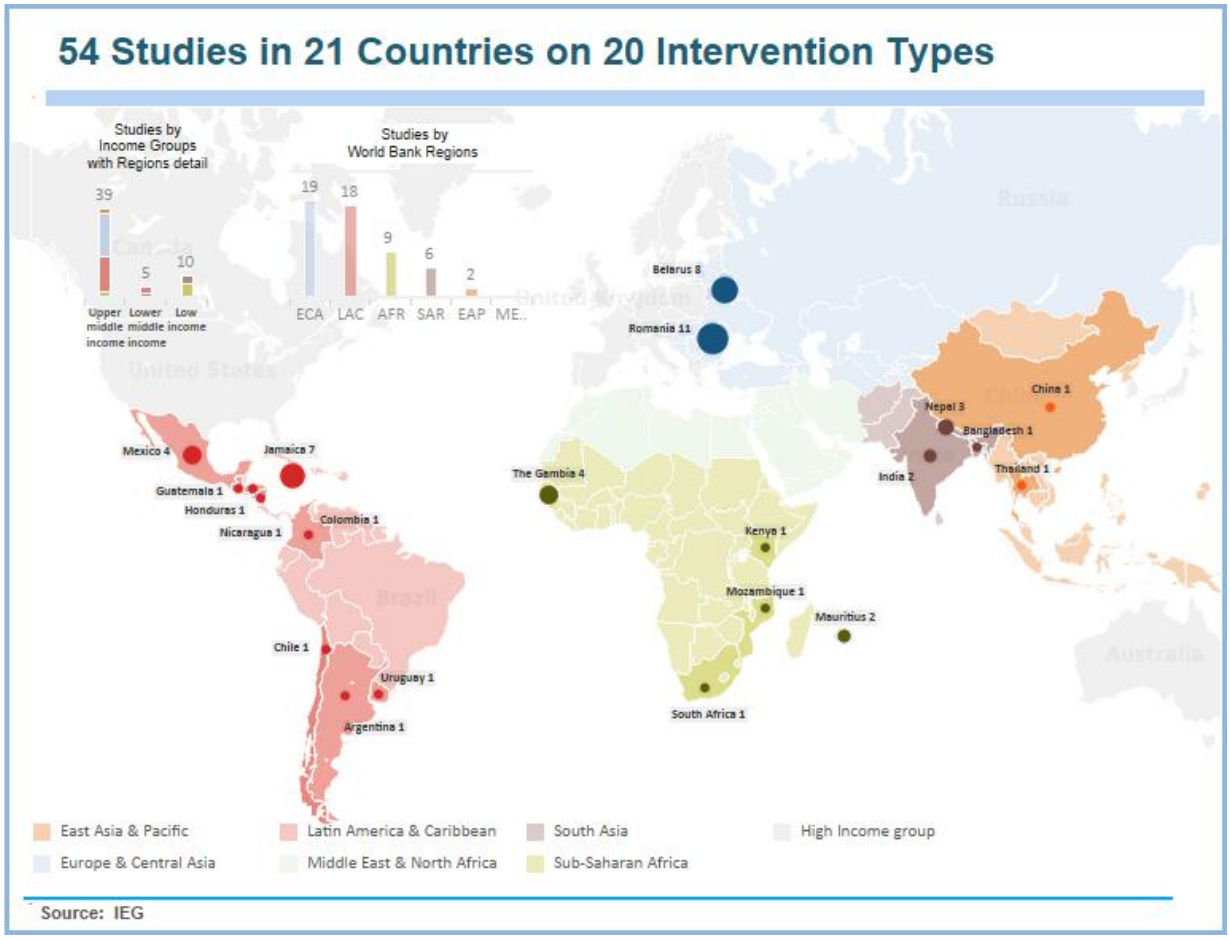
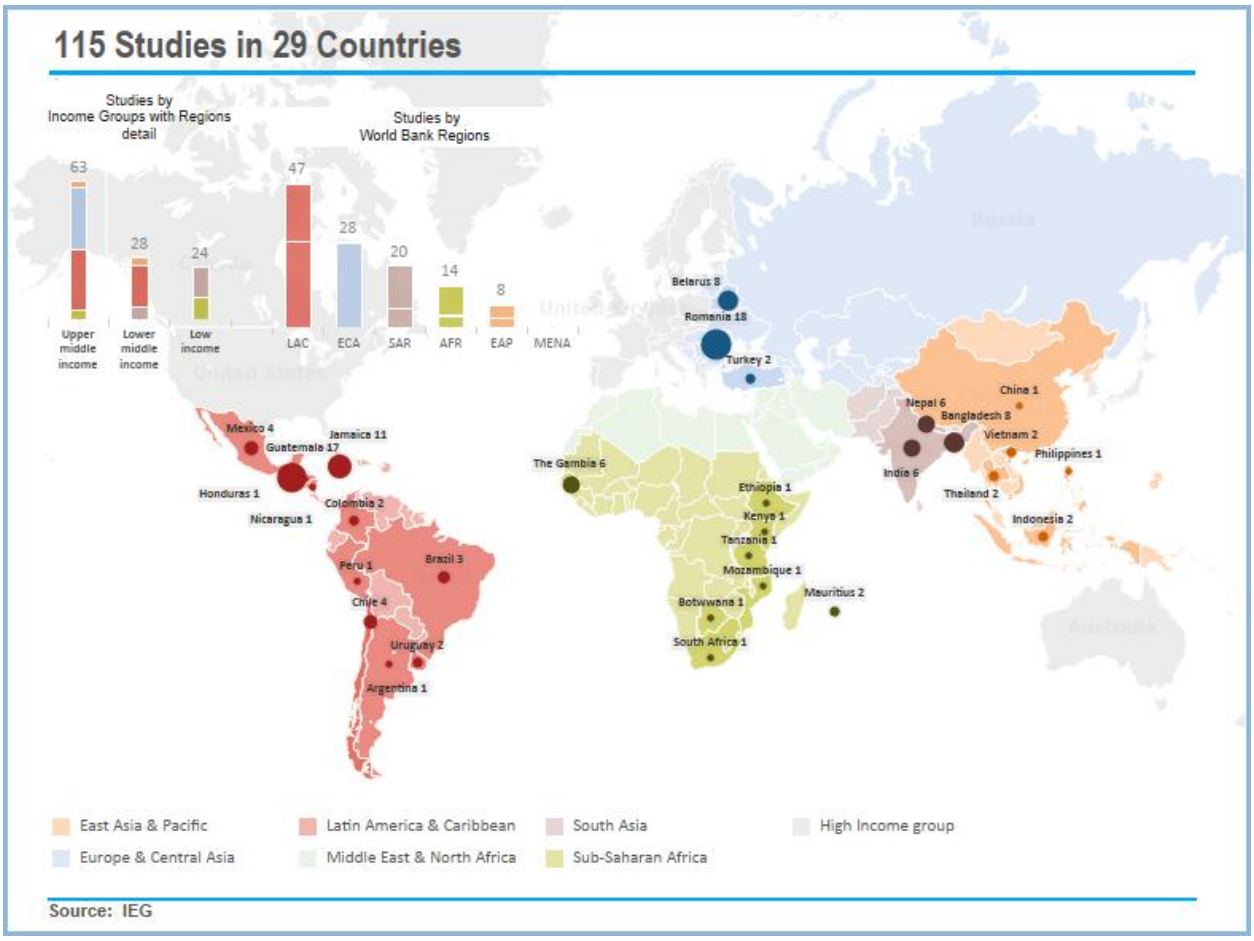


Figure 14. Locations of Early Childhood Development Programs with Impact Evaluations of Any Quality



Addressing the Gaps

10.22 Recent work has greatly increased the knowledge of the effectiveness of ECD programs across a variety of intervention types and outcome domains (Engle and others 2011, Grantham-McGregor and others 2014). Future research can now build upon this evidence base and increase both the breadth and depth of the knowledge of what works in early childhood development. To the extent that planned impact evaluations touch on the gaps identified above, the holes in knowledge of the post-early childhood effects of early childhood interventions may be ameliorated. For example, the World Bank's Strategic Impact Evaluation Fund (SIEF) dedicates a significant amount of its focus to evaluations of ECD programs. SIEF's current portfolio includes several studies that specifically address some of the gaps mentioned here.

10.23 One of the areas in which more research is needed, as discussed previously, is in better understanding the synergistic effects of integrated ECD interventions. While the

recent review from the *Annals of the New York Academy of Sciences* (Grantham-McGregor and others 2014) goes a long way toward addressing some of these questions by focusing on integrated nutrition and stimulation interventions, the longer-term effects are still understudied. However, SIEF's upcoming evaluation of the government of Mozambique's expansion of a community-based integrated ECD program could present a valuable opportunity to explore these effects.

10.24 In Colombia, SIEF will build on the important lessons learned from evaluations of Jamaica's supplementation and stimulation program, and will implement a similar program on a much larger scale. The proposed study design will allow the researchers to evaluate whether interventions during the first two years of life have sustained effects and further investigate the specific causal pathways through which the impacts are achieved. A third study in Indonesia will also assess how access to health services during the early childhood period impacted later schooling and labor market outcomes.

10.25 The results of studies like these will contribute to the knowledge of long-term effects of early childhood interventions across a range of outcomes, in multiple stages of scale-up and in a variety of contexts. The special attention paid to collecting data on cost-effectiveness is also an important step toward quantifying how much ECD interventions could save when compared to later remedial policies.

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[1] Two additional project sites were evaluated by multiple impact evaluations—the supplementary feeding program of Guatemala's Instituto de Nutrición de Centroamérica y Panamá and of Matlab, Bangladesh—but in each case only one of those evaluations in the series passed the quality criteria for inclusion in this review (AA or AAA); the others were graded as A quality.

References

The first set of references are relevant literature sources that are cited in the report. It is followed by a numbered list of the impact evaluations that were assigned a quality rating of AA or AAA by the evaluation team of the Independent Evaluation Group.

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Appendix A. Descriptions of Interventions from Included Studies

Study	Name of Intervention	Country	Description	Counterfactual	Age at Intervention	Age at Evaluation
Berlinski and others 2009 [8197]	Preschool	Argentina	In 1993, the government of Argentina made pre-primary school compulsory and began a massive public school construction program. Given the need to build so many new schools, the pre-primary educational requirement was phased in over six years. Children are eligible for up to 3 years of public pre-primary education. Length of exposure: 1–3 years Scale: National	Children in areas where schools had not yet been built	3–5 years old	8–9years old
Barham 2012 [8277]	Matlab Family Planning Program	Bangladesh	Started in 1977. Local female health workers made monthly home visits to provide free contraception and advice on contraceptives, nutrition, hygiene and breastfeeding. Women were also eligible for a tetanus toxoid vaccine, folic acid and iron during the last trimester of pregnancy. Starting in 1982, half of the treatment communities received child health programs as well, in particular measles vaccines. The other half of the treatment areas began receiving it in	Children in control areas	8–19 year olds: Birth 20–24 year olds: 20 years old	8–24 years old

Study	Name of Intervention	Country	Description	Counterfactual	Age at Intervention	Age at Evaluation
			1985. Starting in 1986, additional child health interventions, including immunizations, vitamin A supplementation for children under five, and nutritional rehabilitation for those who were nutritionally at risk were added. All interventions were administered in the home of the recipient. Control areas continued to receive government healthcare. In this study, children 8–11 years old would have benefited from all of the child health programs as well as the effects of the family planning. Children 12–14 would have been eligible for vaccinations and the benefits of family planning, those 15–19 would have benefits from the family planning program, and those 20–24 were born after the program began but could still benefit from smaller family sizes through the family planning program. Length of exposure: Varies Scale: Approximately 100,000 people			

Study	Name of Intervention	Country	Description	Counterfactual	Age at Intervention	Age at Evaluation
Kramer and others 2007 [8227] Kramer and others 2007a [8190] Kramer and others 2007b [8228] Kramer and others 2008 [1383] Kramer and others 2008a [4693]	Promotion of Breastfeeding Intervention Trial (PROBIT)	Belarus	1996–1997. Thirty-two pairs of maternity hospitals and associated polyclinics from across Belarus were randomly assigned to participate, and women who expressed, upon admission to the postpartum ward, an intentions to breastfeed and had given birth to a full-term, normal birth weight infant were eligible to participate. Midwives, nurses and doctors were trained in lactation and instructed women in the treatment group on the benefits of exclusive breastfeeding and proper duration. Length of exposure: 1 year Scale: 8547 mother-infant pairs	Children whose mothers attended the maternity hospitals or polyclinics that were randomized to not receive the program	<1 year old	6.5 years old
Martin and others 2013 [8187]						11.5 years old
Cortazar 2011 [4138]	Early Childhood Care and Education (ECCE)	Chile	Ongoing program. Center-based pre-kindergarten programs for 2–4 year olds, targeted to those from the two lowest income quintiles. The program included educational activities involving the child, educator and family, as well as a feeding program and health component. The family involvement included promoting home-based activities, inviting parents to participate in classrooms and	Children who did not participate in any pre-kindergarten education program	2–4 years old	Fourth graders (about 10 years old)

Study	Name of Intervention	Country	Description	Counterfactual	Age at Intervention	Age at Evaluation
			helping to organize extracurricular activities. Length of exposure: 1–3 years Scale: National			
Attanasio and Vera-Hernandez 2004 [769]	Hogares Communitarios	Colombia	Started between 1984–1986. Parents of children 0–6 years old from poor households in poor neighborhoods and localities were encouraged to form 'parents associations,' which elected a madre communitaria (community mother). This mother had to have at least a basic education and a large enough house to host up to 15 children. The parents would then pay a small monthly salary to the madre, and the government would provide funds for lunch, two snacks and a nutrition beverage per day for the children (the menu was established by a nutritionist and provided 50–70 % of the advisable daily amount of calories). The program was designed to promote children's physical, social and cognitive development, and madres attended a 40-hour training on child development. Length of exposure: Varies Scale: National, although it is	Distance to nearest hogar communitario and average distance for the town were used as instruments for number of months attended and exposure (number of months attended/age in months)	0–6 years old	8–17 years old

Study	Name of Intervention	Country	Description	Counterfactual	Age at Intervention	Age at Evaluation
			unclear how many localities qualified			
Hawkeswort h and others 2008 [8252] Hawkeswort h and others 2009 [8253] Hawkeswort h and others 2011 [8254]	Maternal supplementation	The Gambia	1989–1994. Women of childbearing age (15–45y) from 28 villages in the West Kiang region were randomized into intervention (biscuits provided from around 20 weeks gestation to term) and control (biscuits provided for 20 weeks after delivery) groups. Women were given 2 biscuits/day that provided extra energy, protein, fat, calcium and iron. Biscuits were prepared by village women and distributed by two birth attendants in each village who intensively encouraged consumption and in whose presence the biscuits had to be consume. Attendants recorded compliance. Women in both groups received routine ANC. The subjects of the impact evaluations were the children of the women who participated. Length of exposure: 20 weeks Scale: 1460 women in both treatment and control	Dose response between receiving biscuits during pregnancy and receiving them for 20 weeks after delivery	Birth	11–17 years old
Alderman and others 2014 [8255]						16–22 years old
Maluccio and others 2009 [4845]	Guatemala's Instituto de Nutrición de Centroamérica y Panamá (INCAP)	Guatemala	1969–1977. Two sets of similar village pairs were selected in rural eastern Guatemala, and one village	Children who lived in villages that were assigned to receive fresco	<36 months	25–42 years old

Study	Name of Intervention	Country	Description	Counterfactual	Age at Intervention	Age at Evaluation
			from each pair was randomly assigned to receive as a dietary supplement a high protein-energy drink atole (53%, 91 kcal and 6.4 g protein/100 mL). The other two villages received a low-energy drink called fresco (47%, 33 kcal/100 mL, no protein). The drinks were distributed at centrally located feeding centers and were available twice a day to any member of the village. All residents of all villages also were offered free medical care throughout the intervention, and preventative services, including immunization and anti-parasites campaigns, were conducted simultaneously in all villages. Length of exposure: 3–7 years Scale: One large (~900 residents) and one small (~500 resident) village			
Walker and others 2010 [5547]	Psychosocial stimulation in LBW-T children	Jamaica	1999–2001. Low birth weight infants from lower socioeconomic households (based on mother's education) were recruited from the main public maternity hospital in Kingston and randomly assigned to treatment or control. Treatment was divided into	Low birth weight infants who were randomly assigned to the control group	At birth	6 years old

Study	Name of Intervention	Country	Description	Counterfactual	Age at Intervention	Age at Evaluation
			two phases, with community health workers visiting the mothers and children weekly. In the first phase (the first 8 weeks of life), the focus was on improving mothers' responsiveness to their infants. In the second phase (from 7–24 months), the health worker demonstrated play techniques, taught proper discipline habits, and provided toys. Length of exposure: 2 years Scale: 140 infants (70 T and 70 C)			
Walker and others 1996 [5549]	Psychosocial Stimulation and Nutritional Supplementation	Jamaica	1986–1987. 129 stunted children were randomly assigned to one of three treatment groups or to a control group. The three treatment groups were: 1. Supplementation with 1 kg milk based formula each week, 2. Weekly play sessions with mother and child, including weekly home visits to help the mothers improve their verbal interactions with the child, and 3. Both supplementation and weekly play sessions. Length of exposure: 2 years Scale: 96	Supplementation : groups 1 and 3 v. group 2 and control Stimulation: groups 2 and 3 v. group 1 and control	9–24 months	7–8 years old
Walker and others 2000 [5544]				Physical outcomes: Each group was compared to the others Cognitive outcomes: Stimulation: groups 2 and 3 v. group 1 and control		11–12 years old
Walker and others 2006 [379]				Stimulation: groups 2 and 3 v. group 1 and control		17-18 years old
Walker and others 2005 [8198]				Supplementation : groups 1 and 3 v. group 2 and control Stimulation: groups 2 and 3 v. group 1 and control		
Gertler and				Stimulation:		22 years

Study	Name of Intervention	Country	Description	Counterfactual	Age at Intervention	Age at Evaluation
others 2013 [1715]				groups 2 and 3 v. group 1 and control		old
Gertler and others 2014 [8275]				Stimulation: groups 2 and 3 v. group 1 and control		
Walker and others 2011 [5602]				Supplementation : groups 1 and 3 v. group 2 and control Stimulation: groups 2 and 3 v. group 1 and control		
Ozier 2014 [8251]	Primary School Deworming Project	Kenya	1998–2001. Schoolchildren in southern Busia, a poor and densely populated farming region in western Kenya, in randomly assigned to receive free deworming treatment. One-third of the schools were assigned to receive it in both 1998 and 1999, one-third in just 1999, and one-third in 2001. Length of exposure: 1–2 years Scale: 73 primary schools	Younger siblings of children who were dewormed are compared to younger siblings of those who were not	<1 year old	8–15 years old
Raine and others 2001 [5156]	Experimental nursery schooling	Mauritius	1973–1976. The enrichment program took place in two specially constructed nursery schools. In addition to regular educational activities, the children were instructed in hygiene and nutrition and received regular medical inspections from doctors who visited the nurseries. Teachers were specially trained in basic	Children who attended the traditional Mauritian petites ecoles	3 years old	11 years old
Raine and others 2003 [5839]						17 years old 23 years old

Study	Name of Intervention	Country	Description	Counterfactual	Age at Intervention	Age at Evaluation
			kindergarten education as well as physical health, art, drama, and music. Parents were encouraged to participate in parent-teacher associations. Length of Exposure: 2 years Scale: 100 participants			
Todd and Winters 2011 [5538]	Progresa *The program changed names to Oportunidad-es in 2002. This report refers to it as Progresa, however, since the IEs included herein are evaluating the effect of the program during the Progresa time period.	Mexico	Early treatment began in April, 1998; late treatment began in November, 1999. Within communities assigned to receive treatment, eligible household (those that qualified as poor based on a marginality index) receive bi-monthly cash transfer, conditional on family members completing regular health checkups and children attending school. Children become eligible for the educational scholarships when they enter third grade. The transfer is, on average, equivalent to an average of 20% of household consumption. Recipients—usually mothers—are required to attend regular meetings (pláticas) in which health and nutrition practices are discussed. In addition to the cash transfer, there is a nutritional	Cohorts of children who turned 3 years old around the time the late treatment started (isolates the impact of receiving an additional 18 months exposure before 3 years old)	0–6 years old*	6–9 years old
Manley and others 2012 [8274 (4288)]						8–10 years old
Secretariat of Social Developmen t 2008 [8237]						7–11 years old
Behrman and others 2009 [8242]				Experimental sample: the effect of an additional 18 months of program participation Matched sample: children who were in the early treatment group were matched with children who had never enrolled in Progresa		7–11 years old**

Study	Name of Intervention	Country	Description	Counterfactual	Age at Intervention	Age at Evaluation
			component, which includes the provision of nutritional supplements to pregnant and lactating women and to children 4–24 months old or up to 59 months old if signs of malnutrition are detected by the clinic personnel. A prerequisite for receiving nutritional complements is ongoing growth monitoring of preschool children. Length of exposure: Varies Scale: 320 villages in the early treatment, 186 villages in the late treatment			
Martinez, Naudeu, and Pereira 2012 [8261]	Early Childhood Development Program	Mozambique	2008–2010. After a successfully pilot program that started in 2005, Save the Children scaled up a community-based preschool model in Gaza province wherein randomly selected communities committed space for classroom construction, as well as locally available construction material and 100 percent of the labor, in exchange for technical assistance and materials for up to three classrooms, playgrounds, child-sized latrines and washing stations. Community	Children in participated in the preschool program were compared to those in communities that were not assigned to receive one	3–5 years old	5–9 years old

Study	Name of Intervention	Country	Description	Counterfactual	Age at Intervention	Age at Evaluation
			members were also to form a committee to encourage parent participation and enrollment and to select two volunteer teachers for each class. Save the Children conducted training for the teachers. Preschool typically lasted 3 hours and 15 minutes with activities designed to stimulate child development. Length of exposure: 1–3 years Scale: 30 communities			
Stewart and others 2009 [8256]	Antenatal Micronutrient Supplementation	Nepal	1999–2001. Pregnant women in the rural southeastern Sarlahi district of Nepal were randomly assigned to receive daily supplementation from early pregnancy to 3 months postpartum. There were four supplementation groups: 1. Folic acid, 2. Folic acid and iron, 3. Folic acid, iron and zinc, and 4. Folic acid, iron, zinc and 11 additional vitamins and minerals. All women—both in the treatment and control groups—were given vitamin A. Length of intervention: Up to 1 year Scale: 4047 women***	Children of women who were in groups 1–4 were compared to children of women who just received vitamin A	In utero	6–8 years old
Barham and	Red de	Nicaragua	Early treatment	Dose response of	At birth	10 years

Study	Name of Intervention	Country	Description	Counterfactual	Age at Intervention	Age at Evaluation
others 2014 [8278]	Protección Social (RPS)		group began in 2000; late treatment group began in 2003. Forty-two poor localities were randomized into equal treatment and control (late treatment) groups wherein poor households received bimonthly transfers equal to approximately 18 percent of households' pre-program expenditures. The transfers were conditional on meeting health and educational (starting at 7 years old) requirements, including regular preventative healthcare visits for children under five. The designated caregiver in each house was also required to attend bimonthly meetings on nutrition and health. Health services were free and delivered by private health providers contracted by RPS. While households in the early treatment group were no longer eligible for the cash transfers after 2003, they continued to receive free private health services through 2005. Length of exposure: 3 years Scale: Rural communities in six	receiving RPS during the first 1,000 days versus receiving it from 2–5 years old		old

Study	Name of Intervention	Country	Description	Counterfactual	Age at Intervention	Age at Evaluation
			municipalities in central and northern Nicaragua			
DSD, SASSA, and UNICEF South Africa 2012 [8222]	Child Support Grant (CSG)	South Africa	1998–present. Caregivers of vulnerable children received a monthly unconditional cash transfer, which can start soon after birth and last until the child is 18 years old (originally, children were only eligible until they were seven years old, but the threshold has increased over the years). Eligibility is based on a means test. Length of exposure: Varies Scale: National	Physical: Children who started CSG before they were 2 years old compared to children who started after they were two Other outcomes: Children who started CSG at birth compared to those who started at six years old	<2 years old	10 years old
Pongcharoen 2010 [5117]	Zinc and Iron Supplementation	Thailand	1998. Infants in Khon Kaen province (northeast) were randomly divided into one of four groups for a double blind, placebo-controlled trial: 1. 10 mg of zinc, 2. 10 mg of iron, 3. Both zinc and iron, 4. placebo. Infants received supplements daily for 6 months. All children received one dose of 1,500 µg retinol equivalent (RE) vitamin A at the beginning of the study. Length of exposure: 6 months Scale: 609 infants, including the placebo group	Each group was compared independently to each of the other groups	4–6 months old	9 years old
Berlinski and others 2008 [5850]	Preschool	Uruguay	Started in 1995. The evaluated intervention is whether a child	Children who did not attend either public or private preschool	3–5 years old	7–15 years old

Study	Name of Intervention	Country	Description	Counterfactual	Age at Intervention	Age at Evaluation
			attended either a public or private preschool. The increase in preschool attendance was triggered by a government program to build new classrooms and hire more preschool teachers. Length of exposure: 1–3 years Scale: National			

- Scale indicates the size of the treatment group.
- *Children are eligible for some portion of Progresa through the end of high school, but for the purposes of this review, the estimates are limited to those who enrolled during the early childhood period,
- **Some of the matched sample outcomes are estimated for children up to 14 years old. However, since this review focuses on the effect of receiving Progresa during the early childhood period, only estimates for children up to 11 years old (5 years old at baseline) are used.
- ***When the control group, which received vitamin A supplements, is included, there were 4926 participants.

Appendix B. Complete List of Outcomes Appearing in Included Studies

List of Unique Outcomes[1]	Source (Endnote ID)
Ability to read a story	8222
Age at 1st grade entry	5117 (iron and zinc), 5117 (iron), 5117 (zinc), 8242 (ages 7–8 girls, T1998 v T1999),* 8242 (9–11 girls, T1998 v T1999), 8242 (7–11 girls, T1998 v T1999), 8242 (7–8 boys, T1998 v T1999), 8242 (9–11 boys, T1998 v T1999), 8242 (7–11 boys, T1998 v T1999), 8242 (7–8 girls, T1998 v C2003),* 8242 (9–11 girls, T1998 v C2003), 8242 (7–11 girls, T1998 v C2003), 8242 (7–8 boys, T1998 v C2003), 8242 (9–11 boys, T1998 v C2003), 8242 (7–11 boys, T1998 v C2003)
Allergies (at least one antigen)	8190
Allergies cat	8190
Allergies house dust mite	8190
Allergies to birch pollen	8190
Alternarianorthern grasses	8190
Anthropometirc index	8278 (girls), 8278 (boys)
Anti-social behavior	379
Anxiety	379,*** 5602 (stimulation), 5602 (supplementation),* 5839
Appropriate grade for age	8261**
Attention-Concentration	8277 (8–14 yr),** 8277 (15–19 yr), 8277 (20–24 yr)
Attention (map search)	5547 (map search), 5547 (Opposite-same switching)
Attention deficit	379,** 5602 (stimulation),** 5602 (supplementation), 5839
Blood pressure (SBP or DBP > 90th percentile)	8256 (folic acid), 8256 (folic acid + iron), 8256 (folic acid + iron + zinc), 8256 (multiple micronutrient)
Block designs	4693

APPENDIX B
COMPLETE LIST OF OUTCOMES APPEARING IN INCLUDED STUDIES

List of Unique Outcomes[1]	Source (Endnote ID)
BMI	5117 (iron and zinc), 5117 (iron), 5117 (zinc), 8187, 8228, 8252 (male), 8252 (female), 8254
BMI ≥85th percentile	8187**
BMI ≥95th percentile	8187*
BMI z score	5117 (iron and zinc), 5117 (iron), 5117 (zinc), 8237, 8274
Body fat	8187, 8252 (male), 8252 (female)
Child is able to count to 20	8261*
Child is able to recognize geometric shapes	8261**
Child is able to remember things easily	8261**
Child is able to say which number is bigger between two	8261***
Child is able to sort and classify objects by a common characteristics (e.g., shape, color, size)	8261**
Child is able to use one-to-one correspondence	8261***
Child is experimenting with writing tools	8261**
Child is interested in games involving numbers	8261*
Child is interested in mathematics	8261**
Cognition index	8278 (girls), 8278 (boys)***
Cognitive assessment score	8274*
Cognitive development	8237
Cognitive development and language	8261**
Cognitive disorganization	5839**
Cognitive perceptual	5839
Cognitive problems or lack of attention	379

List of Unique Outcomes[1]	Source (Endnote ID)
Communication	8261*
Communication and general knowledge	8261
Conduct disorder	5839***
Conduct problems	1383 (assessed by parent), 1383 (assessed by teacher)
Corsi blocks	5544 (stimulation + both interventions), 5547***
Cough in the last 4 weeks	8261
Court-reported criminal offenders	5839*
Depression	379,** 5602 (stimulation),** 5602 (supplementation)
Diastolic blood pressure	8228, 8253, 8254
Digit span	5547
Digit span backward	5544 (stimulation + both interventions), 8251, 8255, 8278
Digit span forward	5544 (stimulation + both interventions), 8198 (stimulation), 8198 (supplementation), 8251, 8255, 8278*
Disorganized	5839
DPT: number of immunizations	8222
DPT: proportion of children receiving all immunizations	8222
Early reading	5547
EEG (electroencephalogram) during continuous performance task	5156
Emotional maturity	8261
Emotional symptoms	1383 (assessed by parent), 1383 (assessed by teacher)

APPENDIX B
COMPLETE LIST OF OUTCOMES APPEARING IN INCLUDED STUDIES

List of Unique Outcomes[1]	Source (Endnote ID)
Employed	8275*
Employed full-time	8275
Employed in Nontemporary Job	8275
English	5117 (iron and zinc), 5117 (iron), 5117 (zinc)
Ever gone to school	8261**
Ever had asthma	8190
Ever had hay fever symptoms	8190
Ever had wheezing	8190
Ever sick in the last 4 weeks	8261**
Exams	1715 (passed 4 or more CXC exams), 1715** (passed at least one Caribbean Advanced Proficiency Examination), 1715* (passed at least one CXC exam)
Externalizing behavior scores	1383 (assessed by parent), 1383 (assessed by teacher)
FFMI	8187, 8252 (male), 8252 (female)
FMI	8187, 8252 (male), 8252 (female), 8254
Full-scale IQ	4693,* 5117 (iron and zinc), 5117 (iron), 5117 (zinc), 5602 (stimulation),*** 5602 (supplementation)
General intelligence - first component	8251**
General Knowledge	5602 (stimulation),*** 5602 (supplementation)
Glucose	8254,** 8256 (folic acid), 8256 (folic acid + iron), 8256 (folic acid + iron + zinc), 8256 (multiple micronutrient)
Gross motor coordination	8261
Had diarrhea in the last 4 weeks	8261
Had skin problems in the last 4 weeks	8261

List of Unique Outcomes[1]	Source (Endnote ID)
Hay fever symptoms in past 12 months	8190
HDL cholesterol	8254, 8256 (folic acid), 8256 (folic acid + iron), 8256 (folic acid + iron + zinc), 8256 (multiple micronutrient)
Head circumference	5425 (supplementation), 5425 (home visits), 5425 (supplementation + home visits), 8187, 8228*
Height	5117 (iron and zinc), 5117 (iron), 5117 (zinc), 8187, 8251
Height for age z score	5117 (iron and zinc),* 5117 (iron), 5117 (zinc), 5425 (supplementation),*** 5425 (home visits),** 5425 (supplementation + home visits), 5544 (supplementation + stimulation), 5544 (supplementation), 5544 (stimulation), 5549 (supplementation + stimulation), 5549 (supplementation), 5549 (stimulation), 8222, 8251, 8261, 8274, 8278
Hepatitis: number of immunizations	8222
Hepatitis: proportion of children receiving all immunizations	8222
Highest grade completed	4845 (men), 4845 (women),** 5602 (stimulation),** 5602 (supplementation), 8222, 8237, 8242 (6–8 girls, T1998 v T1999), 8242 (9–11 girls, T1998 v T1999), 8242 (6–8 boys, T1998 v T1999), 8242 (9–11 boys, T1998 v T1999), 8242 (9–11 girls, T1998 v C2003),*** 8242 (6–8 boys, T1998 v C2003), 8242 (9–11 boys, T1998 v C2003),*** 8255, 8277 (8–14 yr),*** 8277 (15–19 yr), 8277 (20–24 yr)
Hip circumference	8187
HOME scores at end of trial	1715***
Hours spent doing housework per week	8222
Hours spent studying per day	8222
How many of your students pay attention in class	8197**
How many of your students put a large amount of effort into understanding explanations?	8197**
How many of your students regularly participate in your class?	8197**
How many students are well disciplined in the classroom?	8197

APPENDIX B
COMPLETE LIST OF OUTCOMES APPEARING IN INCLUDED STUDIES

List of Unique Outcomes[1]	Source (Endnote ID)
Hyperactivity	379
Hyperactivity (SDQ)	1383 (assessed by parent), 1383 (assessed by teacher)
IGF-I	8187
Incisor DMFT	8227
Internalizing behavior scores	1383 (assessed by parent), 1383 (assessed by teacher)
Interpersonal deficits	5839
Involved in a physical fight	5602 (stimulation),** 5602 (supplementation)
Involved in violent crime	5602 (stimulation),** 5602 (supplementation)
Language development	8237**
Language test score	8197,** 8277 (8–14 yr), 8277 (15–19 yr), 8277 (20–24 yr)
LDL cholesterol	8254
Leg length	8187, 8228
LMI	8254
Log earnings (various versions)	8275
Log insulin	8254
Long-term memory	8278
Looking For Work	1715
Mathematics (school-specific test)	4138,*** 4693, 5117 (iron and zinc), 5117 (iron), 5117 (zinc), 8197**
Mathematics (WRAT)	5602 (stimulation),** 5602 (supplementation), 8198 (stimulation), 8198 (supplementation)
Mathematics (Early Grade Mathematics Assessment)	8222 (overall), 8222 (arithmetic),* 8222 (shape recognition)

List of Unique Outcomes[1]	Source (Endnote ID)
Mean arterial pressure	8253
Mid-upper-arm circumference	5117 (iron and zinc), 5117 (iron), 5117 (zinc), 8187, 8228
Midthigh circumference	8228**
Migration	1715* (full baseline sample), 1715** (sample found at follow-up)
Motor excess	5839**
No. secondary level examination passes	5602 (stimulation),* 5602 (supplementation)
Number of days ill in the last 15 days	8222
Number of days of school missed in a usual month	5538***
Oppositional behavior	379*
Orientation	8277 (8-14 yr),** 8277 (15-19 yr), 8277 (20-24 yr)
Other subjects	4693
Overweight	8237
Peer problems	1383 (assessed by parent), 1383 (assessed by teacher)
Percentage in each current grade- 2,3,4	5117 (iron and zinc), 5117 (iron), 5117 (zinc)
Performance IQ	4693, 5117 (iron and zinc), 5117 (iron), 5117 (zinc), 5602 (stimulation),*** 5602 (supplementation), 8198 (stimulation),* 8198 (supplementation)
Physical health and well-being	8261
Polio: number of immunizations	8222
Polio: proportion of children receiving all immunizations	8222
Positive Schizotypal personality	5839**
Peabody Picture Vocabulary Test (Receptive Vocabulary)	5544 (stimulation + both interventions), 5547, 8198 (stimulation),** 8198 (supplementation), 8251*

APPENDIX B
COMPLETE LIST OF OUTCOMES APPEARING IN INCLUDED STUDIES

List of Unique Outcomes[1]	Source (Endnote ID)
Precise motor coordination	8261*
Primary school drop-out	5850 (7 yr),*** 5850 (8 yr),** 5850 (9 yr), 5850 (10 yr), 5850 (11 yr), 5850 (12 yr), 5850 (13 yr),*** 5850 (14 yr),** 5850 (15 yr),*** 8261
Primary school enrollment	8261***
Probability of attending school	769 (13–17 yrs),** 769 (8–12 yrs)
Probability of completing primary school	5850 (7 yr), 5850 (8 yr), 5850 (9 yr), 5850 (10 yr), 5850 (11 yr),*** 5850 (12 yr), 5850 (13 yr),*** 5850 (14 yr),*** 5850 (15 yr)***
Probability of dealyed enrollment	8222
Probability of enrolling primary school at age 6	5538*
Probability of grade repetition	8222
Probability of illness in the last 15 days	8222
Probability of passing a grade between 2002 and 2003	769 (13–17 yrs),* 769 (8–12 yrs)
Problem solving	8261**
Process speed	8278**
Progressing through school on time	8237, 8242 (9–11 girls, T1998 v T1999), 8242 (9–11 boys, T1998 v T1999), 8242 (9–11 girls, T1998 v C2003),*** 8242 (9–11 boys, T1998 v C2003)**
Proportion of children with incisor DMFT>=1	8227
Proportion of children with total DMFT>=1	8227
Proportion with incisor DMFT ≥2	8227
Proportion with total DMFT ≥2	8227
Prosocial behavior	1383 (assessed by parent), 1383 (assessed by teacher)
Psychotic behavior	5839**
Pulse pressure	8253*

List of Unique Outcomes[1]	Source (Endnote ID)
Raven's matrices (nonverbal cognition)	4693, 4845,** 5117 (iron and zinc), 5117 (iron), 5117 (zinc), 5544 (stimulation + both interventions),** 8251,*** 8255, 8278,** 8198 (stimulation),* 8198 (supplementation)
Raw Changana	8261
Raw Portuguese	8261
Reading	4138,*** 4693,* 4845,** 5547, 5602 (stimulation),*** 5602 (supplementation), 8198 (context, stimulation),*** 8198 (sentence, stimulation),*** 8198 (context, supplementation), 8198 (sentence, supplementation), 8222, 8237
Recall	8277 (8–14 years old), 8277 (15–19 years old), 8277 (20–24 years old)
Recurrent itchy rash	8190
Registration	8277 (8–14 years old),*** 8277 (15–19 years old), 8277 (20–24 yeasr old)
Resting EEG	5156
Risk for metabolic syndrome	8256 (folic acid), 8256 (folic acid + iron), 8256 (folic acid + iron + zinc), 8256 (multiple micronutrient)
Risk of microalbuminuria	8256 (folic acid),* 8256 (folic acid + iron), 8256 (folic acid + iron + zinc),* 8256 (multiple micronutrient)
Schizotypal personality total score	5839
School attendance	5850 (7 yr),** 5850 (8 yr),** 5850 (9 yr),* 5850 (10 yr), 5850 (11 yr), 5850 (12 yr),** 5850 (13 yr),*** 5850 (14 yr),*** 5850 (15 yr)***
Schooling (any college)	1715*
Schooling (any vocational training)	1715
Schooling (In school full time)	1715***
Schooling (In school)	1715***
Science	5117 (iron and zinc), 5117 (iron), 5117 (zinc)
Search	5544 (stimulation + both interventions)
Self-esteem	379**

APPENDIX B
COMPLETE LIST OF OUTCOMES APPEARING IN INCLUDED STUDIES

List of Unique Outcomes[1]	Source (Endnote ID)
Self-reported criminal offenders	5839**
Short-term memory	8278*
Similarities	4693**
Skills (Cognitive factor)	1715***
Skills (Ever expelled from school)	1715**
Skills (Externalizing Behavior factor)	1715
Skills (Internalizing Behavior factor)	1715**
Skin conductance arousal - level	5156***
Skin conductance orienting - latency	5156
Skin conductance orienting -amplitude	5156***
Skin conductance orienting -recovery times	5156***
Skin conductance orienting -rise time	5156***
Skinfold thickness	5425 (supplementation), 5425 (home visits), 5425 (supplementation + home visits), 8187 (subscapular), 8187 (triceps), 8228 (subscapular), 8228 (triceps)
Social competence	8261
Social inhibition	5602 (stimulation),** 5602 (supplementation)
Social science	4138***
Socialized aggression	5839
Standardized Changana	8261
Standardized Portuguese	8261
Strength and Difficulties Questionnaire (total difficulties)	8274 (cash), 8274 (conditionalities),** 8237,** 1383 (assessed by parent), 1383 (assessed by teacher), 5547**

List of Unique Outcomes[1]	Source (Endnote ID)
Stroop (Executive Function)	5544 (stimulation + both interventions)
Stunting	8222, 8237, 8251, 8261
Systolic blood pressure	8228, 8253, 8254
Thai language	5117 (iron and zinc), 5117 (iron), 5117 (zinc)
Time use (caring for children, elders and sick)	8261
Time use (Community Meetings)	8261***
Time use (household chores)	8261
Time use (play)	8261
Time use (school and homework)	8261***
Time use (sleep)	8261
Time Use (work at family's plot)	8261**
Total ASQ score	8261**
Total cholesterol	8254
Total DMFT	8227
Total number of teeth	8227
Total number of teeth with cavities	8227
Total number of teeth with fillings	8227
Triglycerides	8254, 8256 (folic acid), 8256 (folic acid + iron), 8256 (folic acid + iron + zinc), 8256 (multiple micronutrient)
Trunk fat	8252 (male), 8252 (female)
Verbal analogies	5544 (stimulation + both interventions), 8198 (stimulation),** 8198 (supplementation)

APPENDIX B
COMPLETE LIST OF OUTCOMES APPEARING IN INCLUDED STUDIES

List of Unique Outcomes[1]	Source (Endnote ID)
Verbal assessment score	8274***
Verbal fluency: animals	8251**
Verbal fluency: foods	8251*
Verbal IQ	4693,** 5117 (iron and zinc), 5117 (iron), 5117 (zinc), 5602 (stimulation),*** 5602 (supplementation), 8198 (stimulation),** 8198 (supplementation)
Visual spatial working memory	8198 (stimulation), 8198 (supplementation)
Vocabulary	4693,** 5544 (stimulation + both interventions),** 8255, 8278**
Waist circumference	8187, 8228, 8256 (folic acid + iron), 8256 (folic acid + iron + zinc), 8256 (multiple micronutrient)
Waist:hip ratio	8187, 8228
Wasting	8261
Weapon use	5602 (stimulation), 5602 (supplementation)
Weight	5117 (iron and zinc), 5117 (iron), 5117 (zinc), 8252 (male), 8252 (female)
Weight for age z score	5117 (iron and zinc), 5117 (iron), 5117 (zinc), 5425 (supplementation),* 5425 (home visits), 5425 (supplementation + home visits), 5549 (supplementation + stimulation), 5549 (supplementation), 5549 (stimulation), 8261, 8278
Weight for height z score	5425 (supplementation), 5425 (home visits), 5425 (supplementation + home visits)
Wheezing in past 12 months	8190
Whether the child does housework	8222
Whether the child studied in the last week	8222
Freedom from distractability (WISC-III index scores)	5117 (iron and zinc), 5117 (iron), 5117 (zinc)
WISC-III index scores perceptual organization	5117 (iron and zinc), 5117 (iron), 5117 (zinc)
WISC-III index scores verbal comprehension	5117 (iron and zinc), 5117 (iron), 5117 (zinc)

List of Unique Outcomes[1]	Source (Endnote ID)
WISC-III index scoresProcessing Speed Index	5117 (iron and zinc), 5117 (iron), 5117 (zinc)
WISC-R Full-scale	5544 (stimulation + both interventions)**
WISC-R Performance	5544 (stimulation + both interventions)*
WISC-R Verbal	5544 (stimulation + both interventions)**
WPPSI Full-Scale	5547
WPPSI Performance	5547**
WPPSI Verbal	5547
Writing	4693
Years of schooling	5850 (7 yr),** 5850 (8 yr), 5850 (9 yr), 5850 (10 yr), 5850 (11 yr),** 5850 (12 yr),*** 5850 (13 yr),*** 5850 (14 yr),*** 5850 (15 yr),*** 1715*

[1] **Bolded** outcome names indicate categories that are evaluated in this report.

Appendix C. Search Strategy to Identify Most Relevant Studies

The data for the systematic review originate from completed (or nearly completed) impact evaluations (IEs) of early childhood development (ECD) interventions that provided estimates on post-ECD outcomes. Potential IEs were identified through a detailed search strategy developed for *Delivering the Millennium Development Goals to Reduce Maternal and Child Mortality: A Systematic Review of Impact Evaluation Evidence* (IEG 2013) and built on existing systematic review frameworks (Card and others 2010; Drabo, Perez-Arce, and Yoong 2011; IEG 2010, 2011). The search strategy included three rounds of data collection. Potential IEs were then submitted to a full text review and, if they qualified as impact evaluations of ECD interventions with post-ECD outcomes, the coding process (see coding strategy for additional information).

Three categories of search terms were identified to capture studies of interest, using a pilot test to modify the terms as necessary. These terms provided the basis for the bibliographic database search that took place during the first round and identified the majority of potential IEs. Round A also included searches of other research, IE, and donor organizations, World Bank databases, top economic journals, and the curriculum vitae of top health economists. Where possible, the title, subject, and abstract for each result were examined. From Round 1, after eliminating duplicates, 1,937 potential IEs were gathered.

Rounds B and C served as comprehensiveness checks. During Round B, the reference lists were reviewed of systematic reviews that focused on early childhood development. Looking first at title, then subject and abstract (if available), 12 potential IEs were identified. Round C involved reviewing the curriculum vitae of the most prolific authors for missing studies and conducting a snowballing activity in which the reference lists for all of the studies selected for coding were reviewed. As a result, 193 potential IEs were found.

Search Terms

Three categories of search terms were used based on the authors' knowledge of ECD literature to allow capture of studies that used appropriate experimental or quasi-experimental methods to estimate the impact on ECD outcomes in low- or middle-income countries.[1,2] The three search term categories are outcomes (A), methods (B), and low- or middle-income country (C). Each search term category has a universe of related search terms likely to be found in the title, subject, or abstract of relevant studies. Note

that country names in this third category are search terms only and are not official country names. The search term categories should be joined by AND, while the list of search terms should be joined by OR:

A. Outcomes

(early childhood development) OR (early childhood education) OR (early childhood care) OR (infant development) OR (child cognitive development) OR (child linguistic development) OR (child socioemotional development) OR (child physical development) OR (child growth)

AND

B. Methods

(impact) OR (effectiveness) OR (randomized control trial) OR (randomized trial) OR (control trial) OR (RCT) OR (counterfactual) OR (natural experiment) OR (experimental) OR (quasi experimental) OR (difference in difference) OR (double difference) OR (regression discontinuity) OR (matching) OR (instrumental variable) OR (fixed effects) OR (control area) OR (treatment area) OR (control group) OR (treatment group) OR (panel data)

AND

C. Low- or Middle-Income Country

(Afghanistan) OR (Albania) OR (Algeria) OR (American Samoa) OR (Angola) OR (Antigua and Barbuda) OR (Argentina) OR (Armenia) OR (Azerbaijan) OR (Bangladesh) OR (Belarus) OR (Belize) OR (Benin) OR (Bhutan) OR (Bolivia) OR (Bosnia and Herzegovina) OR (Botswana) OR (Brazil) OR (Bulgaria) OR (Burkina Faso) OR (Burundi) OR (Cambodia) OR (Cameroon) OR (Cape Verde) OR (Central African Republic) OR (Chad) OR (Chile) OR (China) OR (Colombia) OR (Comoros) OR (Congo) OR (Republic of Congo) OR (Costa Rica) OR (Côte d'Ivoire) OR (Ivory Coast) OR (Cuba) OR (Djibouti) OR (Dominica) OR (Dominican Republic) OR (Ecuador) OR (Egypt) OR (El Salvador) OR (Eritrea) OR (Ethiopia) OR (Fiji) OR (Gabon) OR (Gambia) OR (Georgia) OR (Ghana) OR (Grenada) OR (Guatemala) OR (Guinea) OR (Guinea-Bissau) OR (Guyana) OR (Haiti) OR (Honduras) OR (India) OR (Indonesia) OR (Iran) OR (Iraq) OR (Jamaica) OR (Jordan) OR (Kazakhstan) OR (Kenya) OR (Kiribati) OR (Korea) OR (Kosovo) OR (Kyrgyz Republic) OR (Kyrgyzstan) OR (Laos) OR (Latvia) OR (Lebanon) OR (Lesotho) OR (Liberia) OR (Libya) OR (Lithuania) OR (FYR Macedonia) OR (Madagascar) OR (Malawi) OR (Malaysia) OR (Maldives) OR (Mali) OR (Marshall Islands) OR (Mauritania) OR (Mauritius) OR (Mayotte) OR (Mexico) OR (Micronesia)

OR (Moldova) OR (Mongolia) OR (Montenegro) OR (Morocco) OR (Mozambique) OR (Myanmar) OR (Namibia) OR (Nepal) OR (Nicaragua) OR (Niger) OR (Nigeria) OR (Pakistan) OR (Palau) OR (Panama) OR (Papua New Guinea) OR (Paraguay) OR (Peru) OR (Philippines) OR (Romania) OR (Russia) OR (Rwanda) OR (Samoa) OR (São Tomé and Principe) OR (Senegal) OR (Serbia) OR (Seychelles) OR (Sierra Leone) OR (Solomon Islands) OR (Somalia) OR (South Africa) OR (South Sudan) OR (Sri Lanka) OR (St. Kitts and Nevis) OR (St. Lucia) OR (St. Vincent and the Grenadines) OR (Sudan) OR (Suriname) OR (Swaziland) OR (Syrian Arab Republic) OR (Tajikistan) OR (Tanzania) OR (Thailand) OR (Timor-Leste) OR (East Timor) OR (Togo) OR (Tonga) OR (Tunisia) OR (Turkey) OR (Turkmenistan) OR (Tuvalu) OR (Uganda) OR (Ukraine) OR (Uruguay) OR (Uzbekistan) OR (Vanuatu) OR (Venezuela) OR (Vietnam) OR (West Bank and Gaza) OR (Yemen) OR (Zambia) OR (Zimbabwe) OR (Latin America) OR (Central America) OR (Caribbean) OR (Eastern Europe) OR (South Asia) OR (Southeast Asia) OR (Africa)

Round A: **Bibliographic** *Databases*

The search term categories guided the search of relevant bibliographic databases. The ideal search strategy was the combination of A , B, and C, although the exact search terms were adapted to each database to exclude high numbers of irrelevant results. General statistics on the number of results yielded from each database are provided in table C.1.

Table C.1. Statistics on the Number of Results Yielded from Each Database

Database	Total Results	Potential Impact Evaluations
EconLit	39	14
Science Direct*	7,785 (3,350) 5,580 (4,976)	916 205
PopLine	1,591 (442)	103
Dialog	55	31
PubMed/MedLine*	1435 2200	121 105
ERIC	105	14
ArticleFirst	4	2
WorldCat	52	10

Note: Two separate searches were performed in Science Direct and PubMed because, when reviewing references from systematic reviews, the original search strategy had missed many relevant IEs that were in these two databases. Consequently a second, more exhaustive search was undertaken. Each row of numbers reflects a different search, and the total results are undoubtedly inflated due to duplicates between the two different searches.

From the total results for each database, titles, subjects, and abstracts were reviewed to identify the relevant IEs. As Science Direct and PopLine returned such a high number of results, an automatic export feature was used to export all of the results into an Excel

file where irrelevant studies were quickly eliminated.[3] The number given in parenthesis is the number of studies for which the title and abstract were reviewed.

IE-Focused *Organizations*

Three organizations were identified that offered online databases of impact evaluations. Broad search terms were used to find publications on the following two websites and 13 relevant IEs were identified:

- Abdul Latif Jameel Poverty Action Lab (J-PAL)
- Innovations for Poverty Action (IPA)

Relevant *Research Organizations*

Institutions that are involved in relevant ECD research were identified, although they are not focused solely on impact evaluation. Their websites were searched for publications, and the results are presented in table C.2.

Table C.2. Statistics on the Number of Results Yielded from Each Database

Organization Name	Potential IEs
Population Council	6
IFPRI	13
RAND	10
IZA	5
GDN	4
BREAD	4

Supplemental Sources

While the majority of results were expected to be found through the bibliographic databases noted above, a number of searches in various supplemental sources were conducted. Additional potential IEs were obtained, and this method also served as an additional check on the comprehensiveness of the initial bibliographic search strategy.

The Lancet

ECD experts identified two relevant series from *The Lancet* and reviewed the references to identify potential impact evaluations. Given that the determination was made strictly on title, more emphasis was placed on inclusion and about 300 were identified. The series were Child Development in Developing Countries (2007) and Child Development in Developing Countries 2 (2011).

World Bank Databases

The bibliographic database searches yielded some impact evaluations of World Bank projects or implemented by World Bank staff. Nonetheless, World Bank databases were checked to identify additional IEs that included outcomes of interest. Reliance was placed primarily on an IE database compiled by IEG for the report entitled *The World Bank Group Impact Evaluations: Relevance and Effectiveness,* which includes IEs from the DIME database, IEs identified by literature reviews for previous IEG reports, or other IEs provided to the IEG team by World Bank staff (IEG 2012). Also searched was the World Bank Safety Nets Publications Database. Together, these databases yielded 61 potential IEs.

Other

The remaining potential impact evaluations were found through seminars attended, personal knowledge of the team, or word of mouth.

Round B: Systematic Reviews

Examined were reference lists of 39 systematic reviews that focused on ECD. Each title was examined, followed by an assessment of the abstracts of those that seemed relevant. Those that passed this scrutiny were marked for a full-text review.

Round C: Most Prolific Authors and Snowballing

Subsequent to undertaking the extensive search in Rounds A and B, the team refined the scope of the report to focus on post-ECD effects of ECD interventions. Consequently, Round C was particularly important in the search process as the initial database search terms were concentrated on ECD outcomes.

Most Prolific Authors

The impact evaluations of ECD interventions that estimate effects on non-ECD outcomes were used to create a list of the most prolific authors who focused on post-ECD outcomes (table C.3). This was done by tabulating the number of times an author's name appeared in the byline of these studies. Their curriculum vitae were browsed to find additional relevant publications. Although those of Susan P. Walker, Susan M. Chang, and Christine A. Powell were not available online, most of their previous work had been done in conjunction with Sally Grantham-McGregor. In sum, 39 new potential IEs were identifed, four of which were passed on for full coding.

Table C.3. Most Prolific Authors Who Focus on Post-ECD Outcomes

Names of Most Prolific Authors	
Sally Grantham-McGregor	Huiman Xie Barnhart
Susan P. Walker	Paul Gertler
Susan M. Chang	Michael S. Kramer
Christine A. Powell	John Hoddinott
Jere Behrman	John Maluccio

Snowballing

As part of the coding process, the reference list of each relevant impact evaluation was examined. Similar to the approach for the reference lists of the systematic reviews, relevant titles were identifed, subjects and abstracts checked, and duplicates eliminated. As a result, 154 potential IEs were gatehred, nine of which were selected for full coding.

2015 Update

The original search ended in fall, 2013, and was updated in February – March 2015. All of the bibliographic databases listed in Table C.1, as well as the DIME database, new systematic reviews, and the CVs of the most prolific authors were re-searched for IEs published from 2013 – 2015. This produced more than 3000 results, 184 of which were exported for additional screening after a review of the title and abstract.

Screening *Studies*

Inclusion and exclusion criteria were applied to the titles, subjects, and abstracts of the studies to generate a list of potential IEs:

- Outcomes: Studies that evaluate ECD outcomes were included.
- Study design: Studies that evaluate interventions based on quantitative experimental or quasi-experimental IE design with a well-defined counterfactual were included.
- Location: Studies were selected that occurred in a country meeting the low- and middle-income specifications for the International Bank for Reconstruction and Development and the International Development Association.
- Language: The search focused on studies in English, though studies in Spanish, French, and Portuguese were found and included.
- Publication date: Studies published since January 1, 1990, and after were included.
- Unit of analysis: Studies that use regional or national time series data were excluded.
- Peer Review: IEs that have been subjected to peer review (for example, published in a quality journal or a book) or are in the process of eliciting

feedback from the research community (such as working papers or papers presented in conferences) were be included.

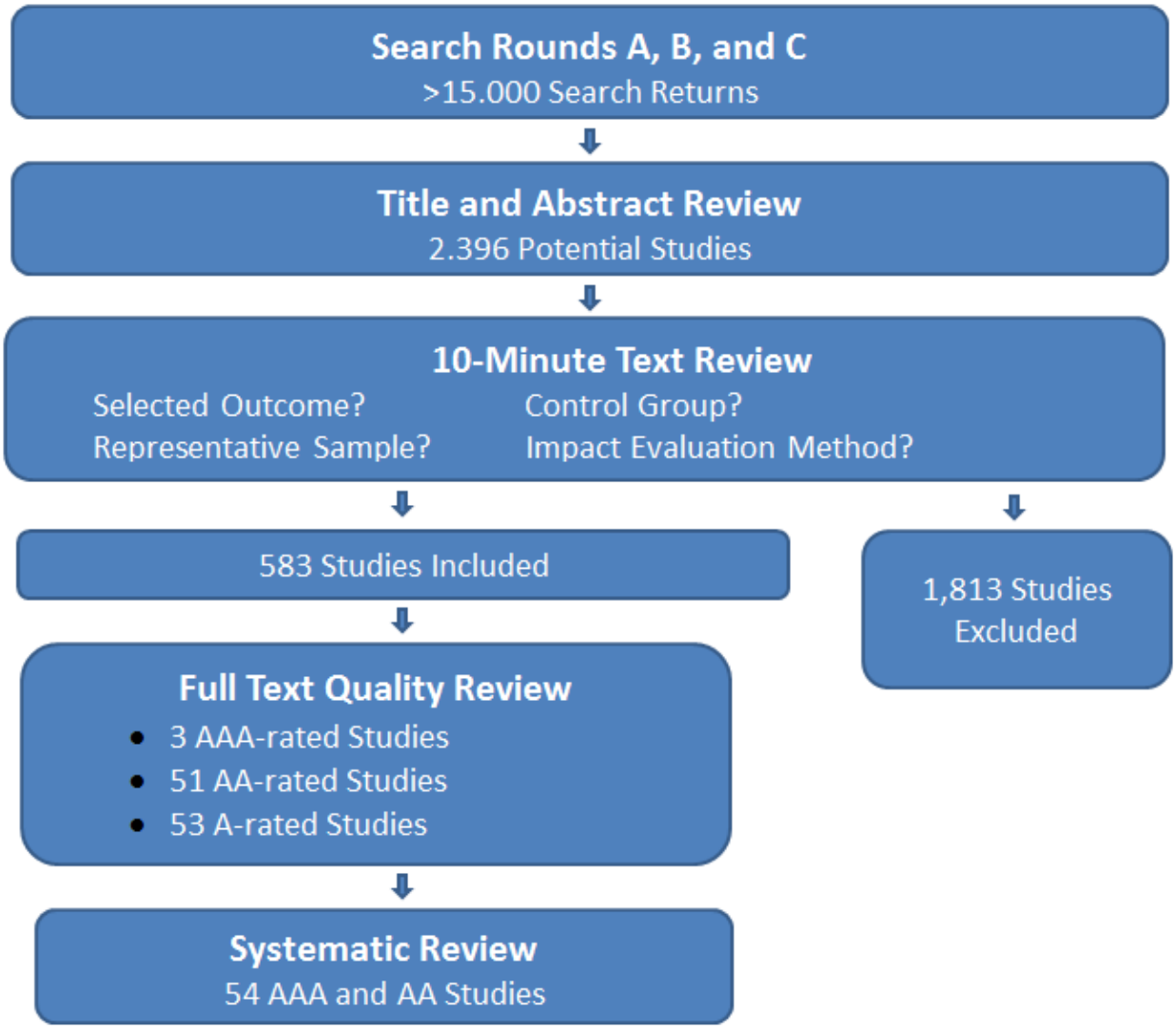
- Nonclinical interventions: Following the advice in the World Bank's handbook *Impact Evaluation in Practice* (Gertler and others 2011) that results are most useful for government and development workers when they are the result of interventions that take place "under normal circumstances, using regular implementation channels," interventions were only included if they were implemented using local capacity.

The titles, subjects, and abstracts did not always provide enough information to determine if the study met the selection criteria, particularly regarding outcomes and study design. When unclear, the study was included as a potential IE for more consideration. A full text review of all potential IEs were performed, and those that qualified as IEs of the selected outcomes were coded (see coding strategy).

Search *Results*

IEG reviewed more than 15,000 search results across Rounds A, B, and C (figure C.1). From a title and abstract review of these, 2,142 potential studies were identified. After a further 10-minute text review of these studies, 552 were included as IEs of ECD interventions on a representative sample, of which 73 looked at post-ECD outcomes and received a full text review for quality, resulting in 3 AAA, 34 AA, and 39 A studies.

Figure C.1. Search Results



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Gertler, Paul J., Sebastian Martinez, Patrick Premand, Laura B. Rawlings, and Christel M.J. Vermeersch. 2011. *Impact Evaluation in Practice*. Washington, DC: World Bank.

IEG (Independent Evaluation Group). 2010. *What Can We Learn from Nutrition Impact Evaluations.* Washington, DC: World Bank.

_____. 2011. *Evidence and Lessons Learned from Impact Evaluations on Social Safety Nets.* Washington, DC: World Bank.

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[1] The team first searched for impact evaluations (IEs) that provided estimates for any early childhood development (ECD) outcome. The full-text review was then used identify IEs that evaluated interventions that took place from birth to five years old and reported estimates for post-ECD outcomes.

[2] Initially, the team used a broad set of outcome terms, which resulted in the identification of studies measuring non-ECD outcomes. However, further research revealed that the outcome domains adequately identified studies reflecting a range of interventions. The following is a broader set of key terms used for the pilot study:

(pre-primary education) OR (early stimulation) OR (nutrition) OR (pre-natal care) OR (parent education) OR (early childhood development) OR (early childhood education) OR (early childhood care) OR (immunization) OR (child health) OR (conditional cash transfer) OR (reduced drop-out) OR (cognitive development) OR (age appropriate school entry) OR (earnings) OR (reduced criminal behavior) OR (birth weight) OR (anthropometric indicators) OR (child mortality) OR (stunting) OR (breast feeding) OR (growth monitoring) OR (maternal mortality)

[3] To search studies in Excel, the title and abstract were exported and a search run that would identify if certain terms appeared in either. If the study contained any of these terms in the title or abstract, it was passed on for a manual title and abstract review. The terms included were:

"Early childhood development" "Early childhood education" "Early childhood care" "Early child care" "infant development" "child cognitive development" "child linguistic development" "child socioemotional development" "child socio emotional development" "child physical development" "child growth" "child health" "child nutrition" "preschool" "pre school" "preschool" "neonatal" "child development" "child" "infant" "under 6" "under 5" "under five" "under six."

Appendix D. Coding Approach and Instruments

After identifying studies based on a title and abstract review as outlined in the search strategy, the potential impact evaluations were retrieved and read in full, and the following approach was used to code the documents. This coding strategy was based on the one used in "Delivering the Millennium Development Goals to Reduce Maternal and Child Mortality: A Systematic Review of Impact Evaluation Evidence."

Step 1: 10-Minute Review

Each study received a 10-minute review, or a brief full-text examination, to find the information described below. If the answer to any of the questions below was no, the study was not included for coding.

- Intervention of interest: Does the study evaluate an intervention that targeted either pregnant women or children under six years old.
- Counterfactual: Does the study use a counterfactual, that is, information on others who do not receive the treatment to proxy for what would have happened in the absence of the treatment? Studies that use time-series or before-after observations on the same treatment group but do not have a comparison group are not to be included. Studies without a control group but that provide convincing exogenous variation in the treatment were placed in a separate folder in EndNote for potential use.
- Impact evaluation method: Does the study utilize an appropriate impact evaluation method: randomized experiment, double or triple difference, matching, instrumental variable, regression discontinuity, or other IE method?
- Representative: Does the study take place in a country that meets the low- and middle-income specifications of the International Bank for Reconstuction and Development and the International Development Asociation, and outside of a controlled environment and in a real-world context (for example, not in a lab)?
- Effectiveness: Was the interventions implemented using local capacity so that it can be replicated by local implementers?
- Post-ECD outcomes: Does the study estimate the effect of the intervention on the recipients for outcomes that are measured after the beginning of primary school (approximately six years old).

Step 2: Quality Rating

For each study that passed the 10-minute review, the full text was read and a quality rating determined. Internal validity was the primary consideration, but also factored in

were any other major concerns with the study (for example, data collection methods, sample size and representativeness, power, policy replicability).

Each study was double coded (two junior coders filled out the Quality and Evaluation Design section and provided a quality rating), and any disputes were settled after a third reading and rating by a senior coder.

The attached coding instrument provides each variable included in the Quality and Evaluation Design section, while key questions requiring additional guidance are outlined below.

- Assessment of internal validity/quality of evaluation design is done vis-à-vis the estimation strategy used to evaluate impacts (see box D.1). The starting point is then to first identify the evaluation design (randomized or quasi-experimental) and IE methods (difference-in-differences, matching, instrumental variables, or regression discontinuity) used to identify impacts by the study. Subsequently, reviewers assessed whether the relevant identification assumptions have been satisfied or adequately discussed, and coded this information as all, some, or none (that is, all, some, or none of the identification assumptions have been satisfied) for each of the methods used in study. Note that in adjacent columns where reviewers coded the extent to which assumptions have been satisfied, they were expected to document the reasons why they coded it as all, some, or none.
- Assessment of the strength and stability of findings, usually achieved through various types of robustness checks. After determining the main impact evaluation method, robustness checks were coded based on the following questions:

    - Did the IE use multiple estimation methods?
    - Did the IE use multiple specifications?
    - Did the IE perform other robustness analyses (for instance, falsification tests, alternative ways to measure the treatment, multiple control groups, sensitivity analysis and bounds)?
    - Was there a problem with missing data (e.g. attrition above 40 percent, refusal to participate?)
    - Was the study likely to suffer from John Henry, Hawthorne or Pygmalion effects?
    - Did the IE protect against spillover, was it free of selective analysis or outcome reporting, and were the standard errors appropriate?
    - Were there any concerns about construct validity?

- Rate overall quality of IEs based on the assessment of internal validity, robustness of findings, and any other major concerns. Reviewers rated the impact evaluations as being low (not meeting most of the criteria), medium (meeting some, but not all, of the criteria), or high (meeting most of the criteria).

Box D.1. Quality of Evaluation Design and Internal Validity

The quality of evaluation design is the most critical determinant of impact evaluation quality; it is the linchpin for estimating the share of the change in outcomes attributable to the intervention. The starting point for this exercise is identifying the evaluation design (experimental or quasi-experimental) and method (difference-in-difference, matching, instrumental variables, or regression discontinuity) used to identify program impacts. The next step is assessing whether the report provides a discussion of the assumptions or conditions under which the estimation method is valid:

Assumptions under randomized experiment: (i) balanced treatment and control groups (the two groups having no statistically significant difference in main baseline or time-invariant characteristics); and (ii) noncompliance or attrition (minimal incidence of beneficiaries not receiving treatment or leaving the program, and vice versa).

Assumptions under double difference: (i) parallel trending (the treatment and control groups progress similarly in terms of the outcomes of interests); and (ii) time-varying confounders (no time-variant variables that may affect the progress of the outcomes other than the intervention).

Assumptions under matching: (i) common support (the overlap in terms of propensity scores or matching variables between the treatment and control group); (ii) balancing checks (the treatment and control groups having no statistically significant difference in main observable characteristics); (iii) matching on outcomes or covariates (the variables used to match are not affected by the intervention); and (iv) selection on unobservables (there should be a discussion of potential selection bias due to unobservable differences between the treatment and control).

Assumptions under instrumental variables: (i) first stage tested (the relationship between the intervention and the instrument is statistically significant; F-test or Wald test); and (ii) exclusion restriction (the instrument affects the outcome only via the intervention).

Assumptions under regression discontinuity: (i) sorting around the assignment rule (beneficiaries tricking the rule to be eligible for the treatment); and (ii) balanced covariates at discontinuity (the two subgroups above and below the eligibility cutoff have statistically similar characteristics).

Step 3: Code Relevant Information

After determining a rating for each study, additional information from medium and high studies was coded. Low studies were not coded further. Since many of the programs were evaluated multiple times, each program was assigned a number, and the program information and questions on external validity were coded once for each

program in a separate document. The program number was then used in the full coding document.

- Study information:
  - Country, author, year and type of publication
  - Type of World Bank involvement
- Program or intervention information:
  - Program or intervention name, description, and start and end dates
  - Intervention classification in up to three categories
  - Intervention duration, length of exposure, delivery modality, delivery location, implementer, and level of operation
  - Program targeting (by age and gender)
  - Adherence or take-up rate
  - Whether the intervention occurred in an low-income or fragile or conflict country
- External validity:
  - Whether the program was a pilot program
  - Barriers and enablers to intervention implementation, scaling up, and sustainability
- Model:
  - Did the authors discuss their logic model? If so, did it explicitly incorporate age?
- Data:
  - Sample size, data source, years of data collection, and length of evaluated exposure and of delays to implementation
  - Unit of analysis, use of retrospective data and baseline data
  - Sampling strategy and representativeness of the sample
- Cost analysis:
  - Presence of cost analysis
  - Cost analysis methodology and estimates, given by outcome
- Findings:
  - Specific outcome, the outcome domain, and the age group for which it was estimated
  - Baseline value and estimate type
  - Estimate, significance level, and interpretation
- Heterogeneous Effects:
  - Estimates of any heterogeneous effects and for what subgroups, given by outcome

The full dataset will be published separately and will include the full coding instrument.

Appendix E. Anthology of Identified ECD Systematic Reviews

	Author	Title	Year	Source
1	Aiello and others	Effects of hand hygiene on infectious disease risk in the community setting: A meta-analysis	2008	3ie
2	Ainsworth	What Can We Learn from Nutrition Impact Evaluations?: Lessons from a Review of Interventions to Reduce Child Malnutrition in Developing Countries	2010	World Bank
3	Arnold and Colford	Treating water with chlorine at point-of-use to improve water quality and reduce child diarrhea in developing countries: a systematic review and meta-analysis.	2007	PubMed: *American Journal of Tropical Medicine and Hygiene*
4	Berti and others	A review of the effectiveness of agricultural interventions in improving nutrition outcomes	2004	3ie (Public Health Nutrition)
5	Bhutta and others	Prevention of diarrhea and pneumonia by zinc supplementation in children in developing countries: Pooled analysis of randomized controlled trials	1999	*Journal of Pediatrics*
6	Bhutta and others	Community-based interventions for improving perinatal and neonatal health outcomes in developing countries: a review of the evidence	2005	*Journal of Pediatrics*
7	Bhutta and others	What works? Interventions for maternal and child undernutrition and survival	2008	*Lancet*
8	Bhutta and others	Evidence-based Interventions for Improvement of Maternal and Child Nutrition: What Can Be Done and at What Cost?	2013	*Lancet*
9	Lengeler	Insecticides-treated bed nets and curtains for preventing malaria	2004	3ie/Cochrane Collaboration
10	Dewey and Adu-Ararwuah	Efficacy and effectiveness of complementary feeding interventions in developing countries	2008	PubMed: *Maternal and Child Nutrition*
11	Engle and others	Strategies to avoid the loss of developmental potential in more than 200 million children in the developing world	2007	*Lancet*
12	Engle and others	Strategies for reducing inequalities and improving developmental outcomes for young children in low and middle income countries	2011	*Lancet*
13	Fewtrell and others	Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis	2005	*Lancet*
14	Gaarder, Glassman, and Todd	Conditional cash transfer: unpacking the causal chain	2010	3ie
15	Gamble and others	Insecticide-Treated Nets for the Prevention of Malaria and Pregnancy: A Systematic Review of Randomised Controlled Trials	2007	*PLoS Medicine*
16	Grantham-McGregor and others	Effects of Integrated Child Development and Nutrition Interventions on Child Development and Nutritional Status	2014	*Annals of the New York Academy of Sciences*
17	Gunaratna and others	A meta-analysis of community based studies on quality protein maize	2010	3ie

18	Hundley and others	Are birth kits a good idea? A systematic review of the evidence	2011	3ie
19	Iannotti and others	Iron supplementation in early childhood: heath benefits and risks	2006	PubMed: *American Journal of Clinical Nutrition*
20	Indad, Yakoob, and Bhutta	Impact of maternal education about complimentary feeding and provision of complimentary foods on child growth in developing countries	2011	PubMed: *BMC Public Health*
21	Kramer and Kakuma	Energy and protein intake during pregnancy	2010	3ie/Cochrane Collaboration
22	Lassi, Heider, and Bhutta	Community-based intervention packages for reducing maternal and neonatal morbidity and mortality and improving neonatal outcomes	2010	Cochrane Library
23	Lassi and others	Systematic review of complementary feeding strategies amongst children less than two years of age	2013	DFID
24	Leroy and others	The impact of daycare programs on child health, nutrition and development in developing countries: a systematic review.	2011	3ie
25	Leroy, Ruel, and Verhofstad	The impact of conditional cash transfer programs on child nutrition: A review of evidence using program theory framework	2009	3ie
26	Manley and others	How effective are cash transfer programs at improving nutritional status? A rapid evidence assessment of programmes' effect on anthropometric outcomes	2012	DFID
27	Masset and others	A systematic review of agricultural interventions that aim to improve nutritional status of children	2011	3ie
28	Maulik and Darmstadt	Community-based interventions to optimize early childhood development in low resource settings	2009	PubMed: *Journal of Perinatology*
29	Nores and Barnett	Benefits of early childhood interventions across the world:(under) investing in the very young	2010	ScienceDirect: *Economics of Education Review*
30	Piroska	The positive deviance/hearth approach to reducing child malnutrition: systematic review	2011	PubMed: *Tropical Medicine and International Health*
31	Sachdev, Gera, and Nestel	Effect of iron supplementation on physical growth in children: systematic review of randomized controlled trials	2005	WHO:(Public Heath Nutrition)
32	Sguassero and others	Community-based supplementary feeding for promoting the growth of children under five years of age in low and middle income countries (*Updated SR - older version published in 2005*)	2012	Cochrane Library
33	Tanner and others	Delivering the MDGs on Maternal and Child Mortality	2013	IEG
34	Waddington and others	Effectiveness and sustainability of water, sanitation and hygiene in combating diarrhoea	2009	3ie
35	Walker and others	Child development in developing countries 2. Child Development: risk factors for adverse outcomes in developing countries	2007	*Lancet*
36	Walker and others	Inequality in early childhood: risk and protective factors for early childhood development	2011	*Lancet*
37	Walker	Promoting Equity through ECD interventions for children from birth through three years of age	2011	World Bank

Appendix F. List of Studies Given an A Rating

Aboud, Frances E., and Kamal Hossain. 2011. "The Impact of Preprimary School on Primary School Achievement in Bangladesh." *Early Childhood Research Quarterly* 26 (2): 237–246.

Aboud, Frances E., Kamal Hossain, and Chloe O'Gara. 2008. "The Succeed Project: Challenging Early School Failure in Bangladesh." *Research in Comparative and International Education* 3 (3).

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Behrman, Jere R., Maria C. Calderon, Samuel H. Preston, John F. Hoddinott, Reynaldo Martorell, and Aryeh D. Stein. 2009. "Nutritional Supplementation in Girls Influences the Growth of Their Children." *American Journal of Clinical Nutrition* 90 (5): 1372–1379.

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Chaudhuri, Anoshua. 2008. "Revisiting the Impact of a Reproductive Health Intervention on Children's Height-for-Age with Evidence from Rural Bangladesh." *Economic Development and Cultural Change* 56 (3): 619–656.

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de Felicio, Fabiana, Rafael Terra, and Ana Carolina Zoghbi. 2012. "The Effects of Early Childhood Education on Literacy Scores Using Data from a New Brazilian Assessment Tool." *Estudos Economicos* 42 (1): 97–128.

Field, Erica, Omar Robles, and Maximo Torero. 2009. "Iodine Deficiency and Schooling Attainment in Tanzania." *American Economic Journal: Applied Economics* 1 (4): 140–69.

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