

# School feeding: Outcomes and costs

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## Abstract

**Background.** School-feeding programs are popular development assistance programs in developing countries but have previously had few sound, empirical analyses of their effectiveness and costs.

**Objective.** The goals of this study were to provide a realistic estimate of the costs of school feeding and combine these estimates with outcome information to obtain the cost per outcome.

**Methods.** Cost studies were conducted in three African countries by reviewing school-feeding costs provided by the World Food Programme and interviewing stakeholders in ministries of education and in the community. In another African country, existing costing information was used. To compare across the countries, costs were standardized for a 200-day school year, a 700-kcal per day ration, and when children were not fed. To obtain cost per outcome data, outcomes were obtained from a review of school-feeding studies.

**Results.** The cost of school feeding ranged from US\$28 to US\$63 per child per year (weighted mean cost of US\$40 per child per year). The cost for an extra day of attendance was less than US\$10 per student, while the cost per extra kilogram of weight ranged from US\$38 to US\$252. Costs for cognitive outcomes were similarly variable.

**Conclusions.** This analysis estimates a higher average cost but a narrower range of costs when compared with previous estimates, reflecting the greater precision of the

current analyses. The cost per outcome was high, but this analysis does not capture the full range of outcomes (e.g., social protection, educational achievement) potentially derived from school feeding.

**Key words:** Costs, feeding, outcomes, schools

## Introduction

Many programs have been implemented in developing countries to improve both the physical health and the psychosocial health of students. In order to appropriately allocate limited resources, it is essential to have sound, empirical evidence on the outcomes and costs of such programs.

School feeding is a longstanding and popular development assistance program in low- and middle-income countries. In fact, it is implemented in over 72 countries by the World Food Programme (WFP) alone. Many studies have evaluated the impact of school meal programs on children's physical and psychological health. Yet, surprisingly, until now there have been few attempts to review and critically synthesize the available literature on outcomes of school feeding. In 1986, Levinger [1] published an often-cited review of 34 studies on school feeding. This review concluded that school feeding can have positive effects on enrollment and attendance, particularly when designed to target vulnerable children, but there was little evidence that school feeding improved cognitive outcomes.

Evidence on the cost of school feeding is similarly rare. Some evidence does come from two earlier studies [2, 3], as reviewed by Del Rosso [4]. Both studies found wide variations in the costs of school feeding. In the first study, 16 school-feeding programs in Latin America delivering 1,000 kcal for 365 days had costs ranging from US\$10.95 to US\$306.60 per year. In the second study, the cost of school feeding, standardized over 365 days and 1,000 kcal per day, ranged from US\$19.25 to US\$208.59 per year (1989 US dollars).

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The WFP estimated that the costs (standardized over 200 days and 700 kcal) of providing a child with food at school were on average US\$34 per child per year in 2001 [5] and US\$20 per child per year in 2006 [6]. Little information was provided in the World Bank [2] and Horton [3] studies on the breakdown of costs, and the WFP reports only on the cost to the WFP and not other contributions from government and civil society. There is a dearth of research in general on the cost per outcome for school-feeding programs.

We sought to fill this gap with a new cost and cost per outcome study of school meal programs. The recent publication of a rigorous systematic review and meta-analysis of available experimental and quasiexperimental studies on school feeding by Kristjansson et al. [7] provided an opportunity to conduct a cost per outcome analysis of school-feeding programs. Our main objectives were to provide an up-to-date, realistic estimate of the costs of school feeding and combine these estimates with results of the review of Kristjansson et al. to calculate the cost per outcome of school feeding. Our focus is on low- and middle-income countries.

## Methods

### Impact

Kristjansson et al. [7] conducted a standardized search for studies and retrieved 400 studies on the nutritional, cognitive, and educational impact of school feeding, including 8 papers from studies conducted before 1986 not included in the Levinger [1] review. However, only 18 studies met their criteria for inclusion in the final synthesis; 9 were from low- and middle-income countries, and 9 were from high-income countries. Within the nine studies from low- and middle-income countries, children participating in the studies ranged in age from 5 to 15 years, and the duration of feeding was 1 month to 2 years, except for one study [8] that was only a few weeks long and examined only short-term cognitive outcomes. Full details on the methodology are available from Kristjansson et al. [7].

For this analysis, only studies from low- and middle-income countries were considered, because the authors sought information of value to policy makers in developing countries about the educational returns from investment in school-feeding programs. Furthermore, the study of Chandler et al. [8] was not used in this analysis for the reasons stated above, which means a total of eight studies were used.

Herein, we consider the following outcomes analyzed by Kristjansson et al. [7]: weight, height, attendance, math performance, and intelligence from eight studies from low- and middle-income countries. Our focus is on effect per school year.

Kristjansson et al. [7] performed meta-analyses

on six studies for both weight and height gain; three [9–11] were randomized, controlled trials (RCTs) and three [12–14] were controlled before-and-after studies (CBAs). The results of the RCTs and the CBAs were analyzed separately. The review found data on attendance from three studies; two were RCTs [10, 15] and one was a CBA [16].

Four studies considered change in math performance: two RCTs [10, 11 as reported in 17] and two CBAs [12, 16]. Meta-analysis was performed on the two CBAs. Two studies, one RCT [11 as reported in 17] and one CBA [12], reported data on intelligence-type tests; the RCT used Raven's Progressive Matrices, and the CBA used the Weschler Intelligence Scale for Children (WISC).

The RCTs and CBAs used standard RCT and CBA methodologies; however, the analysis of Kristjansson et al. developed quality criteria for reviewing the rigor of these methodologies [7]. In the case of RCTs, children were randomized to either school-feeding groups or control groups. In the case of CBAs, outcomes were measured before and after in the school-feeding group and a control group. Control groups were either "no-treatment" controls (lunch or breakfast at home or no feeding) or placebo controls (e.g., low-energy glucose syrup at school). Where studies allocated meals by school or class, Kristjansson et al. adjusted the results to correct for design effects if this was not done in the primary studies.

The rations provided 8% to 33% of the US recommended dietary allowance (RDA) for energy (measured in kilocalories); three of the studies provided less than 15% of the RDA for energy. All studies except two provided cooked meals at school; of these two studies, one provided cookies or cake and a flavored drink and the other provided milk fortified with calcium. The types of foods provided in these studies consisted of dairy products alone or with a food of plant origin; meat and vegetables; or a meal consisting only of foods of plant origin. The studies providing vegetarian meals were conducted in India. **Table 1** gives the details for each study on country of origin, the number, sex, and age of the children participating in the study, the length of the study, and the daily energy ration.

### Gains per school year

To align benefits shown in the review with the cost analyses, gains from school feeding were converted to a 200-day (or 10-month) school year. We calculated effect per month by dividing the total effect by the number of months during which the students were provided with food in each study, and then multiplied this by 10. The standard deviation for change was not available for the Powell 1983 study [16], so we estimated gains per school year for that study by multiplying the standardized mean difference (SMD) (0.31) from the

TABLE 1. Characteristics of nine school-feeding studies

Study	Type	Country	No. and age of children	Length of study	Ration size (kcal)	Ration type	Outcomes
Agarwal (1989) [12]	CBA	India, rural	450 boys and girls, 6–10 yr	356 days of feeding in 24 mo	450–500	Food not described; only nutritional composition	Weight, height, math, intelligence
Bailey (1962) [13]	CBA	India, rural	140 boys, 7–13 yr	12 mo	195	Green gram and palm sugar	Weight, height
Devadas (1979) [14]	CBA	India, rural	400 boys and girls, 5–8 yr	10 mo	345–395	Vegetable protein mixture	Weight, height
Du (2004) [9]	RCT	China, Beijing	757 girls, 10 yr (mean)	24 mo on school days	10% of RDA ( $\approx$ 200)	Milk, fortified with calcium or calcium and cholecalciferol	Weight, height
Jacoby (1996) [15]	RCT	Peru, periurban/rural	352 (80% boys), 11 yr (mean)	5 wk	600	Cookies and instant drink; occasionally a cake and flavored drink	Attendance
Neumann (2003) [11]; includes Whaley (2003) [17]	RCT	Kenya, rural	236 boys and girls, 6–14 yr	23 mo	239 in yr 1, 313 in yr 2	Meat or milk added to the traditional vegetable-based diet	Weight, height, math, Raven's progressive matrices
Powell (1983) [16]	CBA	Jamaica, rural mountains	115 boys and girls, 12.5 yr (mean)	3 mo	380–730 (depending on food children chose)	Milk plus either banana cake or a patty with minced meat and vegetables	Weight, height, attendance, math
Powell (1998) [10]	RCT	Jamaica, rural mountains	813 boys and girls, 9 yr (mean)	8 mo	576–703 (depending on food children chose)	Cheese sandwich or spiced bun and cheese and flavored milk	Weight, height, attendance, math

CBA, controlled before-and-after study; RCT, randomized, controlled trial; RDA, recommended dietary allowance

meta-analysis by the standard deviation for change on the Wide Range Achievement Test (WRAT) subtest for the control group in the Powell 1998 study [10], which we confirmed with the author (Powell) as reasonable. For meta-analyses, we averaged the duration of feeding. Some studies ran for more than 10 months and did not report the duration of feeding [9, 11, 13, 14]. In these circumstances, we assumed that the duration of feeding was 10 months a year. We then calculated the effect per month as described above.

### The cost of school-feeding programs

Our goal was to estimate all the costs of school-feeding programs in Africa, including costs to the WFP, governments, and communities. We chose Kenya, Malawi, Lesotho, and the Gambia for the analysis because their school-feeding programs provided cooked meals, like most of the studies in the review of Kristjansson et al. [7]. The programs in Kenya, Malawi, and the Gambia have subnational coverage. Lesotho is the only

country of the four with a program aiming to cover all schools.

Lesotho has different school-feeding programs for the highlands and the lowlands. The WFP provides meals to all children in mountainous areas, while the government provides meals through contracted caterers in the rest of the country. The government subsidizes the cost of the WFP program by providing operating expenses for a Food Management Unit in the Office of the President, for school-feeding staff, and for operating costs in the Ministry of Education and by paying the salaries of cooks in areas supported by the WFP.

### Calculating WFP costs for 2005

In each of these countries, the WFP keeps records on the costs of its program, including the costs of the commodities, international and internal transport, landside transport storage and handling, other direct costs, direct support costs (WFP staff time in-country), and indirect support costs (WFP overhead, which is usually about 7%).

### Calculating government and community costs in each country for 2005

*Calculating costs for Lesotho.* Lesotho was the only country where field visits were not made, because a comprehensive evaluation of the school-feeding program\* included costs. Costs from this study\*\* were adjusted for 2005 dollars since the costs for the study were collected before 2002; 2005 costing information from WFP [5] costs and the Government of Lesotho/WFP Plan of Operations 2004–07 [18] was also used.

*Calculating costs for Kenya.* The WFP provided information on the cost of school feeding for the Government of Kenya. To obtain information on the costs of salaries, commodities, transportation, supplies, and other costs contributed by government and both cash and in-kind contributions of communities in Kenya, we interviewed two Ministry of Education staff responsible for the school-feeding program and teachers and principals in three districts during meetings for the Ministry of Education's Joint Sector Review for the Education Sector and during field visits for the Joint Sector Review in October, 2006. Schools were chosen by the Ministry of Education for the Joint Sector Review, and questions about school feeding were included in the intake forms developed for the Joint Sector Review process. Principals and teachers responsible for the school-

feeding program at 10 schools were interviewed in one province. These schools included primary schools that were in remote and resource-poor settings, schools for children with disabilities, and one school that was both a boarding school and a day high school. One school financed its school-feeding program. This school was particularly helpful in detailing all the costs of school feeding. Teachers were asked to estimate the amount of time they contributed to school feeding, the types of foods provided, and the cash and in-kind contributions made by communities. Kitchens and storage areas were examined, and in some cases food preparation and mealtimes were observed. At some schools, other teachers were interviewed for their perceptions about the benefits of the school-feeding program. The local cost of commodities purchased by the community was obtained by interviewing teachers.

*Calculating costs for Malawi and the Gambia.* WFP Country Office staff and Ministry of Education staff were interviewed in October 2006 and December 2006, respectively, to estimate the cost of salaries, commodities, transportation, supplies, and other costs contributed by government and both cash and in-kind contributions made by teachers and communities to the school-feeding program in each country. In the case of the Gambia, two school-feeding coordinators and the HIV coordinator for the Ministry of Education were interviewed. To obtain more information on the benefits of school feeding and community contributions from teachers, a focus group was conducted with 12 teachers. In Malawi, WFP school-feeding programs were examined during January 2003. Observations were made at five schools (primary schools in rural areas and one boarding high school) on the community contribution to the school-feeding program. Observations were also conducted of storage facilities, food preparation, mealtimes, and the community members participating in school feeding. At the time of the visit, Malawi was experiencing food shortages, and all schools participating in the school-feeding program in Malawi were in particularly food-insecure areas. The coordinator for school health and nutrition in the Ministry of Education was interviewed and provided estimates for teachers' involvement, salaries, commodities, and so forth.

*Subtracting costs of take-home rations.* The WFP also provides take-home rations to orphans and vulnerable children for the entire year in Lesotho and for part of the year in Malawi. The cost of the commodity for the take-home ration (maize) was calculated by using a regional producers' price for maize (US\$136/metric ton) [19] multiplied by the tonnage of maize used in the take-home rations reported by the WFP, along with estimates of the share of the program costs needed to deliver take-home rations. This amount was

\* Carr-Hill R, Sebata M, Caraher M. Evaluation of school feeding programme in Lesotho. Final Draft. University of London, National University of Lesotho, Thames Valley University, 2002.

\*\* Ibid.

then subtracted from the cost of the school-feeding program in these countries to factor out the cost of the take-home ration.

*Calculating days fed and energy provided.* The energy provided at each meal and the number of school days varied in each country. To allow meaningful comparisons across the different countries, the cost data were standardized to 200 days per school year and a daily meal providing 700 kcal. We chose a 200-day school year or 200 days of school feeding because in all four countries, the school year approached 200 days, but we standardized against either the known length of the school year (Kenya, Lesotho, and Malawi) or, in the case of the Gambia, where the number of days on which children were fed was known, we standardized against the number of school-feeding days. The ration of 700 kcal provides one-third to one-half of the RDA for primary schoolchildren. This is more energy than that provided in most studies in the analysis of Kristjansson et al. [7] and by the school-feeding programs in Malawi and the Gambia; however, we chose this higher ration because many of the studies analyzed by Kristjansson et al. provided animal foods (e.g., meat, milk), and we felt the higher energy ration in the four countries in this analysis, all of which provide a plant-based meal, would compensate for the higher cost of providing animal foods. In addition, many WFP and government school-feeding programs provide roughly one-third of the energy requirements for school-age children, as evidenced by the programs in Kenya and Lesotho.

*Calculating the costs.* In order to accurately calculate costs, we needed to know the actual number of days of school feeding. This number may be different from the planned number of school-feeding days due to pipeline breaks, which occur when food is not delivered because of problems with supply or climate.

The number of actual days of feeding was reported in the Gambia, where the standardized cost per beneficiary ( $c_s$ ) was calculated as follows:

$$c_s = c_{pr} \times \left( \frac{200}{d_{sf}} \right) \times \left( \frac{700}{k_{cal}} \right)$$

where

- $c_{pr}$  = actual cost per beneficiary using total project expenditure,
- $d_{sf}$  = number of days fed, and
- $k_{cal}$  = planned ration in kilocalories.

In Kenya, Lesotho, and Malawi, however, there were no data for specific pipeline breaks for school feeding, and we do not know how many days the students actually received food. Therefore, in those countries, except for the reported costs of school feeding implemented by the Government of Lesotho, where we could not make

this adjustment because we did not know the type or size of the ration or the number of days children were fed, we accounted for pipeline breaks by scaling the cost per beneficiary by planned versus actual food tonnage distribution using the following equation:

$$c_s = c_{pr} \times \left( \frac{200}{d_{sd}} \right) \times \left( \frac{700}{k_{cal}} \right) \times \left( \frac{T_p}{T_a} \right)$$

where

- $c_{pr}$  = actual cost per beneficiary using total project expenditure,
- $d_{sd}$  = number of days in the school year,
- $k_{cal}$  = planned ration in kilocalories,
- $T_p$  = planned school-feeding tonnage, and
- $T_a$  = actual school-feeding tonnage.

### Cost per outcome

We took the findings on outcomes from the eight studies from low- and middle-income countries in the review of Kristjansson et al. [7] (methodology explained above) and combined these results with the cost information collected for four countries in this study to determine the cost per outcome for school-feeding programs. The cost per outcome was calculated by dividing the average costs of school feeding per child per year in each of the four countries in this study by the average gain (e.g., IQ points, days of attendance, kilograms of weight) per 200-day school year from eight studies in the analysis of Kristjansson et al. [7].

## Results

### Impact

Selected findings on the impact of school feeding on attendance, weight, and height per school year are summarized in **table 2**. For a full report on the review, please consult Kristjansson et al. [7].

The RCTs showed an increase in attendance that translated into 4 to 6 days per 200-day (10-month) school year. The effect was much greater, but not statistically significant, in the CBA, with children attending an additional 16.5 days per year.

For the RCTs and CBAs, there were significant effects on weight gain. There was no significant impact on height from three RCTs, but analysis of the three CBAs showed that students who received school meals gained 1.12 cm per year more than those who did not. There was an interaction between age and treatment such that younger children grew more in the CBAs. In the RCTs, there was also an interaction, but it was complex and may have been confounded by low energy intensity in one study.

## Cognitive function

**Table 3** shows the effects of school feeding on cognitive function. School feeding had a consistent impact on math performance (achievement and aptitude). Gains in math aptitude were rather small in the RCTs. Interestingly, in the Powell RCT [10], the math increase was largest for the youngest children. In the CBAs, the gains for the experimental group were 0.31 SMD (or  $\frac{1}{2}$  of a standard deviation higher than that of the control group) over an average period of 6 months. There were also improvements in some aspects of short-term cognition and on-task, in-classroom, and playground

social behavior. These, however, are not included in any analyses because of the impossibility of extrapolating to a school year.

## Cost of school-feeding programs

**Table 4** shows the WFP, government, community, and total costs of school-feeding programs in Kenya, Lesotho, Malawi, and the Gambia per child per year. The first cost per child per year (the second to the last row in the table) provides the estimates of the school-feeding programs in all countries without standardization for a 200-day school year and a 700-kcal ration

TABLE 2. Effects of school meals on attendance, weight gain, and height gain in schoolchildren in low- and middle-income countries

Variable	Attendance		Weight gain		Height gain	
	RCT	CBA	RCT	CBA	RCT	CBA
No. of studies	2	1	3	3	3	3
Duration of feeding (month)	1, 8	3	Average 15.3	Average 9.7	Average 15.3	Average 9.7
Ration size (kilocalorie)	600, 576–703	380–730	200, 239–313, 576–703	195, 345–395, 450–500	200, 239–313, 576–703	195, 345–395, 450–500
Effect per month	0.40–0.60 days	1.65 days	0.025 kg	0.073 kg	0.025 cm	0.147 cm
Effect size <sup>a</sup>	0.18	0.19	0.25	0.75	0.17	1.12
Effect per school year <sup>b</sup>	4–6 days <sup>c</sup>	16.5 days	0.25 kg	0.73 kg	0.25 cm	2.7 cm (5–6 yr), 1.29 cm (6–8 yr), 1.47 cm (overall)

CBA, controlled before-and-after study; RCT, randomized, controlled trial

Source: Kristjansson et al. [7].

a. Hedges' adjusted *g*.

b. Assumes linear gains in attendance and a 10-month school year.

c. Note that the estimate of 4 days is probably more realistic, since it came from a study that was 8 months long.

TABLE 3. Effects of school feeding on cognitive function

Variable	Intelligence-type tests		Math performance	
	RCT	CBA	RCT	CBA
No. of studies	1	1	2	2
Duration of feeding (mo)	20	18	8, 10	Average 6
Ration size (kcal)	239–313	450–500	239–313, 576–703	380–730, 450–500
Points per school year	0.34 on Raven's Progressive Matrices	2.2 IQ	0.89 <sup>a</sup> 0.18 on Math subtest of WISC	1.2 <sup>a</sup>
Significance	$p < .05$ (significant)	Not significant	$p < .05$ (significant)	$p < .05$ (significant)
Effect size <sup>b</sup>	0.11 (not significant)	0.15 (not significant)	0.12 WRAT Math 0.11 WISC Math	0.31

CBA, controlled before-and-after study; RCT, randomized, controlled trial; WISC, Weschler Intelligence Scale for Children; WRAT, Wide Range Achievement Test.

Source: Kristjansson et al. [7].

a. See methods for details of calculation.

b. Hedges' adjusted *g*.

or adjusted for pipeline breaks. The second cost per child per year (the last row in the table) provides the estimates of the cost of providing a 700-kcal ration at school for 200 days per year, which ranged from US\$28 per child per year in Kenya to US\$63 per child per year in Lesotho. The weighted mean cost across the four countries is US\$40 per child per year.

As can be seen from **table 4**, the Government of Lesotho pays for most of the national school-feeding program (87%). In Kenya, Malawi, and the Gambia, the WFP paid for most of the school-feeding program (71% to 92%), whereas government shares ranged from 3% in Malawi to 14% in Kenya. Community contributions to school feeding ranged from 0% in Lesotho to 15% in Kenya. (In Lesotho, the government absorbed costs that communities were previously paying, so there

were no community costs for school feeding).

**Table 5** shows the breakdown of costs to the WFP and the government in Kenya, Lesotho, Malawi, and the Gambia. The cost of the commodities made up the largest share of the school-feeding budget in all countries: Kenya (57%), Lesotho (74%), Malawi (54%), and the Gambia (51%).

### Cost of school feeding per outcome

**Tables 6** and **7** show the cost per outcome of school feeding for selected outcomes. These varied widely according to outcome. For example, the cost of an extra day of attendance ranged from \$4.7 to \$15.8 in the RCTs and \$1.7 to \$3.8 in the CBAs. The cost of an extra kilogram of weight ranged from \$112 to \$252 in

TABLE 4. Cost of providing meals at school for selected school-feeding programs

Variable	Kenya 2005	Lesotho 2005 (highlands)	Lesotho 2005 (lowlands)	Lesotho 2005 (country average)	Malawi 2005	Gambia 2005
No. of children (thousands)	1,156	146	245	391	214	113
No. of days <sup>a</sup>	195	180	180	180	183	146
Reported daily energy value of ration (kcal)	703	NA	838	NA	376	551
WFP costs (US\$1,000)	15,526 (71%)	2,834 (44%)	0	2,834 (13%)	4,564 (92%)	2,274 (82%)
Government costs (US\$1,000) <sup>b</sup>	3,195 (14%)	3,669 (56%)	15,053 (100%)	18,722 (87%)	135 (3%)	216 (8%)
Community costs (US\$1,000)	3,214 (15%)	0	0	0	264 (5%)	270 (10%)
Total costs (US\$1,000)	21,935	6,503	15,054	21,556	4,962	2,787
Cost/child/year (US\$)	18.97	44.60	61.44	55.16	23.20	24.67
Standardized costs/child/year (US\$) <sup>c</sup>	28.09	53.34	68.27	62.70 <sup>d</sup>	59.00	42.93

NA, not available; WFP, World Food Programme

a. Number of school days in the school year (Kenya, Lesotho and Malawi) or number of days of school feeding (the Gambia).

b. Includes teachers' time.

c. Adjusted for a 700-kcal ration and a 200-day school year. Also adjusted for planned vs. actual tonnage (data not shown), except in the Gambia, where we know the actual number of days that students were fed. In Lesotho highlands, the figure represents only an adjustment for the school year, since we do not know the ration size.

d. Weighted average for WFP and Government of Lesotho programs.

TABLE 5. Breakdown of cost of school feeding by element (US\$1,000)

Element	Kenya	Lesotho	Malawi	Gambia
Commodities	12,447 (57%)	16,033 (74%) <sup>a</sup>	2,696 (54%)	1,417 (51%)
External transport, storage, and handling	1,757 (8%)	112 (0.5%)	229 (5%)	535 (20%)
Internal transport, storage, and handling	1,902 (9%)	893 (4%)	629 (13%)	186 (7%)
Direct operational costs <sup>b</sup>	4,782 (22%)	4,310 (20%)	971 (20%)	507 (18%)
WFP overhead <sup>c</sup>	1,047 (4%)	208 (1.5%)	437 (8%)	143 (4%)
Total	21,935	21,556	4,962	2,787

WFP, World Food Programme.

a. Includes government costs for caterers, which include not only the cost of food but also the caterers' costs for salaries, etc., which could not be disaggregated.

b. Includes all in-country program costs (except internal travel), including salaries and benefits, housing, insurance, and community costs.

c. When the percentages did not add up to 100%, the differences were either added or subtracted from the WFP overhead.

TABLE 6. Cost per year per outcome of school feeding in improving attendance, height, and weight (US\$)<sup>a</sup>

Cost	Cost per extra day of attendance	Cost per additional centimeter of height	Cost per additional kilogram of weight
Range of costs for RCTs	4.7–15.8	112.0–252.0	112.0–252.0
Average cost per average for RCTs	8.0	160	160
Range of costs for CBAs	1.7–3.8	10.4–23.3 (5–6 yr of age) 21.7–48.8 (6–8 yr of age) 19.0–42.9 (overall)	38.4–86.3
Average cost per average for CBAs	2.4	14.8 (5–6 yr of age) 31.0 (6–8 yr of age) 27.2 (average)	54.8

CBA, controlled before-and-after study; RCT, randomized, controlled trial

a. The calculations combine information from the analysis of Kristjansson et al. [7], as shown in **table 2**, and the cost information, as shown in **table 4**.

TABLE 7. Cost per year per outcome of school feeding for gains on IQ and math tests (US\$)<sup>a</sup>

Cost	Cost per point on Raven's Progressive Matrices	Cost per IQ point	Cost per point on math achievement or aptitude
Range of costs for RCTs	82.4–185.3	Not in the analysis	31.5–70.8 (WRAT) 155.6–350.0 (Math subtest of WISC)
Average cost per average for RCTs	117.6	Not in the analysis	44.9 (WRAT) 222.2 (Math subtest of WISC)
Range of costs for CBAs	Not in the analysis	12.7–28.6	23.3–52.5
Average cost per average for CBAs	Not in the analysis	18.2	33.3

CBA, controlled before-and-after study; RCT, randomized, controlled trial; WISC, Weschler Intelligence Scale for Children; WRAT, Wide Range Achievement Test

a. The calculations combine information from the analysis of Kristjansson et al. [7], as shown in **table 3**, and the cost information, as shown in **table 4**.

the RCTs and \$38 to \$86 in the CBAs. These data are provided to contribute to future meta-analyses that will compare costs within individual outcomes, or between outcomes where the benefits of different outcomes are sufficiently well known. It is not intended that these cost data be used here to compare costs between different outcomes, since, for example, the relative value of a day of schooling versus a gain in weight of 1 kg is not considered. For any one outcome, the cost per outcome was higher in the RCTs than in the CBAs, although the costs were of the same order of magnitude, suggesting that the comparison is valid. This difference may reflect the higher precision of the RCTs in estimating actual effects.

## Discussion

### Systematic review of outcomes: Results, strengths, and weaknesses

Educating children is one of the most important development activities. Attaining higher levels of education in low- and middle-income countries increases

individual and national incomes, reduces fertility rates, and improves the health and nutritional status of schoolchildren and future generations of children [20]. Age-appropriate enrollment, attendance, and ability to learn may be affected by external factors, including the health and nutritional status of children before and during primary school [21, 22]. School-feeding programs have been implemented in low- and middle-income countries to increase enrollment and attendance, improve learning, and decrease hunger and malnutrition, although there have been few systematic studies to determine if these goals are being met.

Kristjansson et al. [7] concluded that school feeding can benefit weight, school attendance, math achievement, aspects of short-term cognition, and behavior and that these effects are generally small. The results for height were mixed and it is difficult to draw any firm conclusions, but, based on the results from the CBAs, the authors believe that there may be a small effect. The authors also believe that the effects found in the school meals review are an underestimate of the potential benefits of school feeding because of a number of problems with implementation, including inadequate energy provision in some of the studies

(two provided less than 15% of the RDA) and the “substitution effect,” which means that children consumed less at home when they received a meal at school (in the studies that reported on this, children consumed an average of 50% less of the RDA for energy at home). Furthermore, the systematic review did not incorporate the effects on enrollment or of micronutrient fortification of school meals.

These effect sizes from school feeding are generally in the same range as those seen in reviews or studies of other school health and nutrition interventions, including an increase of 0.41 in IQ (pooled standardized mean difference) with iron supplementation for children 8 years of age or older [23], a 0.34-kg increase in weight for children 16 years of age or younger with annual deworming [24], and an increase in attendance of 5 days per year among children receiving regular doses of chloroquine for malaria prevention [25] (as reported in Taylor-Robinson et al. [24]).

### **Costing: Results, strengths, and weakness**

The costing study has sought to provide comparable and realistic estimates of the cost of school feeding, which range from US\$28 per child per year in Kenya to US\$63 per child per year in Lesotho. The estimates of the costs included those for the major donor of school-feeding programs (the WFP), governments, and communities. Our analysis also standardized the costs across the four countries using a 200-day school year and a uniform ration (700 kcal/day) and made adjustments to the cost based on pipeline breaks. Previous estimates of school feeding report on the cost per child per year, but these costs are variable because they are not based on feeding children every day during the school year. We believe our analysis is the first that considers the costs of the pipeline breaks, using planned and actual tonnage of food, to determine what the costs of school feeding would be if children were fed every day of the school year.

In all countries, adding government and community costs, which are rarely accounted for in costing estimates for public health programs, standardizing the school year and size of the ration, and adjusting for pipeline breaks increased the cost of school feeding over the average cost of school feeding reported most recently by the WFP (US\$20 per child per year) [26]. In fact, the weighted average of the cost per child per year (US\$40) was double the previous estimate by the WFP. A drawback of our analysis of costs is that we sampled a small number of schools and communities to obtain estimates of the costs of teachers' time and of community time and resources. In addition, it is difficult to place a real value on the resources and time parents and communities contribute to the school-feeding program. Although most cost exercises do not include community costs, we feel it is important to get estimates

of these costs. All the school-feeding programs we visited in Kenya and Malawi were in food-insecure areas, but there were still differences in the quality of schools in terms of, for example, infrastructure and the availability of latrines, fuel, and water. In very resource-poor communities, the time and resources parents contribute could be seen as adding greater value than similar contributions in schools where facilities were already of a higher standard or water and fuel were abundant. On the other hand, the contributions of communities to the overall costs of school feeding were not large compared with the costs of the commodities and transportation. Standardizing for pipeline breaks proved to be the biggest factor in narrowing the range of the costs of school-feeding programs compared with previous analyses.

Even after standardization, the cost of school feeding varied between US\$28 and US\$63 per child per year among countries in this analysis. Cost determinants of school feeding are known to include location, geography, the type and amount of commodities provided, and the number of children being fed. Costs are generally highest in landlocked countries and in countries with inaccessible areas (e.g., mountains). The costs for the countries considered in this analysis follow this logical pattern; the total cost per child per year was highest in Lesotho (US\$63) and Malawi (US\$59), which are both landlocked countries with inaccessible regions and/or seasons when access is difficult. The cost of school feeding in Kenya is only half the cost in Malawi and Lesotho, perhaps because Kenya serves more children than Lesotho and Malawi and hence has the advantage of economies of scale.

The cost of commodities accounted for the largest proportion of school-feeding costs in all countries (over 50%). The contribution of the community varied from 0% in Lesotho to 5% in Malawi, 10% in the Gambia, and 15% in Kenya. These differences may be due to better estimations of community costs in Kenya, the only country where we were able to conduct in-depth surveys at the school level, and the fact that community involvement in development projects has traditionally been high in Kenya.

A limitation of the costing exercise was that we did not conduct interviews to determine the community costs in every country, which may have resulted in underestimation of country contributions. We also assumed that the planned tonnage was based on the expectation that each child would be fed every day of the school year.

### **Cost per outcome: Results, strengths, and limitations**

Here we have used the outcomes estimated in the review of Kristjansson et al. [7] to compare the cost per outcome. The outcomes were estimated from programs that were different from those used to estimate the

costs, not least in that the former included programs from outside Africa. In the absence of adequate impact analyses from the studies in Africa, these are the most rigorous outcome data available and allow us to estimate a potential range of expected costs per outcome. Further empirical studies will be required to validate these estimates.

The limitation lies in the fact that the costing part of the study was conducted in African countries, whereas the analysis of Kristjansson et al. involved studies from Africa, Asia, and Latin America. The reason that the cost data are limited to Africa was opportunistic, as the analysis was funded by trust funds to the Africa region of the World Bank. However, because the cost of commodities accounts for the greater proportion of the cost of these programs, we do not expect the cost data will vary much by region, particularly when school-feeding programs in other regions provide staple foods and the food is imported. We feel the strength of the use of the Kristjansson study is that eight studies were conducted in countries representing the major developing-country regions of the world (Africa, Asia, Latin America, and the Caribbean). In the absence of adequate impact analyses from the studies in Africa, these are the most rigorous outcome data available, and they allow us to estimate a potential range of expected costs per outcome. Further empirical studies will be required to validate these estimates.

The calculation of effects per year in the cost-per-outcome analysis assumes that the gains are linear. We believe that this is not a problem for the analyses of weight, height, and intelligence, since studies on those outcomes ran for a full school year. This assumption might present more of a problem for the analyses of attendance and math achievement, since the RCTs evaluating attendance ran for 1 and 8 months, and those evaluating math achievement ran for 6 and 8 months. It is also important to note that, although 700 kcal was used as a standard to estimate the cost, several studies in the review of Kristjansson et al. provided less than a third of that. As mentioned previously, we felt that using the larger ration size to standardize the costs was justified, because several of the studies in the analysis of Kristjansson et al. used animal foods.

The costs of school feeding are higher than the costs of deworming, iron supplementation, and malaria prevention (less than \$4 per child per year), which may mean that the cost per outcome for these other school health and nutrition interventions are lower.

However, it is important to note that the present analysis may be more rigorous in costing school feeding and the quality of the studies accepted in the outcome analysis may be higher than in other school health interventions. It may be possible to reduce some of the costs and improve the cost per outcome of school feeding. Since food accounts for the majority of the cost of school feeding (more than 50%), finding ways to

reduce the cost of food would reduce the overall cost. Although this analysis is based on food staples that are lower in cost than animal-based foods and fruits and vegetables, most of the staple foods are donated foods that need to be transported long distances. Purchasing food locally could reduce costs and at the same time stimulate local agricultural production.

Variability also existed among the interventions, with attendance showing the best returns for investment in school feeding. Although most studies did not report on the substitution effect (children eating less at home when they are fed at school), we expect that this is a major reason why the magnitude of the change in attendance is greater than that of anthropometric and cognitive outcomes. Improving attendance should increase children's contact with opportunities to improve their math skills, for example, but these opportunities may be limited if their nutritional status or the quality of their education remains poor.

The substitution effect can be reduced by raising awareness in communities that school meals are supposed to augment the child's diet at home. High-energy, micronutrient-fortified biscuits may be interpreted as a snack instead of a meal, because a meal is more likely to be substituted for at home. In addition, there is evidence that biscuits are less expensive (US\$11 to US\$12 per child per year) than cooked meals reported in this [27]. Micronutrient fortification of school meals may also improve outcomes in cognitive functioning when iron is used [23]. Other simple interventions known to enhance growth and cognition in school-age children, such as deworming [21, 22], might usefully support school-feeding programs, as is already promoted programmatically by the WFP.

The cost may be further reduced if food is provided in a more targeted fashion. The review of Kristjansson et al. provided some evidence for greater short-term cognitive benefits for children who were undernourished. Therefore, targeting children who need the food most, the areas where they live, and the times of year when poverty and malnutrition are highest and school attendance is lowest would not only increase the effect but also reduce the cost of feeding all children every day of the year.

## Conclusions

The purpose of this analysis was to link outcomes for school feeding with a systematic analysis of the costs of four school-feeding programs, using donor, government, and community costs and standardizing the costs for the school year, the size of the ration, and pipeline breaks. The analysis of Kristjansson et al. found that school feeding had a small effect on weight, school attendance, math achievement, and short-term cognition and behavior. The cost analysis found that the cost

of school feeding ranged from US\$28 per child per year to US\$63 per child per year. This is a much narrower range than that estimated previously (US\$19 to US\$209 per child per year). The current estimates suggest a weighted average cost of US\$40, which is higher than the previous estimate of US\$20. We attribute these differences to careful accumulation of nearly all actual costs in making the present estimates, which increased the precision and thus reduced the range, and included a number of costs not usually included, in particular accounting for pipeline breaks.

School feeding is expensive when compared with much simpler school health and nutrition interventions, which typically cost less than US\$4 per child per year. However, it is important to note that true comparability will only be possible when the methodologies for analyzing the costs and outcomes are the same. In addition, in reflecting on these cost and outcome data, as well as cost and outcome data from

other school health and nutrition interventions, it is important to recognize that all interventions can result in several useful outcomes at the same time, and that these outcomes are not mutually exclusive and may be additive. For example, school feeding provides important social benefits, including a safety net function, that are not provided by other interventions. On the other hand, deworming schoolchildren benefits the entire community by reducing the overall worm burden in the community. For future cost and outcome or cost-effectiveness studies of school health and nutrition interventions, it would be useful to develop a weighted equation that would allow consideration of the cost for the combined outcomes. This might contribute to identifying the most cost-effective package of interventions in terms of returns on investment in school health and nutrition. We hope that the data presented here will contribute to future cost–outcome analyses.

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