Chapter 22

Getting to Education Outcomes: Reviewing Evidence from Health and Education Interventions

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INTRODUCTION

Over the past several decades, efforts to fight infectious diseases and malnutrition have increased alongside attempts to enroll children in basic education, demonstrating a global commitment to equity and quality in child health and education. Health and education interventions can be complementary, as discussed in chapter 30 of this volume (Pradhan and others 2017). Improvements in access to quality education have contributed to preventing disease—for example, an encouraging drop in infant mortality rates is attributed not only to health services but also to worldwide improvements in education. Work commissioned by the International Commission on Financing Global Education Opportunity found that about 7.3 million lives were saved between 2010 and 2015 in low- and middle-income countries (LMICs) because of increases in educational attainment since 1990 (Pradhan and others 2017). Poor health is linked to poor student outcomes. Disease and malnutrition reduce children's capacity to attend school and their ability to learn, particularly in poor communities lacking quality education services (Jukes, Drake, and Bundy 2008).

Indeed, some development strategies have explicitly pursued cross-sector synergies. For example, the 2015 Incheon Declaration states that quality education instills skills, values, and attitudes that lead to healthy lives. Explicit recognition of the role of health in promoting education is less common. As a complement to the global state of education, as detailed in chapter 4 of this volume (Wu 2017), this chapter outlines the theoretical role of health interventions in increasing education access and quality. It then surveys evidence from LMICs on the extent to which common education interventions and school-based health interventions improve education outcomes. It considers the potential of primary and secondary schools to serve as platforms for health interventions, focusing on interventions targeting middle childhood through adolescence, understood to be the range comprising ages 5–19 years. This focus precludes a discussion of the high returns to investment in early childhood, but the studies included are particularly relevant to policy makers in countries where participation rates in early childhood education are still very low. Definitions of age groupings and age-specific terminology used in this volume can be found in chapter 1 (Bundy, de Silva, and others 2017).

EDUCATION: PROGRESS AND GAPS

Enormous progress has been made in global education in the past few decades, especially with respect to achieving universal primary education and reducing gender

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disparity (UNESCO 2015). However, several of the Millennium Development Goals (MDGs) for education were not met by 2015. This brief summary of the state of global education provides the background for the ensuing discussion of school-based education and health interventions.

Since the 1990 Jomtien Conference on Education for All, international support for education has focused on improving access and quality (UNESCO 2013). Partly reflecting the MDG focus on primary enrollment and gender parity in primary and secondary school, access has taken overwhelming priority. Quality, initially interpreted mainly as educational inputs (teachers, textbooks), has, since the mid-2000s, come to be interpreted as not just inputs but also as outcomes—that is, learning. Indeed, the Sustainable Development Goals emphasize both access and learning at all levels of education.

Access to primary education has expanded significantly with widespread enrollment efforts. Nearly 60 million additional children enrolled in school between 1999 and 2013 (ISS 2014). Equally impressive has been the progress made in primary school gender parity, illustrated by a female-to-male pupil ratio of 0.94 in low-income countries in 2011 (World Bank 2013). Although this progress is unprecedented, major gaps persist in access to education worldwide. Growth in enrollment has slowed significantly since 2008, and more than 59 million children were still not enrolled in primary school in 2013 (ISS 2014). This figure not only has significant moral implications, but also costs LMIC economies up to 10 percent of gross domestic product (Thomas and Burnett 2013). At the secondary school level, growth in enrollment began from a relatively low base. Secondary enrollment stood at only 65 percent in 2012 (World Bank 2013), and only 63 percent of countries achieved gender parity in secondary education enrollment (UNESCO 2015).

Gaps in global education are even larger when it comes to learning outcomes. About 250 million of the world's 650 million primary schoolchildren are not acquiring basic skills in literacy and mathematics (UNESCO 2014). The Global Partnership for Education's LMIC partners face a learning crisis, with only 44 percent of their 180 million children reaching grade 4 and learning the basic literacy and numeracy skills appropriate for that grade (Global Partnership for Education 2013). Citizen-led assessments of learning in East Africa and India show similarly daunting numbers. In East Africa, Uwezo (2013) found that less than a third of standard three children in 2013 were passing their grade 2 tests on basic numeracy (29 percent) and literacy (25 percent). In India, only 48 percent of grade 5 children are able to read at a grade 2 level (ASER Centre 2014). Major quality-related challenges in education clearly persist in LMICs.

CONCEPTUAL FRAMEWORK

To understand how health interventions might be critical to achieving global education goals, it is important to understand how they fit conceptually alongside education interventions. As illustrated in figure 22.1, health interventions should play a key role in improving education outcomes along with education interventions that seek to improve access to education and student learning. For the purposes of this chapter, health interventions are narrowly defined as programs designed to enhance the physical well-being of students. They can improve education outcomes by preventing and treating health deficiencies that might otherwise deter children from attending school. By enabling children to attend school more often and in better health, these interventions affect access to education and the ability to learn.

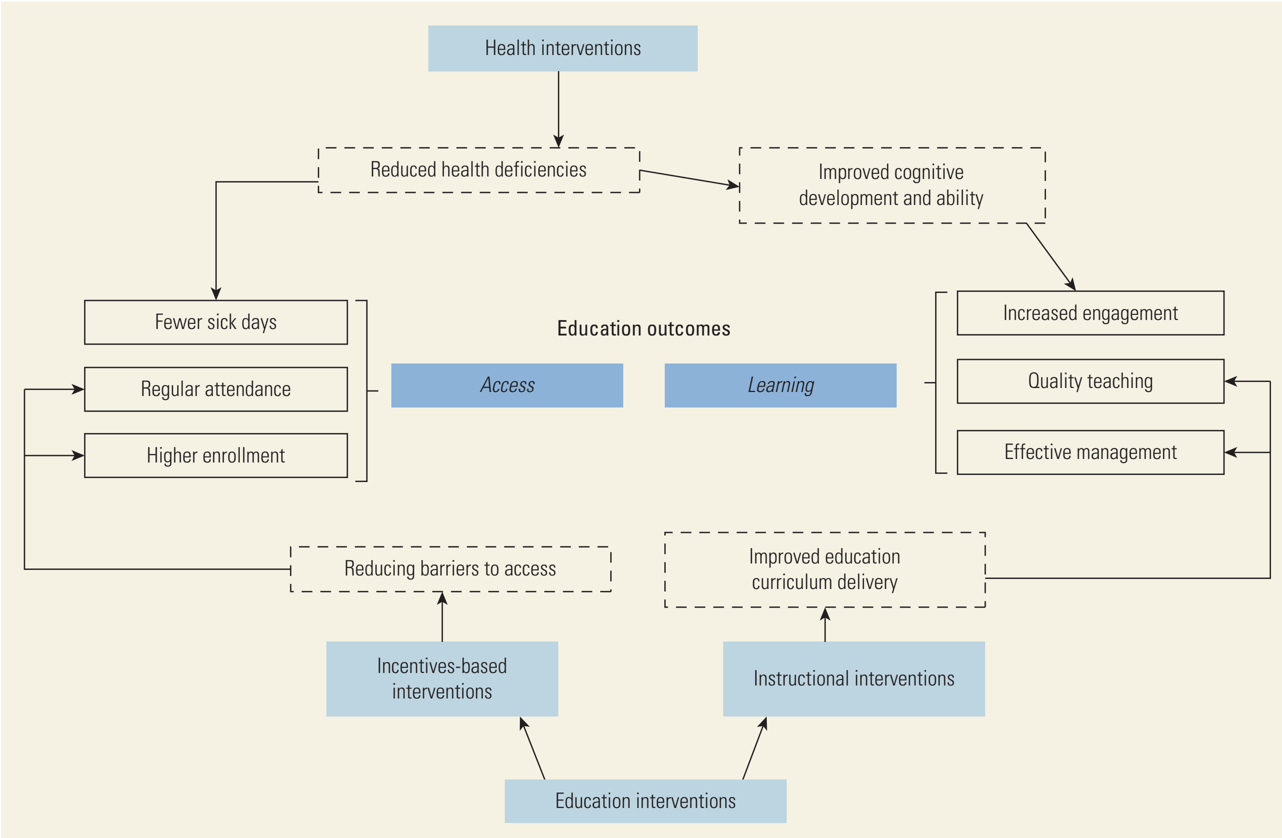
Health interventions may also affect education outcomes by improving children's cognitive skills. As demonstrated by Jukes, Drake, and Bundy (2008), malnutrition and infectious disease are linked to poor cognitive skills among school-age children (children ages 5 to 14 years). Conversely, interventions addressing health conditions, particularly malnutrition and malaria, may improve indicators of cognitive skills (Conn 2014).

Although the conceptual link between health interventions and improved education outcomes is clear, there is little consensus regarding the extent of their impact or how it compares with the impact of education interventions. To fill this gap, several meta-analyses have evaluated interventions in LMICs (Banerjee and others 2013; Conn 2014; Evans and Popova 2015; Krishnaratne, White, and Carpenter 2013; McEwan 2015; Petrosino and others 2012). This chapter draws largely from studies that satisfy the inclusion criteria of those meta-analyses to understand the impacts of selected health interventions on education outcomes. As the following sections show, evidence of the impact of these health interventions on increasing access to education (including increasing attendance) is mixed, but generally positive. Their impact on learning is less clear.

SURVEY OF EDUCATION INTERVENTIONS

To address education challenges, governments and nongovernmental organizations have implemented a range of education interventions to improve access and learning. This section provides an overview of common education interventions and evidence on their impact.

Figure 22.1 Example of a Conceptual Framework for the Impact of Health and Education Interventions on Education Outcomes



McEwan (2015) distinguishes between incentives-based and instruction-based education interventions:

- *Incentives-based interventions* improve learning by changing incentives for teachers, parents, students, and administrators. Interventions include reducing tuition costs (for example, scholarships, subsidies), introducing performance-based pay for teachers, changing school management structures, and providing families with information about the importance of education.
- *Instruction-based interventions* expand access and improve learning by providing materials and services to schools. They include building physical infrastructure, providing textbooks and technology, and training teachers.

The impact of these interventions is measured by a variety of indicators. Enrollment, attendance, progression, and dropout rates are used to indicate access. Literacy and numeracy test scores are typically used to indicate learning. Evidence about the impact of these interventions is discussed next.

Incentives-Based Interventions

Cost-Reduction Interventions

Among the principal demand-side barriers to education for the poor are household costs: tuition and related expenses, such as textbooks, uniforms, transportation costs, and the opportunity cost of forgone labor by parents and children. Cost-based interventions reduce the price of education for students and households, stimulating demand for education services. The abolition of primary school fees in many countries since the early 2000s has contributed to a rise in enrollment, but rarely to an increase in learning outcomes (UNESCO 2014). Abolishing school fees does not always translate into higher public school enrollment, particularly in countries where households shoulder the burden of costs other than tuition (Foko, Tiyab, and Husson 2012). Furthermore, as demonstrated by Bold and others (2011), free primary education can exacerbate concerns about the low quality of education provided by public schools in LMICs.

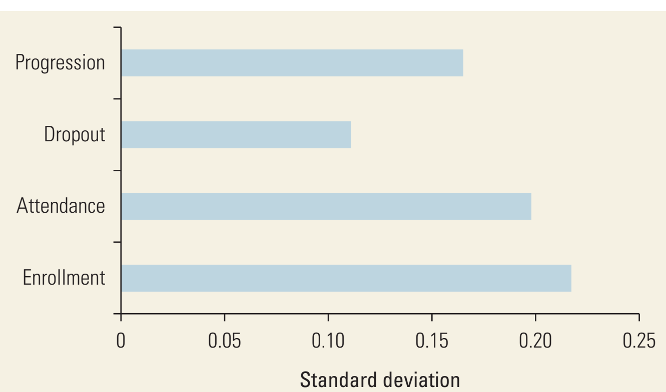
Conditional cash transfers (CCTs) are promising cost-reduction interventions for increasing enrollment and attendance rates (chapter 23 in this volume, de Walque and others 2017). Cash transfers are direct and regular cash payments that supplement the income of poor and vulnerable households (Arnold, Conway, and Greenslade 2011). In education, CCTs have been applied to bolster school enrollment, with payments contingent on children's school attendance. CCTs provide incentives for attendance, make education more accessible to the poor, and offset the opportunity costs of enrolling children in school. Although Krishnaratne, White, and Carpenter (2013) claim that CCTs have had a significant impact on access (figure 22.2), their impact on learning is less clear.

School-Based Management

School-based management (SBM) refers to interventions that improve the management and supervision of schools through authority and accountability at the school level (McEwan 2015). SBM is premised on the notion that local communities and parents are most motivated to ensure quality school performance (Banerjee and others 2010). SBM interventions can support existing education management structures, such as the Pratham Initiative in India, which sought to bring about renewed engagement among village education committees (Banerjee and others 2010), as well as new management structures, such as in Pakistan where new committees were established under a community support process (Kim, Alderman, and Orazem 1999).

One category of SBM interventions is the allocation of funds for school improvement through school management committees. For example, the Quality Schools Program in Mexico allowed parents and teachers to develop school improvement plans and provided cash grants over five years to implement them (Skoufias and Shapiro 2006). SBM interventions can also provide community members with the authority to monitor teacher performance and hire and fire teachers (Duflo, Dupas, and Kremer 2009; Kim, Alderman, and Orazem 1999).

Figure 22.2 Impact of Conditional Cash Transfers on Improving Access to Education



Note: Figure reflects a weighted sum of Cohen's *d* (differences in mean between control and treatment groups, normalized by the study's standard deviation) from the individual studies. The weighted sum is calculated using random effects estimation.

Although SBM interventions have demonstrated a positive impact on learning outcomes, McEwan (2015) found the average effects of management and supervision interventions to be small and not robust. According to that review, interventions in The Gambia, Indonesia, and Madagascar showed few effects of SBM and supervision reforms (Blimpo and Evans 2011; Glewwe and Maïga 2011; Pradhan and others 2011). Thus, while the limited evidence base suggests that SBM could positively improve learning outcomes, not enough is known about the mechanisms through which this process occurs (Krishnaratne, White, and Carpenter 2013).

Information-Based Interventions

Information asymmetries can affect access to and quality of education (box 22.1). Providing information about the education system has been shown to have an impact on indicators of both access and quality (Murnane and Ganimian 2014).

Several interventions have sought to increase the perceived value parents and students assign to education, often by providing information on the economic benefits of staying in school. Two studies suggest that providing information on the returns to education can change perceptions, exerting a positive impact on school access and learning outcomes at relatively low cost.

Jensen (2010) targeted grade 8 students in the Dominican Republic with information about the economic returns of continuing to secondary education. Results showed that participating students perceived significantly higher returns to education when they were interviewed several months later. Moreover, dropout rates fell 3.9 percentage points, or 7 percent, the following year; four years later the average years of education was 0.20 year higher. These results were concentrated among students from households above the median income level, and there was little or no effect on schooling for the poorest students. Given that both socioeconomic groups increased their perception of returns to schooling, financial constraints may have prevented the poorest households from continuing their education (Banerjee and others 2013).

Nguyen (2008) similarly found that providing students and parents in Madagascar with statistics about increased earnings from higher levels of education boosted average school attendance by 3.5 percentage points. The information also had a positive effect on language and math test scores, raising scores by 0.20 standard deviation after three months, but only for students who had underestimated the returns to education at baseline.

Box 22.1

Information Interventions Regarding Learning Outcomes

Several studies have explored the ability of targeted information campaigns about poor learning outcomes to bring about improvements in education quality and school accountability. According to Bruns, Filmer, and Patrinos (2011), providing information on students' educational attainment may have a positive impact on learning outcomes by empowering parents to choose higher-performing schools, encouraging parents and students to monitor school resource allocations and learning outcomes, and pressuring governments and education providers to improve learning outcomes.

Many interventions providing information on children's educational attainment have improved learning outcomes. The Learning and Education Achievement in Pakistan Schools Project provided two report cards to parents in randomly selected villages on the basis of results from learning assessments in English, mathematics, and Urdu (Andrabi, Das, and Khwaja 2015). The first report card included each child's individual test scores and ranking compared with other students; the second included each school's average score and ranking against other schools. This intervention reduced schools' ability to operate in the context of information asymmetries and applied competitive pressure on schools to improve their quality or reduce their price. Andrabi, Das, and Khwaja (2015) concluded that the intervention improved learning outcomes by 0.10 standard deviation and reduced private school fees 21 percent.

Banerjee and others (2006) analyzed three types of information interventions to encourage local participation in improving education outcomes. While the first two were passive, the third involved a targeted intervention to facilitate community action for improving learning. The targeted intervention was found to have the largest impact on parental engagement. Results suggest that the provision of information alone may be insufficient to affect learning outcomes and that additional interventions are likely needed to generate and sustain impact on students' learning.

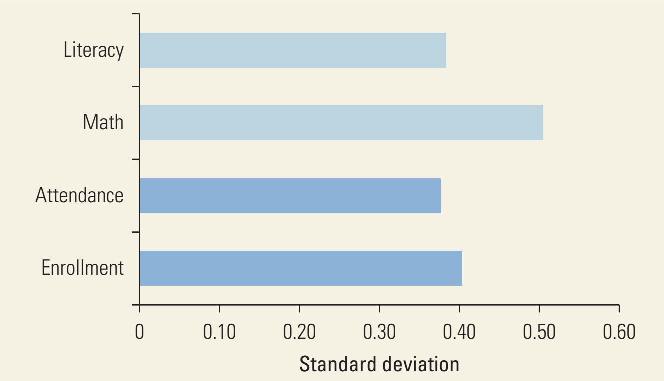
Instructional Interventions

Infrastructure

Proximity of schools has been shown to increase participation dramatically, especially for children who live in remote regions or who face cultural barriers to enrollment and participation. A randomized study by Burde and Linden (2009) assessing the impact of the Partnership for Advancing Community-Based Education in Afghanistan demonstrated the importance of school proximity in providing incentives for school participation. They found that enrollment rates were greater than 70 percent in areas where schools were within a mile of home. Enrollment declined significantly as distance from school increased, reaching about 30 percent for children living more than two miles away. These results illustrate the importance of local infrastructure and have significant implications for understanding gender disparity in education. Enrollment of girls in rural Afghanistan proved to be particularly sensitive to school proximity, improving 21 percent with the provision of nearby community-based schools. Overall, community-based schools in rural Afghanistan increased formal school enrollment 47 percent and raised test scores by 0.59 standard deviation.

Kazianga, de Walque, and Alderman (2009) found similar results in their evaluation of the Burkinabé Response to Improve Girls' Chances to Succeed Program in Burkina Faso, which placed well-equipped schools in 132 villages where the potential for primary-school-age girls to attend school was particularly high. The initiative led to a significant improvement in enrollment (19 percent), with the enrollment of girls increasing more than that of boys. Improvement was also seen in test scores, which rose by 0.41 standard deviation (figure 22.3). The study found that "girl-friendly" amenities, including separate latrines for boys and girls, contributed to the improvement in enrollment, demonstrating the potential role of specialized infrastructure in targeting previously neglected populations.

Figure 22.3 Impact of Infrastructure Interventions on Access and Learning



Source: Krishnaratne, White, and Carpenter 2013.
Note: Figure reflects a weighted sum of Cohen's *d* (differences in mean between control and treatment groups, normalized by the study's standard deviation) from the individual studies. The weighted sum is calculated using random effects estimation.

Box 22.2

Impact of Pedagogical Interventions on Learning Outcomes

In a meta-analysis of interventions seeking to improve learning outcomes, Conn (2014) found that the types of learning interventions with the most impact are "those that alter instructional techniques." Two pedagogical interventions have proved effective:

- Adaptive instruction that caters to children's particular learning levels
- Teacher coaching that provides long-term teacher mentoring or coaching, rather than one-off in-service training events.

These sorts of interventions have the largest significant impact on learning outcomes, but differences in categorization illustrate some of the limitations of meta-analysis in providing conclusive and comparable findings regarding intervention types and their impact (Evans and Popova 2015).

Teacher Resources

Because teaching quality is a key determinant of education outcomes, interventions have sought to improve the quality of teaching through various means. These measures include the provision of extra teachers (García-Huidobro 2000), financial rewards for improved student performance (Muralidharan and Sundararaman 2008), and additional and improved teaching resources and support materials (Lai, Zhang, Qu, and others 2012). Such interventions improve learning outcomes by improving the quality of teaching, reducing class sizes, providing incentives to teachers to do their jobs, and equipping teachers with the necessary resources to teach effectively (box 22.2). Although generally targeted to improving learning outcomes, these interventions can also improve attendance and enrollment because parents are more likely to send their children to school if they trust that teachers are present and believe that children are learning (Krishnaratne, White, and Carpenter 2013).

In general, interventions providing additional teaching resources demonstrate a significant impact on the full range of access and learning education outcomes (Krishnaratne, White, and Carpenter 2013). Although promising, such interventions need to be designed carefully to avoid distorting incentives. For example, while providing financial incentives to teachers on the basis of student performance (test scores) may push teachers to raise the quality of their instruction, it may also adversely provide teachers with incentives to maintain artificially high average exam scores by pressuring poorly performing students to drop out or repeat grades (Glewwe, Ilias, and Kremer 2003).

Materials and Technology

A key category of instructional interventions to improve education outcomes is the provision of additional materials and technology for both students and teachers. Such interventions can include textbooks (Glewwe, Kremer, and Moulin 2009), writing materials and chalkboards (Krishnaratne, White, and Carpenter 2013), flipcharts (Glewwe and others 2004), lesson plans or curriculum guides (Banerjee and others 2007), as well as technology or computer-based learning in the classroom (Barrera-Osorio and Linden 2009; Cristia and others 2012; Lai, Zhang, Hu, and others 2012; Lai, Zhang, Qu, and others 2012). Overall, such interventions have had some positive impact on math test scores, but no effect on attendance, enrollment, or progression (Krishnaratne, White, and Carpenter 2013).

The context and manner in which materials are provided are important in determining impact. Although the provision of materials alone is often ineffective (Glewwe and others 2004; Glewwe, Kremer, and Moulin 2009; Kremer, Moulin, and Namanyu 2003), combining materials with training and a well-defined teaching model augments the efficacy of materials (Friedman, Gerard, and Ralaingita 2010; Lucas and others 2014). According to McEwan (2015), computers and instructional technology interventions have shown the largest effect on learning outcomes.

Summary of the Impacts of Selected Education Interventions

The education interventions described in this section are some of the more promising approaches currently in practice. Each type of intervention has merits, and meta-analyses have explored their impacts relative to each other, with mixed results. Table 22.1 summarizes the education interventions with randomized controlled trials (RCTs) that have shown statistically significant effects on education outcomes in one meta-analysis by Krishnaratne, White, and Carpenter (2013).

Incentives-based interventions such as CCTs and school fees have demonstrated a greater impact on improving access to education (increasing enrollment, attendance, and progression and decreasing dropout), while instruction-based interventions have proved to be more effective at improving learning. The provision of infrastructure and teacher resources shows promise across both access and learning indicators, with pedagogical interventions demonstrating the largest and most significant effect on improving learning outcomes. Instruction-based interventions clearly are promising for improving learning outcomes.

Although these findings reveal several interventions with large and significant effects, Conn (2014) and Evans and Popova (2015) caution against drawing inferences about many of those interventions because of the small number of studies. Findings of the impact of CCTs on access and the impact of teacher resources and materials on learning are based on more studies, so their effect sizes are particularly meaningful (box 22.3).

THE CASE FOR HEALTH INTERVENTIONS

While education interventions are crucial for improving access and learning, health interventions can also play an important role. The role of health in education is particularly important in LMICs, which are burdened with a disproportionate share of morbidity and mortality caused by widespread malnutrition, parasites, and other infectious diseases. Many children in South Asia and Sub-Saharan Africa are unable to access school because of acute and chronic illnesses. For example, a national survey in the Democratic Republic of Congo (ISSP 2012) showed that health issues kept 7 percent of the country's 4 million out-of-school children from enrolling.

Table 22.1 Impact of Incentives-Based and Instructional Education Interventions on Access and Learning

Type of education intervention	Access to Schooling				Learning Outcomes		
	Enrollment	Attendance	Dropout	Progression	Math	Language	Global
Incentives-based interventions							
Cost-reduction interventions							
CCTs	0.22* (16)	0.20* (8)	0.11* (4)	0.17* (4)	−0.02 (2)	−0.03 (1)	0.05 (3)
School fees	0.02 (2)	0.63* (1)	—	—	0.13* (1)	—	—
Provision of infrastructure	0.40* (4)	0.38* (3)	0.42 (2)	0.20 (1)	0.51* (2)	0.38* (2)	—
Information-based interventions	0.03 (2)	−0.10 (3)	−0.01 (2)	—	0.40 (2)	0.05* (2)	0.03 (2)
Instructional interventions							
Teacher resources	0.23* (2)	0.09* (4)	0.09* (3)	—	0.29* (5)	0.28* (5)	−0.02 (3)
Materials	—	0.05 (8)	0.22 (2)	0.00 (1)	0.16* (10)	0.20 (9)	0.11 (2)
School-based management	0.08 (3)	−0.02 (3)	0.02 (3)	0.06* (3)	0.23* (3)	0.12 (2)	0.20* (1)

Source: Krishnaratne, White, and Carpenter 2013.
Note: Numbers in parentheses indicate the number of studies; — = not available; CCTs = conditional cash transfers. Table reflects a weighted sum of Cohen's *d* (differences in mean between control and treatment groups, normalized by the study's standard deviation) from the individual studies. The weighted sum is calculated using random effects estimation.
$*p < 0.05$.

Box 22.3

International Commission on Financing Global Education Opportunity

In 2016, the International Commission on Financing Global Education Opportunity was set up to reinvigorate the case for investing in education. Chaired by Gordon Brown, former prime minister of the United Kingdom, the commission released its report entitled, "The Learning Generation: Investing in Education for a Changing World," at the United Nations in September 2016. The report provides a series of 12 recommendations to ensure all children are learning (International Commission on Financing Global Education Opportunity 2016). A key set of recommendations focuses on promoting inclusion, within which the commission emphasizes the importance of countries investing beyond education to address other barriers that prevent learning. The report draws attention to the fact that up to 500 million school days are lost because of ill health each year in low-income countries, often from preventable conditions, and recommends that decision makers invest in joint education-health initiatives. Early childhood development and services for adolescent girls are recommended in particular as investments that can deliver strong complementary health and education benefits. Chapter 30 of this volume (Pradhan and others 2017) was prepared as a background paper for the Brown Commission. The chapter estimates the effects of education on under-five mortality, adult mortality, and fertility. In addition, it calculates the economic returns to education resulting from declines in under-five mortality and adult mortality, while also taking into account the effects of education investments on income. Estimates of the internal rate of return to education are about 50 percent higher if the impact of mortality is included in the analysis.

Poor health is a major barrier to educational achievement (Glewwe and Miguel 2008). Addressing chronic health conditions is essential for increasing school enrollment, while preventing and treating acute illness are critical for reducing absenteeism. Even if they are healthy enough to attend school, children in poor health are less able to learn. For example, children with insufficient calories and micronutrients may lack the energy to focus in class, limiting their ability to learn (Gomes-Neto and others 1997).

Health interventions could improve cognitive development and education outcomes by ensuring that enrolled children are present, ready, and able to learn (Bundy, Schultz, and others 2017). Even where the conditions of access and instruction are ideal, cognitive function may constrain learning and achievement. For example, Holding and Snow (2001) examined the lasting, adverse impact of malaria infection on cognition and behavior, and Black (2003) reviewed the effects of micronutrient deficiencies on children's cognitive functioning.

Given the physiological importance of children's health status in determining their readiness to learn, a growing literature has emerged on the impact of health interventions on cognitive skills. However, identifying a relationship between cognition and learning is complicated by the myriad assessments measuring the two main dimensions of cognitive skills: (1) general intelligence and reasoning and (2) memory and attention. Tests of cognitive skills vary by study, and the choice of tests is determined by budgetary considerations, adaptability to local contexts, and ease of implementation. A related complication is that cognitive skills and learning are cumulative processes, and detectable improvements may require more time to manifest than is typical for health trials.

Effectiveness of health interventions depends on context, specifically disease burden and the education system. For example, the effectiveness of deworming may be greater if delivered regularly to high-risk areas or if delivered at the beginning rather than the end of the school term. The provision of school feeding to children with untreated helminth infection may not lead to improved attendance or learning. The relationship between anemia and cognition is well established, but the condition may be due to nutritional deficiencies, helminth infection, HIV/AIDS, or a combination of factors (Stephenson, Latham, and Kurz 1985). Integrated health interventions are likely to be more effective and cost-effective.

Taking into account these caveats on heterogeneity and the difficulty of measuring the effects of health interventions, this section reviews recent evidence on the effectiveness of deworming, malaria control, school feeding, and nutrition in promoting education outcomes. These health interventions were chosen because they address some of the most prevalent threats to child health in LMICs and because schools have been used as a delivery platform to support their scalability and enhance their cost-effectiveness, as discussed in chapters 20 (Bundy, Schultz, and others 2017) and 25 (Fernandes and Aurino 2017) in this volume.

Deworming Treatment

More than 600 million school-age children are in need of treatment for intestinal worm infection (WHO 2016). Infected children suffer from listlessness, diarrhea, abdominal pain, wasting, stunting, anemia, cognitive impairment, lower productivity, and lower earning capacity (Guyatt 2000).

School-age children are more likely than adults to spread worm infection because they are frequently in contact with other students, less likely to use latrines, and more likely to have poor hygienic practices. School-based interventions have tremendous potential for positive externalities—if a critical mass of students is dewormed in a school, students who do not receive deworming treatment are less likely to be infected by their classmates (Anderson and May 1991). School-based deworming programs distribute oral deworming medicine every 6–12 months to prevent infection. They sometimes also include teacher training on preventive behaviors.

Many studies indicate that deworming has strong impacts on enrollment and attendance, as reviewed by Petrosino and others (2012) and discussed in chapters 13 (Bundy, Appleby, and others 2017) and 29 (Ahuja and others 2017) in this volume. A study of hookworm eradication in the American South found that mass deworming increased enrollment, attention, and literacy (Bleakley 2007). Miguel and Kremer (2004) found that low-cost, single-dose therapies reduced hookworm, roundworm, and schistosomiasis infections by 99 percent and improved school participation by 7 percentage points in a large study (30,000 schoolchildren) in Kenya. These estimates mask heterogeneity given that children who are worse off have the most to gain. Simeon and others (1995) discerned no average impact, but did find significant impacts on attendance for the subset of children who had heavy *Trichuris* infection or were stunted.

Alderman and others (2006) found no impact of albendazole on test scores, while Grigorenko and others (2006) found that praziquantel improved scores on some cognitive tests. Meta-analyses of quasi-experimental results show no clear impact of deworming on learning (Evans and Popova 2015; McEwan 2015). Over the long term, persistent infections are associated with impaired cognitive development and lower educational achievement (Mendez and Adair 1999), and worm infections are estimated to lead to an intelligence quotient (IQ) loss of 3.75 points per child infected, on average, and 200 million years of lost schooling (Jukes, Drake, and Bundy 2008). Ozier (2014) found that, because of externalities, a mass school-based deworming program in Kenya was associated with improved cognitive performance for nontreated infants 10 years after the program. However, just as for learning, conclusive evidence from recent empirical studies with quasi-experimental design is lacking for cognition (Taylor-Robinson and others 2015). The mixed evidence on learning and cognitive impact may be in part due to measurement issues, as discussed in chapter 13 in this volume (Bundy, Appleby, and others 2017).

Malaria Control

More than 500 million school-age children worldwide are at risk of malaria infection, which can be prevented through a variety of interventions, including insecticide-treated bednets and prophylactic antimalarial drugs, as discussed in chapter 14 in this volume (Brooker and others 2017). Although malaria is most severe and common in early childhood, it has serious consequences during the school-age years, accounting for up to 20 percent of mortality in schoolchildren in malaria-ridden countries (World Bank 2015). A range of malaria prevention strategies is typically delivered through schools or communities.

The effect of malaria reduction on educational attainment is indeterminate because of the prevalence of child labor in most malaria-ridden countries (Bleakley 2007). Reducing malaria increases the benefits of education because healthy children are more able to capitalize on opportunities generated by schooling. Conversely, reducing malaria increases the opportunity costs of education because healthy children are more able to supplement household income. The effect on educational attainment of reducing malaria thus requires empirical investigation.

Studies of school-based delivery provide strong evidence that malaria prevention improves attendance and cognition among children in endemic areas. Repeated provision can ensure better results, especially for the most vulnerable. Studies demonstrate that malaria is a significant contributor to absenteeism, accounting for 13 percent to 50 percent of medical absences from school (Nankabirwa and others 2014). In Kenya alone, an estimated 4 million to 10 million school days were lost because of malaria in 2000 (Brooker and others 2000).

School health education programs that promote antimalarial practices were found to reduce absenteeism 25 percent among Kenyan schoolchildren (Ogutu and others 1992). Malaria prevention combined with chloroquine prophylaxis in Sri Lanka was linked to a 62 percent reduction in school absenteeism and a 26 percent increase in mathematics and language test scores (Fernando and others 2006).

Some debate surrounds the impact of malaria on school performance. Bangirana and others (2011) found a minimal impact of malaria on test scores in Uganda, but suggested that the effect of malaria on cognition in schoolchildren may develop too gradually to be observed during the short periods common in controlled studies. Similarly, Clarke and others (2008) found that intermittent preventive treatment of schoolchildren in Kenya had no effect on achievement, but did positively affect performance on attention and memory tests.

Indeed, such results do not preclude an impact of malaria prevention on students' cognitive skills. A strong body of evidence demonstrates that cerebral and uncomplicated malaria can impair cognitive function (Fernando, Rodrigo, and Rajapakse 2010; Kihara, Carter, and Newton 2006; Thuilliez and others 2010), while a consistent association has not been found for asymptomatic parasitemia (Halliday and others 2012). These studies suggest that school-based malaria programs offering diagnostic services, treatment, and prevention may improve education outcomes by promoting readiness to learn.

School Feeding

More than 165 million children worldwide face chronic malnutrition (UNICEF 2013), which can be alleviated to some degree by school feeding—the regular provision of food to children attending schools, discussed in chapter 12 in this volume (Drake and others 2017). Although malaria and deworming treatments are typically limited to low-income countries, school feeding is implemented in almost every country in the world (WFP 2013). The recognition of its potential impacts on education outcomes is also widespread. School feeding programs can help get children into school and keep them there. They can contribute to learning once children are in school, given the well-established link between nutrition and cognition (Adelman, Gilligan, and Lehrer 2008). In LMICs, school feeding programs have traditionally focused on boosting enrollment and attendance, although the emphasis is shifting to assessing their impact on academic achievement, as has been done in high-income countries.

School feeding could affect education outcomes through several channels. First, school feeding can provide incentives for enrollment by lowering the opportunity cost of attendance. On average, school feeding represents an income transfer of US$60 per child per year, as discussed in chapter 12 in this volume (Drake and others 2017). Second, school feeding alleviates hunger, which improves attention span and increases a student's capacity for performance. Third, school feeding provides the nutritional inputs to boost cognitive development, especially in early childhood (Martorell 1996), which could improve performance. Finally, nutrition promotes health by improving resistance to disease, which enables children to stay healthy and maintain better attendance (Buttenheim and others 2011). Thus, school feeding could, in theory, affect education access, cognition, and learning outcomes.

Although the impact of improved nutrition is undisputed, its logistical implementation through school feeding has an ambiguous impact on education outcomes. Several issues associated with the implementation of school feeding could counteract the positive influence of improved nutrition. School feeding could provide food that is insufficiently nutritious. School feeding could also reduce teaching time or overcrowd schools if enrollment increases rapidly, both of which could cause a drop in education quality (Conn 2014). Furthermore, in resource-constrained settings, there could be a substitution effect whereby children who receive school feeding are given less to eat at home, negating any possible gains. In addition, by increasing attendance, school feeding programs could induce a reduction in child labor, which reduces household income and the availability of food at home (Adelman, Gilligan, and Lehrer 2008). It is thus critical to look to the evidence to judge whether the merits of school feeding hold up empirically.

Several reviews have highlighted the positive effects of school feeding on enrollment, attendance, and retention (Jomaa, McDonnell, and Probart 2011). However, the impact of school feeding on cognition and learning is more nuanced and dependent on the quality of schooling. Studies suggest that school feeding can influence the two domains of cognition by reducing micronutrient deficiencies, although the impacts are less than for micronutrient supplementation (Conn 2014). Breakfast programs may be especially important for cognitive function, especially in contexts where breakfast is rarely consumed at home, as discussed in chapter 12 in this volume (Drake and others 2017). Learning effects are stronger for arithmetic tests than for reading, writing, and spelling (Jomaa, McDonnell, and Probart 2011).

Nutrition

Nutrition interventions are also commonly distributed through schools, separately or in conjunction with school meals. These interventions include the provision of supplement tablets as well as micronutrient powders, which can be sprinkled on meals to enhance their nutrient content. By tackling micronutrient deficiencies associated with health status and cognition, nutrition interventions can promote learning and academic achievement.

Nutrition interventions may seek to address one or more micronutrient deficiencies, with one of the most common being iron deficiency. In a review of the literature, Best and others (2011) found positive effects of supplementation of multiple micronutrients on micronutrient and anemia status as compared with supplementation of a single micronutrient. Impact can also depend on the dose, initial micronutrient status, and interactions with other micronutrient supplements. For instance, the inclusion of iron-fortified flour enhanced the iron status of Kenyan schoolchildren (Andang'o and others 2007). However, in Vietnam, iron supplementation alone did not affect anemia status, although the provision of multiple-fortified biscuits did, suggesting that the presence of other nutrients may affect iron absorption and anemia status (Hieu and others 2012). In a review of the literature, Conn (2014) found that nutrition interventions had significant impacts on cognitive function, but not academic achievement, suggesting the need for complementary education interventions.

Summary of the Impacts of Selected Health Interventions

Table 22.2, which is based on a meta-analysis by Krishnaratne, White, and Carpenter (2013), combines effect sizes from disparate, context-specific studies to arrive at a general conclusion. It is based on just one meta-analysis of school-based health interventions, so it should only be taken as suggestive, rather than the final word on these interventions. Similarly, online annexes 22A and 22B combine both health and education intervention effect sizes from Krishnaratne, White, and Carpenter (2013) to illustrate their effect sizes relative to each other. Both demonstrate that, in some cases, health interventions can have as large an effect size on access and learning outcomes as education interventions.

While the size of some of the effects are large and appear to be statistically significant, making these inferences about statistical significance at the 95 percent confidence level hinges on assuming that normal approximation is valid for a very small number of studies. No result for an individual intervention is based on more than four studies. Tipton (2015) highlights the danger of making inferences from small samples. Evans and Popova (2015) considered the results from Krishnaratne, White, and Carpenter (2013) and five other meta-analyses and concluded that they largely agree that school-based health interventions have a significant impact on access indicators (consistent with results in the table), but are not effective in improving test scores.

However, these findings cannot necessarily be taken as evidence that improvements in health are not essential

Table 22.2 Impact of Health Interventions on Access and Learning

Type of health intervention	Access to schooling				Learning outcomes		
	Enrollment	Attendance	Dropout	Progression	Math	Language	Global
School feeding	0.24* (4)	0.26* (4)	—	0.69* (1)	0.40 (1)	0.19 (2)	0.02 (1)
Nutrition	0.04* (1)	0.27* (2)	0.33 (1)	—	0.65* (2)	0.66* (2)	—
Malaria prevention	—	0.59* (1)	0.24* (1)	0.38* (1)	0.62* (1)	0.56* (1)	—
Deworming	0.29 (1)	0.09 (1)	—	—	0.04 (1)	0.02 (1)	–0.03 (1)

Source: Based on data from Krishnaratne, White, and Carpenter 2013.
Note: Numbers in parentheses indicate the number of studies; — = not available. Table reflects a weighted sum of Cohen's *d* (differences in mean between control and treatment groups, normalized by the study's standard deviation) from the individual studies. The weighted sum is calculated using random effects estimation.
$*p < 0.05$.

for improving learning outcomes. Analyzing impact evaluations from Sub-Saharan Africa, Conn (2014) found that, although deworming had no discernible impact on test scores, it did significantly improve cognitive skills (as measured by tests like Raven's Progressive Matrices). This result suggests that the improvements in health yielded by health interventions may be necessary, but not sufficient, for promoting learning.

Although most experimental studies focus on measuring changes in access and achievement indicators, RCT studies that measure cognitive function also show encouraging results. High-quality evidence is available for nutritional supplements and malaria prevention interventions in particular. For example, Sungthong and others (2004) found that Thai primary schoolchildren receiving iron supplements performed moderately better than the control group on a standardized test of cognitive function (TONI II), while Clarke and others (2008) showed that Kenya schoolchildren treated with a preventive malaria program performed significantly better on attention tests than untreated students. Both studies were placebo controlled and double blind. More should be done to rigorously assess the impact of these and other interventions in other contexts and to link them to learning.

In summary, evidence on the impacts of health interventions is inconclusive, particularly for learning outcomes. More research using cluster-randomized approaches, larger sample sizes, and longer timeframes is needed to assess the impacts of health interventions on learning outcomes.

Evidence on the importance of health in determining readiness to learn and the lack of clear evidence on the impact of health interventions on learning outcomes do not necessarily contradict each other. Rather, other necessary conditions (such as adequate educational resources) may be lacking in the settings where these studies took place, preventing health interventions from improving education outcomes. Cunha and Heckman (2007) discussed a theoretical model involving such

Box 22.4

Assessing Cost and Cost-Effectiveness

On the basis of a systematic review of studies by the *Disease Control Priorities* (third edition) Economics Team (which calculated costs per student per year in 2012 U.S. dollars), deworming treatment costs, on average, US$0.93. Programs for malaria control cost US$3.67, and programs for school feeding cost US$75.90, on average. Although these studies cover interventions that varied considerably in scope, the averages provide a sense of the resources required to fund such programs. Although the review did not include studies on nutritional supplements, such interventions have been recognized elsewhere as generally cost-effective (Dhaliwal and others 2012), and on the basis of an observational study of Filipino schoolchildren, Glewwe, Jacoby, and King (2001) suggest that in developing countries, a dollar invested in an early childhood nutrition program returns at least three dollars worth of gains in academic achievement. Chapters 12 (Drake and others 2017), 20 (Bundy, Schultz, and others 2017), 24 (Horton and Black 2017), 26 (Horton and others 2017), and 14 (Brooker and others 2017) in this volume provide more details on the costs of these health interventions.

The comparative cost-effectiveness of interventions for education outcomes has been analyzed. Jensen (2010) found that information-based interventions, which cost as little as US$0.08 per student (Nguyen 2008), may be a highly cost-effective way to promote school access for marginal students. These findings are in sharp contrast to conditional cash transfers like Mexico's Progresa, which costs US$500 per person. Dhaliwal and others (2012) cite examples suggesting that information-based interventions, deworming, and nutritional supplements are highly cost-effective. Kremer, Brannen, and Glennerster (2013) note that pedagogical interventions matching teaching to students' learning levels and providing information might be the most cost-effective interventions for learning. McEwan (2015) found that computer-assisted teaching and textbook distribution are among the least cost-effective learning interventions. Further research and cost-effectiveness analysis of both education and health interventions are needed.

dynamic complementarities in inputs to education. Moreover, conclusions drawn from meta-analyses can be incomplete or misleading because of heterogeneous effects (the impact of interventions could vary by beneficiary gender or socioeconomic status), temporal effects (the size of impacts at the endline of a study does not necessarily indicate lasting effects), and differences in age at exposure (the impacts are age dependent for some health interventions, such as the wealth of evidence on the heightened importance of adequate nutrition in a child's first 1,000 days).

Reviewing the cost and cost-effectiveness of school-based interventions falls outside the remit of this chapter. Furthermore, the vast majority of cost-effectiveness studies measure cost over a single outcome (disability-adjusted life years averted), not taking into account the multisectoral benefits of an intervention. However, because cost-effectiveness has central implications for the feasibility of interventions in resource-constrained settings, box 22.4 briefly notes some cost evidence specific to school-based delivery.

CONCLUSIONS: THE EMERGING NEXUS OF HEALTH AND EDUCATION

Our understanding of the interaction between children's health status and education outcomes has progressed considerably. Indeed, a wealth of evidence on a range of health interventions has been generated from nonexperimental studies and RCTs during the past two decades, including for some health interventions not discussed in this chapter (such as HIV/AIDS prevention and treatment, provision of eyeglasses, disability access, and sanitation).

Overall, the data suggest that health interventions can have a significant impact on education outcomes. Health interventions have been widely shown to improve indicators of access, such as attendance and enrollment. The impact of these interventions on learning and cognitive skills is mixed and uncertain. Despite years of opportunity for definitive research the very plausible hypothesis that sick, malnourished, and hungry children learn less in school remains to be adequately tested. The limited research on interventions to address these problems has so far been inconclusive. This point is but one example of an important theme of this volume as a whole: research on child health and nutrition has been dominated by studies of children younger than age five years, leaving an important gap concerning school-age children.

As discussed in the previous section, the lack of consensus on some interventions is likely due in part to methodological challenges. Furthermore, the lack of universal conclusions about the effects of both health and education interventions is not surprising, given how education and health outcomes are interdependent. In some contexts, education interventions may fail to improve education outcomes because poor health is the binding constraint on educational achievement. In others, health interventions may fail to improve education outcomes because school infrastructure is so poor that improving children's individual abilities to excel in school does not improve actual outcomes. Health interventions alone do not guarantee improved learning outcomes and vice versa; quality education and health services must be provided contemporaneously to maximize the impact of each.

For this reason, focusing on integrated implementation is important. Studies such as Banerjee and others (2006) and Piper and Korda (2010) have shown that incentives-based interventions can have a greater impact when implemented alongside instruction-based interventions. Scant evidence on integrated health and education interventions is available for LMICs. An intervention in Jamaica that combined early stimulation with nutritional supplements for stunted children illustrates the potential impact of integrated interventions: more than two decades after its implementation, the impact on IQ and learning outcomes was still significant (Grantham-McGregor and others 2014). Although the timing of this intervention, which targeted children younger than age four years, was likely a factor in its impact, this promising intervention provides an example of how a more holistic approach to interventions seeking to improve education outcomes by improving cognitive skills could provide significant long-term gains.

However, in more developed settings, even the distinction between health and education outcomes has started to blur as policy makers measure development using more comprehensive measures of well-being. This is evident in theoretical frameworks in which education is recognized as a causal factor for health (Braveman and Gottlieb 2014), as well as in practice. In the United States, programs such as Fast Track and Communities That Care provide comprehensive services for children and their families. The Centers for Disease Control initiative Healthy People 2020 uses high school graduation as a leading indicator of social determinants of health. This merging of education and health in policy and practice may provide guidance for designing programs that integrate education with critical interventions for malnutrition and diseases that are no longer pervasive in high-income countries.

Many chapters in this volume make the economic and social case for investing in health. This chapter has shown that these cases become even stronger when policy makers bear in mind the importance of health interventions for promoting education.

ANNEXES

The annexes to this chapter are as follows. They are available at http://www.dcp-3.org/CAHD.

- Annex 22A. Impact of Interventions on Education Outcomes
- Annex 22B. Median Significant Effect Sizes on Education Outcomes

NOTE

World Bank Income Classifications as of July 2014 are as follows, based on estimates of gross national income (GNI) per capita for 2013:

- Low-income countries (LICs) = US$1,045 or less
- Middle-income countries (MICs) are subdivided:
  a) lower-middle-income = US$1,046 to US$4,125
  b) upper-middle-income (UMICs) = US$4,126 to US$12,745
- High-income countries (HICs) = US$12,746 or more.

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