Chapter 25

Identifying an Essential Package for School-Age Child Health: Economic Analysis

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INTRODUCTION

This chapter presents the investment case for providing an integrated package of essential health services for children attending primary schools in low- and middle-income countries (LMICs). In doing so, it builds on chapter 20 in this volume (Bundy, Schultz, and others 2017), which presents a range of relevant health services for the school-age population and the economic rationale for administering them through educational systems. This chapter identifies a package of essential health services that low- and middle-income countries (LMICs) can aspire to implement through the primary and secondary school platforms. In addition, the chapter considers the design of such programs, including targeting strategies. Upper-middle-income countries and high-income countries (HICs) typically aim to implement such interventions on a larger scale and to include and promote additional health services relevant to their populations. Studies have documented the contribution of school health interventions to a range of child health and educational outcomes, particularly in the United States (Durlak and others 2011; Murray and others 2007; Shackleton and others 2016). Health services selected for the essential package are those that have demonstrated benefits and relevance for children in LMICs. The estimated costs of implementation are drawn from the academic literature. The concept of a package of essential school health interventions and its justification through a cost-benefit perspective was pioneered by Jamison and Leslie (1990).

As chapter 20 notes, health services for school-age children can promote educational outcomes, including access, attendance, and academic achievement, by mitigating earlier nutrition and health deprivations and by addressing current infections and nutritional deficiencies (Bundy, Schultz, and others 2017). This age group is particularly at risk for parasitic helminth infections (Jukes, Drake, and Bundy 2008), and malaria has become prevalent in school-age populations as control for younger children delays the acquisition of immunity from early childhood to school age (Brooker and others 2017). Furthermore, school health services are commonly viewed as a means for building and reinforcing healthy habits to lower the risk of noncommunicable disease later in life (Bundy 2011).

This chapter focuses on packages and programs to reach school-age children, while the previous chapter, chapter 24 (Horton and Black 2017), focuses on early childhood interventions, and the next chapter, chapter 26 (Horton and others 2017), focuses on adolescent interventions. These packages are all part of the same continuum of care from age 5 years to early adulthood, as discussed in chapter 1 (Bundy, de Silva, and others 2017). A particular emphasis of the economic rationale for targeting school-age children is to promote their health and education while they are in the process of learning; many of the interventions that are part of the package have been shown to yield substantial benefits in educational outcomes (Bundy 2011; Jukes, Drake, and Bundy 2008). They might be viewed as health interventions that leverage the investment in education.

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Schools are an effective platform through which to deliver the essential package of health and nutrition services (Bundy, Schultz, and others 2017). Primary enrollment and attendance rates increased substantially during the Millennium Development Goals era, making schools a delivery platform with the potential to reach large numbers of children equitably. Furthermore, unlike health centers, almost every community has a primary school, and teachers can be trained to deliver simple health interventions, resulting in the potential for high returns for relatively low costs by using the existing infrastructure.

This chapter identifies a core set of interventions for children ages 5–14 years that can be delivered effectively through schools. It then simulates the returns to health and education and benchmarks them against the costs of the intervention, drawing on published estimates. The investment returns illustrate the scale of returns provided by school-based health interventions, highlighting the value of integrated health services and the parameters driving costs, benefits, and value for money (the ratio of benefits to costs). Countries seeking to introduce such a package need to undertake context-specific analyses of critical needs to ensure that the package responds to the specific local needs.

CONDITIONS AND POSSIBLE INTERVENTIONS

Possible interventions for the essential package were considered from the perspective of four domains of child development. Three of which (physical, nutrition, and psychosocial) pertain primarily to health, and one (cognition) primarily to education. Table 25.1 presents an overview of low-cost interventions in each domain and the possible delivery platforms identified in the literature.

Although interventions promoting psychosocial health may be beneficial for primary-school-age children, most studies focus on secondary school and adolescents. Interventions delivered through population-based mechanisms, such as the media, are likely targeted to decision makers and to adolescents rather than children. For some conditions, such as oral health, identification and prevention may be through one platform (schools or communities), and remedial treatment may be through another (primary health centers).

Most of the interventions have potential impacts on education as a consequence of improvements in health, although the specific pathways vary. Providing meals in schools may help mitigate the energy intake gap for children experiencing low to moderate undernutrition, thereby promoting overall health status and school participation. The regular provision of iron-folate pills or meals fortified with micronutrient powders may reduce the prevalence of anemia and so improve cognitive ability, thereby improving school attendance and learning. Correcting refractive error may have a direct impact on future economic productivity by improving learning and academic achievement.

The benefits of interventions such as oral hygiene and vaccines are related primarily to health. Although most vaccines are delivered in early childhood, primary schools can be optimal delivery platforms for primary doses of the human papillomavirus (HPV) vaccine and booster doses of tetanus vaccine (LaMontagne and

Table 25.1 Platforms for Delivering School-Based Health Interventions

	Platform			
Domain	**Population level**	**Community**	**School**	**Primary health center**
Physical health	Education	Refractive error	**Deworming; insecticide-treated bednets; malaria chemoprevention; tetanus toxoid and HPV vaccination; oral health prevention;** sex education messages; **refractive error**	**Deworming; insecticide-treated bednets; tetanus toxoid and HPV vaccination; oral health and dentistry**
Nutrition	Nutrition education messages	**Micronutrient supplementation; multifortified foods**	**Micronutrient supplementation; multifortified foods; school feeding;** nutrition education messages	**Micronutrient supplementation**
Psychosocial	Mental health messages	n.a.	Mental health education and counseling	Mental health counseling
Cognition	Conditional cash transfers	School promotion	**Vision screening**	**Vision screening**

Note: HPV = human papillomavirus; n.a. = not applicable. Interventions in bold are covered in this chapter.

others 2017), while health centers can target out-of-school children and marginalized girls. In a global survey, 95 of 174 countries used schools to deliver some vaccines, but the prevalence was much lower among LMICs than HICs, 28 percent and 64 percent, respectively (Vandelaer and Olaniran 2015). Effective immunization from tetanus requires several doses in infancy through early childhood, with boosters in middle childhood (around ages 4–7 years) and adolescence (ages 12–15 years). The World Health Organization (WHO) recommends delivering tetanus-diphtheria toxoid combination immunizations rather than a single antigen tetanus toxoid (WHO 2006). At least 80 countries include the tetanus toxoid and booster immunizations in school-based programs, making it the vaccine most commonly delivered through schools (Vandelaer and Olaniran 2015) and part of the essential package.

An estimated 80 percent of the global burden of cervical cancer is concentrated in LMICs, underscoring the relevance of the HPV vaccine as a preventive measure. The essential package promotes the administration of two doses of the HPV vaccine to girls in a given grade in primary school, with the selected grade containing the largest share of the target age group.

The package includes hygiene education, but not the water and sanitation components of WASH. This decision reflects the high cost of intervention, especially the construction of water supply infrastructure and school facility infrastructure and maintenance (Snilstveit and others 2015)-the costs of which would exceed the costs of all other candidate interventions for the essential package.

Table 25.2 estimates the burden of conditions treatable by interventions in the essential package in LMICs, underscoring the potential global impact of school-based health services.

ESTIMATING THE COSTS

Table 25.3 summarizes the evidence on the costs and outcomes of interventions in the essential package. The estimates typically focus on average annual costs incurred in delivering the intervention; they exclude

Table 25.2 Burden of Conditions Affecting the Health and Development of School-Age Children

Domain and condition or infection	Estimated school-age population at risk	Possible interventions
Physical health		
Schistosoma and STHs, including hookworm, roundworm, whipworm	Schistosomiasis: 207 million cases globally STHs: 870 million cases in 2014[a]	Deworming treatment
Malaria	568 million at risk globally; more than 200 million cases of *Plasmodium falciparum* in ages 5–14 years in 2010 in Sub-Saharan Africa alone	ITNs, intermittent preventive screening and administration of malaria chemoprevention, indoor residual spraying
Tetanus	All school-age children	Tetanus toxoid vaccine
HPV	All girls ages 9–14 years	HPV vaccine
Tooth decay	40 percent to 90 percent of children age 12 years in LMICs[b]	Provision of toothbrushes, promotion of oral care, dental screening and referrals
Nutrition		
Micronutrient deficiencies	Anemia: 304.6 million[c]	Micronutrient powders, food fortification, micronutrient-rich foods
Underweight	Girls: 16 percent; boys: 25 percent[d]	School feeding
Cognition		
Uncorrected refractive error	13 million[e]	Vision screening and provision of inexpensive eyeglasses

Note: HPV = human papillomavirus; ITNs = insecticide-treated bednets; LMICs = low- and middle-income countries; STHs = soil-transmitted helminths.
a. Fenwick 2012.
b. Bagramian, Garcia-Godoy, and Volpe 2009.
c. McLean and others 2009.
d. Manyanga and others 2014. Seven African countries (Benin, Djibouti, the Arab Republic of Egypt, Ghana, Malawi, Mauritania, and Morocco) reported prevalence for students ages 11–17 years.
e. Resnikoff and others 2008.

Table 25.3 Costs of Potential Interventions

Costs per year (2012 US$ unless otherwise noted)

Domain	Intervention	Cost per child	Cost per case averted	Cost per death averted	Cost per DALY averted
Nutrition	School meals[a]	41 (2008)	100 kilocalorie gain: 10.22	—	n.a.
	Micronutrient powder supplementation[b]	2.92 (2014)	Anemia: 8.59	—	n.a.
Infectious disease	Deworming: Mass drug administration[c]	0.35	Helminth infection: 0.93–5.28	n.a.	3.36–6.92
	Malaria: Intermittent parasite clearance[d]	1.88–4.03 (2009) (White and others 2011)	Infection: 5.36–9 (Horton and Wu 2015); 1.45–33 (2009) (White and others 2011); anemia: 29.84–50 (Horton and Wu 2015)	110–4,961 (2009)	24 (2009)
	Malaria: Insecticide treated bednets[d]	0.40	Infection: 10–48	950–2,500 (2009)	20–48 (2009)
Vision screening	Refractive error screening and provision of corrective glasses[e]	Ready-made glasses: 2–3; Screening kit: 9 each	Poor vision: 0.71–1.07	—	84
Oral health	Toothbrush provision and education[f]	0.60	Caries reduction: 40 percent, 1.25 per child	—	n.a.
Vaccines	Tetanus toxoid vaccine[g]	0.40 (2003)	—	117 (2003)	3.61 (2003)
	HPV bivalent vaccine[h]	Vaccine cost: 0.55–2.00 per dose for Gavi-eligible countries; Delivery: 4.88–6.73 per fully vaccinated girl (2009)		2,161–2,608	QALY gained for reduced cervical cancer risk: 4,500–8,890 (2011 international $)

Note: — = not available; n.a. = not applicable; DALY = disability-adjusted life year; HPV = human papillomavirus; LMICs = low- and middle-income countries; QALY = quality-adjusted life year.

a. Standardized cost of school meals in LMICs in 2008 US$ (Kristjanssen and others 2015). Cost is standardized to 401 kilocalories. School meals should contribute at least 30 percent to international recommendations, or 555 kilocalories.

b. Cost estimate from Stopford and others, forthcoming. Cost per case averted was calculated assuming that micronutrient powders reduce anemia by 34 percent, based on a review of the evidence (Salam and others 2013).

c. Cost per case averted from Horton and Wu 2015.

d. Cost per death and DALY averted from Horton and Wu 2015; White and others 2011.

e. Cost per DALY for ages 5–10 years from Baltussen, Naus, and Limburg 2009. Cost per case averted assumes that eyeglasses have a useful lifespan of four years, one teacher has one kit for 165 schoolchildren, and compliance is 70 percent, similar to Baltussen, Naus, and Limburg 2009.

f. Monse and others 2013.

g. Griffiths and others 2004.

h. Change in recommendation from a three-dose to a two-dose schedule is likely to improve cost-effectiveness. Gavi eligibility is based on average gross national income. At least 54 LMICs qualify for support (http://www.gavi.org/support/apply/countries-eligible-for-support/). Estimate of cost per death averted from Levin and others 2015.

teacher training, policy development, and monitoring and evaluation. The estimates are drawn from existing studies; therefore the components of each cost estimate are not presented or standardized.

Training Costs

Regular training and refresher courses are needed for teachers delivering the interventions. Training could cover all interventions in the essential package and be integrated with other teacher training courses. Refresher courses are particularly critical in contexts with high teacher turnover. Appropriate monitoring and evaluation are also strongly recommended to ensure appropriate implementation.

Nutrition Costs

School meals can contribute to the recommended energy intake for undernourished children (Drake and others 2017). The three possible modalities include meals, biscuits or snacks, and take-home rations. Almost every country in the world offers school feeding in some form, and meals are the most common modality. The essential package includes the provision of meals or alternatively of snacks in contexts where meals are not possible. Snacks such as packaged biscuits or milk may be more appropriate in emergency contexts or where schools do not have the infrastructure to prepare or serve meals. The inclusion of micronutrients may increase costs, but also benefits. Various studies assess the value of iron-folate pills for girls, especially those entering adolescence. The intervention in the essential package focuses on addressing micronutrient deficiencies.

Infectious Disease Treatment Costs

The cost-effectiveness estimates for infectious diseases—in particular, malaria and helminth infection—may vary with the transmission setting and level of treatment coverage. Deworming treatment is included in the essential package, given the prevalence of soil-transmitted helminths (STHs) and *Schistosoma* infection in this age group (Bundy, Appleby, and others 2017). The pills are free to public health systems because they are donated by the global pharmaceutical industry via the WHO, and costs are related primarily to delivery. In some contexts, one oral treatment provided to each child annually is sufficient; in contexts with higher prevalence, two treatments may be needed. The cost of delivering schistosomiasis treatment in addition to STH treatment is marginal and assumed to be absorbed almost fully in the modeling of costs. The alternative of screening for worm infections, for example by using the Kato-Katz test, and treating only those who are infected is significantly more expensive and is not included in the package (Speich and others 2010).

For malaria, three school-based interventions were considered for inclusion in the essential package. The alternative of intermittent preventive treatment (Stuckey and others 2014)—that is, the distribution of antimalarials to all children at specific times, for example, when malaria is seasonally epidemic—was also ruled out because there is no affordable treatment available that is recommended by the WHO for this use in school-age children.

The evidence clearly demonstrates the cost-effectiveness of ITNs to lower the risk of malaria (Lim and others 2011), as well as the low usage rate among school-age children (Noor and others 2009). The essential package includes malaria education in schools for endemic countries because it is deemed to be the most effective way to promote use of ITNs (Nankabirwa, Wandera, and others 2014).

Vision and the Correction of Refractive Error

Refractive error can be detected through basic screening and can be corrected by the provision of inexpensive corrective lenses (Graham and others 2017). Schools are important in this context as a focus for identifying children with poor vision: children are typically unaware of their impairment and health systems in LMICs rarely have community outreach. The prevalence of refractive error is low, and the costs of corrective lenses can be spread across the target population, reducing the cost per child and increasing the affordability of the intervention. Studies suggest that uncorrected refractive error affects 2.34 per 1,000 people in Africa and 6.59 per 1,000 people in South-East Asia (Baltussen, Naus, and Limburg 2009); however, the proportion in Africa will likely rise as more children have access to schools and books. Studies suggest that the corrective lenses affordable in LMICs are likely to be ready-made.

Oral Health Costs

Two options for oral health are dental services and prevention through skills-based oral health education (Benzian and others 2017). In LMICs, oral health services are typically provided in clinics and hospitals, and are limited by the availability of qualified personnel; the ratio of dentists to population is roughly 1 to 2,000 in HICs, compared with 1 to 150,000 in Sub-Saharan Africa. Oral disease is an expensive condition to treat and is poorly integrated in primary health systems in LMICs (Kandelman and others 2012).

Dental screening at schools and referrals to mobile health teams with dental expertise may be possible in some settings but was not considered affordable and generalizable to be included in the essential package. In contrast, oral health promotion through schools is low cost and has the potential to shape long-term oral hygiene behaviors and is included. Oral health promotion can take place through information provided in health education classes regarding the benefits of using a toothbrush and fluorination; it may involve daily group brushing with fluoride toothpaste at school. The essential package proposes the inclusion of the Fit for School integrated oral health intervention, which has been tested in Cambodia, Indonesia, the Lao People's Democratic Republic, and the Philippines. The program, which cost US$0.60 per child per year for supplies in the Philippines, reduced school absences as well as caries by one-third after one year (Monse and others 2013).

Vaccine Costs

Evidence on the costs of administering the tetanus toxoid vaccine in schools is lacking for LMICs, hence the estimates are based on studies of the cost of antenatal vaccination in primary health clinics. The share of children reached through schools is likely to be higher, depending on attendance rates. School-based delivery is unlikely to have significant economies of scale compared with interventions such as school feeding that reach all children on a daily basis. The tetanus toxoid booster vaccine is typically administered once a year to all children at the beginning and end of primary school, in accordance with the national immunization schedule.

Vaccination to prevent HPV includes two doses administered to girls between ages 9 and 13 years. The costing exercise reflects the administration of two doses to girls in one grade in primary school. The cost of the vaccine is highly dependent on the price of the vaccine itself, which may be subsidized through GAVI, the Vaccine Alliance. On average, the cost of administering HPV immunizations in LMICS is greater than for other routine immunizations, which range from US$0.75 to US$1.40 per dose. However, the cost has dropped in recent years, enabling HPV vaccination to be delivered in low-resource settings. Some studies have found that delivering HPV vaccines through schools costs more than delivering them through health facilities and integrated school-health centers (Hutubessy and others 2012; Levin and others 2014), but coverage may also be higher. School-based delivery is likely to reach a larger share of the population, including children from disadvantaged households.

ESTIMATING THE BENEFITS

Each intervention in the essential package is justified by its low costs of delivery and high ratio of benefits to costs, making it a sound and affordable investment for LMIC governments. Improved education and health outcomes translate into improved productivity and higher national gross domestic product (GDP). To permit comparisons with costs, these benefits must be quantified in financial terms.

This section summarizes the economic benefits of each intervention and the pathways through which they are achieved, based on the literature. Estimates for the benefits of school feeding are based on evidence on specific pathways leading to health and educational outcomes.

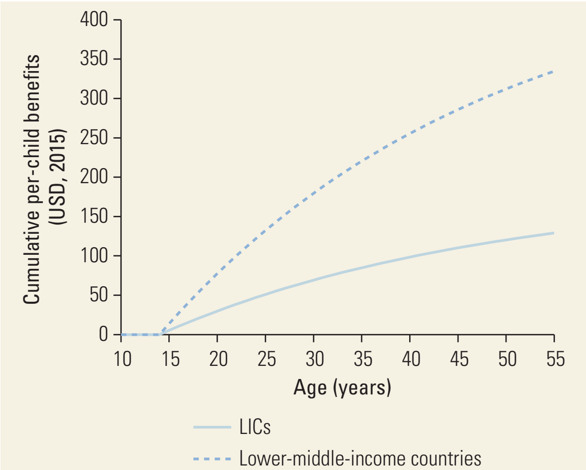
Nutrition and Food

School feeding has at least three objectives: social protection, education, and health (Drake and others 2017). School meals transfer a significant amount of noncash income to households, which can cushion shocks such as high food prices. School meals can draw children to school, support learning, and support physical growth by reducing energy deficits. Meals enhanced with micronutrients can also support child nutrition and enhance cognition. Iron-deficiency anemia is one of the top five causes of years lost to disability, contributing nearly 50 percent of the total for ages 10–19 years (Murray and others 2013). While these multiple benefits support the case for school feeding, they are difficult to quantify and aggregate (see chapter 12 in this volume, Drake and others 2017 for more discussion on school feeding).

A recent systematic review (Snilstveit and others 2015) synthesizes the findings from 16 studies (15 unique programs) published in 21 papers, of the effects of school feeding (where feeding occurs in school, that is, does not include take-home rations). The review examines three access outcomes (enrollment, drop-out, and attendance), as well as four measures of schooling outcomes (cognitive scores, math scores, language arts scores, and composite achievement scores). A meta-analysis indicated that although in many cases the point estimate of the effect of school feeding was in the expected direction (improving enrollment, reducing drop-out, and improving scores), none of the effects was statistically significant, other than an increase in attendance.

We use the effect on enrollment (a 9 percent increase, equivalent to 8 extra days in school [Snilstveit and others 2015]), the cost per school meal of $41 per child (table 25.4), and mean per capita GDP in 2015 of $620 in low-income countries and $2035 in lower-middle income countries in 2015 (World Bank 2016a). We assume that the average child eating school meals for one year is 10 years old, enters the labor force at age 15, and continues working until age 55. Annual wage income per person of working age was therefore about $574 in low-income countries and about $1,489 in lower-middle-income countries in 2015 (based on the proportion of the population of working age, 15–64 years, being 54 percent in low-income countries and 64 percent in lower-middle-income countries [World Bank 2016b], and labor income being approximately half of GDP). The returns to an extra year of education are 12 percent per annum in Sub-Saharan Africa (Montenegro and Patrinos 2014;

Figure 25.1 Estimated Cumulative Per-Child Benefits from Receipt of One Year of School Feeding in LICs and lower-middle-income countries



Note: LICs = low-income countries.

Pradhan and others 2017, chapter 30, estimate somewhat lower but still substantial returns to education across low- and middle-income countries).

With these assumptions, we can calculate that eight days of increased attendance increases future wages by 1.08 percent (12 percent multiplied by 0.09). A stream of future wages of \$W per year (starting 5 years in the future and continuing for 40 years) is worth about 20W currently, when discounted at 3 percent. Figure 25.1 presents the estimated trajectory of benefits that accrue due to the delivery of school feeding for one year based on the calculation described.

Combining these assumptions implies that the benefit-cost of school meals is around 3 in low-income countries and exceeds 7 for lower-middle income countries. With more optimistic assumptions (for example, that there are additional benefits from improved cognitive scores), the benefit-cost ratio would be even higher.

Infectious Disease

Children infected with intestinal worms are often too sick or tired to attend school or to concentrate in school when they do attend. Persistent worm infections are associated with impaired cognitive development and lower educational achievement (Mendez and Adair 1999; Simeon, Grantham-McGregor, and Wong 1995). A study from Kenya found that after a deworming program, enrollment increased 7 percent and school absenteeism decreased 25 percent (Miguel and Kremer 2004). However, these effects mask heterogeneity; children who are worse off to begin with are likely to gain more. Simeon, Grantham-McGregor, and Wong (1995) found significant impacts on attendance for children who had heavy *Trichuris* infection or were stunted. Two studies have calculated the economic and social returns to deworming in the United States and Kenya, respectively, through long-term follow-ups (Baird and others 2015; Bleakley 2007). In the United States, hookworm eradication led to gains in income and returns to schooling. In Kenya, deworming increased labor and educational outcomes among men and women, respectively. The authors estimated a conservative internal rate of return to deworming of 32 percent.

Schools can provide significant economies of scale for deworming treatment. The cost for delivery through schools was US\$0.03 (Tanzania) and US\$0.04 (Ghana) per child per year, compared with delivery through mobile health teams coordinated by primary health centers of US\$0.21 in Tanzania and US\$0.51 in Montserrat (Guyatt 2003). See also chapters 13 (Bundy, Appleby, and others 2017) and 29 (Ahuja and others 2017) in this volume for discussion of these issues.

Malaria places a significant burden on health care systems and productivity in endemic countries. In Sub-Saharan Africa, malaria is responsible for at least 15 percent of disability-adjusted life years (DALYs) (WHO 2001). Furthermore, mortality from malaria is concentrated among the poor. An estimated 60 percent of malaria-related deaths occur in the poorest 20 percent of the global population, a higher share than other common infectious diseases and conditions. Various studies have estimated the impact of malaria with regard to nutritional, cognitive and educational impairments among school-age children, such as anemia, diminished cognitive function and motor and language skills, and school absenteeism (Boivin and others 2007; Clarke and others 2004; John and others 2008; Nankabirwa, Brooker, and others 2014; Nankabirwa, Wandera, and others 2014). Malaria is associated with GDP losses of 1 percent to 20 percent, averaging 10 percent in Sub-Saharan Africa (Gallup and Sachs 2001). The regional loss in economic output is about US\$12 billion a year (WHO 2001).

Several strategies are in place to control and eradicate malaria. Ultimately, effectiveness varies with the intensity of transmission and other factors contributing to anemia, such as undernutrition and helminth infection. Global policy efforts have focused on pregnant women and children younger than age five years because of strong evidence on the effectiveness of interventions such as ITNs (White and others 2011). Recent efforts have shifted to providing ITNs to everyone, not only the most vulnerable. Less attention has been given to school-age children, although the prevalence of malaria in the school-age population is often high and can explain approximately one-half of mortality occurring in this age group (Nankabirwa, Brooker, and others 2014).

For the school-age population, strategies to control and eradicate malaria can provide benefits, such as averted cases of malaria and anemia; reduced absenteeism; enhanced attention span and cognitive function; and lowered risk of cerebral malaria, which may alter speech, language, and motor skills.

ITNs are a cost-effective intervention for reducing malaria and anemia among asymptomatic cases (White and others 2011). School-age children are the least likely to use ITNs, although studies generally find positive evidence that they face a lower risk when they do (chapter 14 in this volume, Brooker and others 2017). Based on data from 18 Sub-Saharan African countries, about 40 percent of school-age children are not protected (Noor and others 2009).

As demonstrated in studies from Ghana, Kenya, Lao PDR, and Thailand, skills-based health education in schools can increase knowledge about malaria and the correct use of ITNs and decrease parasite prevalence (Ayi and others 2010; Nonaka and others 2008; Okabayashi and others 2006; Onyango-Ouma, Aagaard-Hansen, and Jensen 2005). In Ghana, school-based education regarding ITN use was associated with a decline in malaria prevalence to 10 percent from 30 percent over the course of one year (Ayi and others 2010). Averting even a single episode of malaria may bring substantial benefits, such as increased participation in higher education and improved cognitive development over the life of the child.

Vision and the Correction of Refractive Error

The benefits of correcting poor vision are related primarily to education pathways and gains in labor market outcomes. An estimated 153 million people globally suffer from poor vision, including 13 million school-age children (Resnikoff and others 2008; Smith and others 2009). Economic losses due to impaired vision exceed an estimated US$200 billion a year globally (Fricke and others 2012). Although little is known about the prevalence of uncorrected refractive error among school-age children, an estimated 9 percent of children in Ethiopia (Yared and others 2012) and 13 percent in China (Glewwe, Park, and Zhao 2012) have undiagnosed or untreated vision problems. In Brazil, poor vision resulted in a 10 percentage point higher probability of dropping out and an 18 percentage point higher probability of repeating a grade (Gomes-Neto and others 1997). In China, poor vision decreased students' academic performance, as measured by test scores, by 0.2–0.3 standard deviations, equivalent to a loss of 0.3 years of schooling (Glewwe, Park, and Zhao 2012).

Providing eye care screening and free glasses in schools can overcome the barriers of cost and lack of skilled eye care personnel (Limburg, Kansara, and d'Souza 1999; Sharma and others 2008; Wedner and others 2000). Training teachers to assess whether children should be examined and potentially receive glasses has been tested in various contexts; in a rural region in Cambodia, fewer than 100 teachers in less than four weeks screened 13,175 students and referred 44 to a team of refractionists to be assessed for eyeglasses (Keeffe 2012).

The essential package recommends periodic screening of children in a specific grade for refractive error and provision of glasses, with the aim of screening all children at risk over time (Baltussen and Smith 2012).

Oral Health

The burden of poor oral health and hygiene is concentrated in upper-middle-income countries and HICs, although the share of the population that is untreated is highest in LMICs. Tooth decay can affect psychosocial well-being and lead to school absenteeism (Kakoei and others 2013; Krisdapong and others 2013; Naidoo, Chikte, and Sheiham 2001). Prevention of cavities may also reduce undernutrition because of the pain associated with severe tooth decay (Benzian and others 2011). The risk of poor oral health is expected to rise as diets in LMICs shift to greater consumption of processed foods and sugars (Viswanath and others 2014). Between 1990 and 2012, the average increase in DALYs due to dental caries was between 42 percent and 78 percent in most countries in Sub-Saharan Africa (Dye and others 2013; Kassebaum and others 2015). Building healthy habits in childhood may provide benefits over the life course. Group activities in school may be an effective means for establishing these norms (Claessen and others 2008).

Vaccines

Although the HPV vaccine is substantially more expensive than the tetanus toxoid vaccine, both are cost-effective. At the global level, cervical cancer caused 6.9 million DALYs in 2013, with more than 80 percent of cases occurring in LMICs (Fitzmaurice and others 2015). Country- and region-specific studies have been conducted on the benefits of HPV vaccination, with a focus on health benefits. The overwhelming majority of these studies indicate that HPV vaccination of preadolescent girls (usually ages 8–14 years, depending on the specific country) has the potential to substantially reduce the morbidity and mortality associated with cervical cancer. Assuming coverage of 70 percent, effective over a lifetime, HPV vaccination could avert more than 670,000 cervical cancer cases in Sub-Saharan Africa over five consecutive birth cohorts of girls vaccinated as young adolescents (Kim and others 2013).

The HPV vaccination is now part of the recommended national schedule in more than 60 countries or territories, but only 8 of these are LMICs (WHO and UNICEF 2013). However, more than 25 LMICs, about one-third in Africa, have piloted the vaccine in one or more urban and rural districts. Recommendations to replace the three-dose schedule with a two-dose schedule, with a minimum interval of six months between doses, would increase the benefits in relation to the costs (WHO 2014). More information on the HPV vaccine can be found in volume 3, chapter 4 (Denny and others 2015).

Delivery of the tetanus toxoid vaccine lowers the risk of contracting tetanus, both for recipients and for their children who have not yet been vaccinated, providing an intergenerational benefit. In Africa, tetanus has caused 3 million DALYs (Ehreth 2003). For the essential package, countries need to administer the tetanus toxoid vaccine to children in the grade that captures the largest proportion of children ages 4–7 or 12–15 years.

COMPARING COSTS AND BENEFITS OF THE ESSENTIAL PACKAGE

Figure 25.2 provides an illustrative mapping of the benefits and costs for all of the interventions in the essential package. Some interventions should be delivered to all children, while others should be targeted geographically or by age to limit overall costs.

Table 25.4 presents the essential package of school health interventions for LMICs, based on costs and benefits. Differences between LICs and lower-middle-income countries are due to differences in resources. Upper-middle-income countries can augment the essential package with additional interventions or expand coverage of targeted interventions to a wider age group or to more schools. All countries may tailor the package to the context and add additional components.

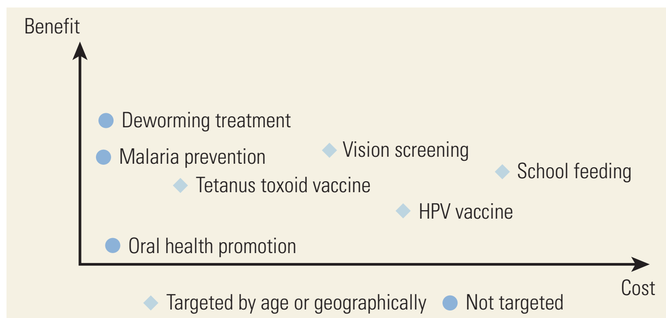
The essential package addresses a variety of health risks facing school-age children. Some are tackled directly; others seek to change behaviors associated with poor health outcomes, including the use of ITNs and promotion of oral health. The frequency of delivery is also noteworthy. Some interventions are delivered just once over the course of primary school (HPV vaccination), while others recur daily (school feeding) or annually (deworming and vision screening). All costs are standardized to one calendar year.

In total, the essential package costs an estimated US$10.30 per child per year in LICs. The average cost per child of each intervention draws on the cost per treated child in table 25.3. For targeted interventions, the cost per treated child exceeds the average cost per child. Some efficiencies can be expected. In this exercise, a 20 percent reduction in costs for the integrated delivery of malaria and oral health education was assumed (figure 25.3).

The delivery of some interventions is recommended for all children (oral hygiene). For other interventions, screening of all children and treatment for an identified subset of children is recommended (eyeglass screening). For some interventions, the economic returns are greater when targeted to a subset of the population, such as school feeding for food-insecure areas or for children at risk of dropping out.

These estimates exclude start-up costs, which could include the costs of establishing policies or guidelines or undertaking mapping exercises. For example, a national mapping exercise of helminth worms would indicate where deworming treatment is needed, and mapping of poverty and food security would support

Figure 25.2 Indicative Mapping of Benefits and Costs of Essential Package Interventions



Note: HPV = human papillomavirus.

Figure 25.3 Cost Shares of the Essential Package, by Country Income Level
U.S. dollars

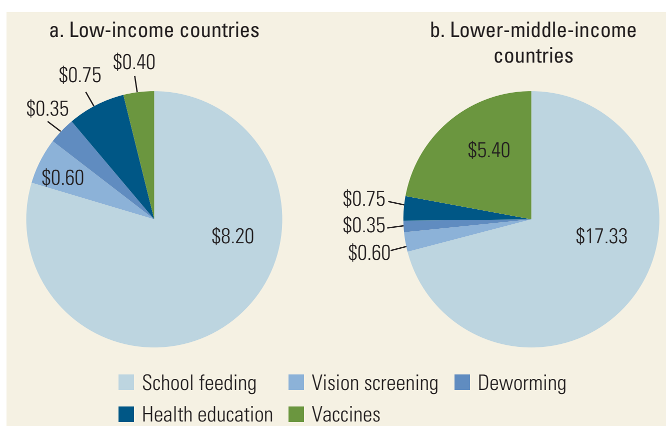


Table 25.4 Costs of the Essential Package of Health Interventions for School-Age Children

	Low-Income Countries			Lower-Middle-Income Countries		
Domain	Intervention	Target	Average annual cost per child (US$)	Intervention	Target	Average annual cost per child (US$)
School feeding	Daily snacks or meals with micronutrient fortification	All children in at least 20% of schools in regions with the highest levels of poverty and food insecurity	8.20	Daily meals with micronutrient fortification	All children in at least 40% of schools in regions with the highest level of poverty and food insecurity	16.40
Deworming	Deworming treatment	All children attending schools in areas endemic for STHs and schistosomiasis[a]	0.35	Deworming treatment	All children attending schools in areas endemic for STHs and schistosomiasis[a]	0.35
Vision screening	Screening and provision of ready-made glasses	All children in a select grade	0.60	Screening and provision of custom or ready-made glasses	All children in a select grade	0.60
Oral health and malaria	Health education about prevention of tooth decay and usage of ITNs	All children for oral health promotion and all children attending schools in endemic areas for malaria[a]	0.75	Health education about prevention of tooth decay and usage of ITNs	All children for oral health promotion and all children attending schools in endemic areas for malaria[a]	0.75
Vaccines	Tetanus toxoid vaccine	Children in a select grade in all schools	0.40	Tetanus toxoid vaccine	Children in a select grade in all schools	0.40
	HPV vaccine			HPV vaccine	Girls from a select grade in all schools (two doses)	5

Note: HPV = human papillomavirus; ITNs = insecticide-treated bednets; STHs = soil transmitted helminths.
a. Assuming 50 percent of child population at risk.

the targeting of school feeding to the most disadvantaged households. Costs of the total package are aggregated by size of population in low-income and lower-middle income countries in chapter 1 (Bundy, de Silva, and others 2017).

CONCLUSIONS

Several low-cost health interventions to support the development of children can be delivered through schools. The health and education benefits for each intervention are significant, but there is comparatively less evidence on the combined benefits of providing several interventions jointly. The provision of a set of integrated basic interventions may create cost efficiencies and increase the benefit-cost ratio. For example, health education classes can include material on both oral hygiene and malaria prevention.

This chapter defines an affordable package of school-based health interventions for LMICs and estimates the costs and potential benefits. The interventions can improve the quality and the quantity of schooling, generating a high benefit-cost ratio. The returns to education are highest in LICs, but this finding is due, in part, to higher per capita income in lower-middle-income countries. More research is needed on how to support countries in financing the essential package as well as evaluating the benefits over the life course.

Interventions for school-age children can have significant impacts on schooling, earnings, health status, and productivity in LMICs. The estimated benefit-cost ratios for such interventions consistently exceed one, suggesting that the discounted value of gains exceeds the costs. These results support the case for placing school health high on the policy agenda and for promoting coherence with early childhood health intervention programs to maximize benefit gains. Causal estimates of the impacts of interventions stem mostly from small-scale local interventions and are likely to be sensitive to population heterogeneity (social, economic, and cultural differences), differences in program implementation (administrative capacity and trust), and differences in the wider political economy of reform. As a result, available impact estimates may have limited external validity. In addition, benefit-cost ratios based on these impact estimates are sensitive to the choice of rates of return and discount rates applied in evaluating future impacts against costs.

If benefit-cost ratios associated with interventions for the school-age child are so attractive, why have governments not implemented them at scale? Benefits may not scale up, despite scale economies, and the benefit-cost ratio for nationwide implementation may be lower. Moreover, governments may not be sufficiently aware of the benefits of the interventions; indeed, the documents guiding national and international policy tend to evaluate immediate reductions in clinical morbidity and mortality and to give low priority to the long-term socioeconomic benefits. Furthermore, the health and development of school-age children has historically been given low priority in health system planning, so even where governments recognize the net benefits of interventions for the school-age child, they may face budgetary constraints and conflicting priorities, especially given the strong vested interests in existing programs for other age groups.

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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