Evaluation of school feeding programs: some Jamaican examples\textsuperscript{1–3}

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ABSTRACT  It is hypothesized that giving children a daily breakfast at school may improve their scholastic achievement through several mechanisms: increasing the time spent in school, improving certain cognitive functions and attention to tasks, and, perhaps indirectly, improving nutritional status. Two Jamaican studies showed that providing breakfast to students at school improved some cognitive functions, particularly in undernourished children. However, changes in classroom behavior varied depending on the quality of the school. Children in better-organized schools concentrated on tasks for longer periods and made fewer undesirable movements, whereas in poorly organized schools the children’s behavior deteriorated. Studies to date have provided insufficient evidence to determine whether children’s long-term scholastic achievement is improved by eating breakfast daily. Well-designed, randomized, controlled, long-term trials are essential for determining public policy on the implementation of school feeding programs. Am J Clin Nutr 1998;67(suppl):785S–9S.

KEY WORDS  Cognition, schoolchildren, breakfast, classroom behavior, school achievement, school feeding programs, Jamaica

INTRODUCTION

For decades, international agencies such as the World Food Programme and national governments in both developed and developing countries have spent millions of dollars on school feeding programs. However, program evaluations have been surprisingly few and have often lacked scientific rigor (1), most likely because of the enormous difficulty involved.

Political concerns

School feeding programs often have political implications. Parents in developing countries generally welcome the provision of school meals, and politicians see it as a way to gain instant popularity. School meals are also often seen as a form of income substitution for poor families as well as a source of jobs for local farmers and cooks. In some developed countries, school feeding programs are used as an outlet for agricultural produce that cannot be sold. Food sold in the schools is often used as a way to generate funds for the school or to supplement the teachers’ personal income. The general perception is that schoolchildren who are undernourished or merely poor should be provided with meals. Finally, editors of scientific journals are often reluctant to publish results indicating no benefit. For these reasons there is undue pressure on researchers to produce positive evaluations.

Outcome variables

Many outcomes have reportedly been improved with school feeding. These outcomes can be divided into school performance and health and nutritional variables. School performance variables include enrollment, attendance, dropout rate, repetition of grades, school attainment levels, cognitive function, and classroom behavior. Health and nutritional variables include improved dietary intakes and nutritional status and the establishment of good dietary practices. The hypothesized relations among these outcome variables are shown in Figure 1; it is important to understand them before evaluations are conducted.

The provision of school meals reduces the parents’ cost of sending children to school. It is therefore possible that children would enroll earlier, attend more often, and be less likely to drop out early if meals were provided. Evidence suggests that providing school meals does improve attendance (2–5). Time-on-task, which includes time allocated by teachers and time engaged by the children, is an essential component of learning (6). With the quality of instruction and ability controlled for, the more time children spend on a task the more likely they are to learn. Regular attendance also ensures that the sequence of instruction is maintained.

If the children have inadequate breakfasts at home, they may suffer from periods of hunger. The alleviation of short-term hunger may affect cognitive functions (7, 8) such as memory and efficiency of information processing and, thus, should enable children to learn more in the available time. Their classroom behavior—attention and participation—may also improve and fidgeting may be reduced, all of which should facilitate learning. These positive outcomes, as well as more time-on-task, should lead to higher attainment levels.

The length of time a feeding program needs to be in place before evaluation depends on the outcome measures used. Changes in cognitive function and behavior may occur relatively quickly and would

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FIGURE 1. The hypothesized relations between breakfast and possible outcome variables in schoolchildren. Allocated time is time allocated by teacher, engaged time is time child spends concentrating on learning tasks.

be recognized in short-term evaluations. However, changes in attainment levels probably take longer to develop, especially in schools where little learning normally takes place. Therefore, if an improvement in attainment levels is hypothesized, the program should be in place for a longer time than would be needed to assess cognitive function and behavior before postintervention evaluation begins.

An additional consideration is that it is possible to improve nutritional status in an undernourished population if school meals are provided over a long period of time. There is considerable evidence that children who are better nourished have more efficient cognitive function than those who are undernourished (9). It is therefore conceivable that school meals could indirectly improve cognitive function by improving the nutritional status of undernourished children. It is also possible that better-nourished children will attend school more often. However, only a few studies have shown an improvement in children’s nutritional status with school feeding (3, 5, 10–12). This may be because these studies focused on adequately nourished populations (13, 14). Another explanation may be that, as with many supplementation programs, the school meal is used as a substitute for part of the children’s usual diet (2). In a Mexican study, children who were given nutritional supplementation through the first 7 y of life were more attentive in class and participated more than unsupplemented children (15).

Research questions

There are many questions relevant to research on the effects of providing school meals, and much work remains before we can confidently answer them. However, some progress has been made by studies conducted in Jamaica (8, 16), Sweden (17), Peru (18), the United States (4), and India (5). These questions are classified as basic, applied, or policy questions.

Basic questions

1) Does hunger or missing breakfast have an effect on children’s behavior and cognition in the laboratory, where dietary conditions and activities are tightly controlled?
2) Is the effect the same in all subjects, or does it vary with age, sex, nutritional status, or dietary habits?
3) What is the mechanism underlying a particular effect?
4) Does the timing of the meal—ie, breakfast, midmorning snack, or lunch—make a difference?

Applied questions

1) Is the effect on cognition and behavior still apparent during school, considering that the children consumed different amounts of food and had different physical activity levels before school?
2) If the child is functioning more efficiently in terms of cognition and behavior, is this reflected in improved school performance?
3) Do the benefits of providing school breakfasts vary in different school systems?

Policy questions

1) How do the benefits of school meals compare with the benefits of other inputs, such as the provision of furniture and textbooks, training of teachers, and improvement of curricula, and are these improvements sufficient to justify the investment of resources?
2) What combination of inputs promotes optimal performance among schoolchildren?

STUDY DESIGN

Several investigators have shown associations between dietary intake and children’s cognitive scores or intelligence quotients (19, 20). Others have found associations between lack of breakfast and the ability to concentrate (21), or feeling hungry and school achievement (21, 22). In Jamaica, associations were shown between children’s consumption (or lack) of breakfast at home and school achievement levels after many socioeconomic, health, nutritional, and family characteristics were controlled for (23). However, associations are not sufficient to prove a cause-and-effect relation and experimental trials are needed to prove such a relation. Crossover trials are probably the most sensitive for determining the short-term effects of a child’s missing or receiving breakfast. Such trials compare each child with him or herself—ie, performance with treatment and with placebo—and the order of treatment is controlled by randomly assigning the children to the first treatment given. To study the longer-term effect of a child’s missing or receiving breakfast, subjects should be randomly assigned to treatment or placebo. When studies are conducted in schools, it is best to assign children within the same class to treatment or placebo. In this way it is possible to control for the many differences among teachers, students, and facilities and in the organization of the school. However, social and ethical concerns generally forbid the feeding of some children in a class and not others. An alternative, but less efficient, strategy is to assign entire classes to different treatments. Where treatment is assigned by school, it is highly unlikely that small groups of schools will be similar in all factors affecting the children’s performance, and thus random assignment would necessitate inclusion of a large number of schools to be successful. Even when many potential confounding variables are measured and controlled for in the analysis, the use of two or three treatment schools and two or three controls may give spurious results because of unmeasured differences among schools.

Jamaican studies

We investigated school feeding issues in Jamaica. We previously conducted a trial of the short-term effects of missing breakfast on the cognitive function of children of differing nutri-
tional status in a laboratory situation (16). Using a crossover design in which subjects were compared with themselves after being given or not given breakfast, we showed that missing breakfast detrimentally affected the cognitive function of undernourished children, but not of adequately nourished children. This was the first demonstration of an interaction between two types of nutritional insults to children’s cognitive function (24).

We then moved from the basic to the applied question of whether children’s cognitive function underwent changes in everyday life at school, where we lacked control over their dietary intake and activities at home. We also extended the outcome measures and included classroom behavior as well as cognitive function. This study also had a crossover design, with children being compared with themselves when they were given or not given breakfast (8).

Population sample

The sample was chosen from four rural government primary schools (schools A, B, C, and D), which served poor farming communities in a remote, mountainous area. Many children had to walk a considerable distance to school. We selected only schools where ≥25% of the students had a weight-for-age below −1 SD of the National Center for Health Statistics (NCHS) references (25). We chose this selection cutoff point because more severely undernourished children were not available in significant numbers in Jamaican schools. Undernourished and adequately nourished children aged 8–11 y were selected from grades 3 and 4 in the four schools. The undernourished group had 100 children with a weight-for-age below −1 SD of NCHS standards. Each child was matched for school, class, and sex with a child whose weight-for-age was greater than −1 SD of the NCHS standards. The characteristics of the children are shown in Table 1. We decided to treat all children in the class, whether they were in the study or not, because it was difficult to focus on small groups of children. Thus, children were randomly assigned by class to either receive breakfast first or receive a slice of orange as a placebo. The placebo was given in an attempt to control for the extra attention that the children given breakfast would receive. We took baseline measurements after 1 wk of treatment, then stopped the treatment when the last measurements were completed. After another 2 wk we started the reverse treatment, i.e., those who had received breakfast on the first occasion now received the orange and vice versa.

Measurements

Cognitive function tests

After eating either the breakfast or the orange, all subjects were given a battery of cognitive function tests: visual search, digit-span forwards, categoric fluency, and speed of decision making. The visual search test measures sustained attention. The child is asked to identify, as quickly as possible, specific target letters from several lines of random letters. In the digit-span test, which measures auditory working memory, the child is asked to repeat strings of numbers of increasing length. Categoric fluency measures the ability to generate items from two semantic categories—in this case, animals and things to eat—in a set time. For the speed-of-decision-making test, the child must identify, as quickly as possible, the larger number of a pair in several lines of paired numbers. The test-retest reliabilities shown in Table 2 all had an $r$ value ≥0.74.

### Classroom behavior

For our classroom behavioral observations we focused on a subsample of subjects because these tests were more time consuming than the cognitive function tests and could not feasibly include all the children. Sixty of the most undernourished children and their matched control subjects were selected for the observations. Each child was observed for two mornings after being served breakfast and for two mornings after being given the orange, for two half-hours during class instruction and two half-hours while the child worked on a reading or writing task. The behavior we recorded included talking and moving without permission and answering the teacher’s questions. We also recorded the time each child spent paying attention, either to the instruction or to the task at hand. The reliabilities of the measurements were satisfactory. For the behavioral observations, all reliabilities had an $r$ value ≥0.6, except for the teaching session, when the gross motor behavior reliability was $r = 0.55$.

## RESULTS

### Cognitive function

Nutritional status had no significant effect on the cognitive function tests. There was a significant treatment effect in fluency ($P < 0.02$) and a significant interaction between nutritional group and treatment ($P < 0.05$) (Figure 2). The undernourished children performed better after they received breakfast ($t = 3.11, P < 0.01$), whereas adequately nourished children had no change in scores. The cognitive function tests showed no other significant main effects of treatment or treatment group interactions.

### Classroom behavior

To examine treatment effects, we used repeated-measures analyses of variance. The within subject factor was behavior with and without breakfast, whereas intersubject factors were nutritional group, sex, and school. There were no main effects of nutritional group or treatment. Girls talked and moved more than boys during the set task, but neither nutritional group nor sex had any significant interactions with treatment. There were signifi-

### Table 1

Characteristics of the study groups

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Undernourished</th>
<th>Adequately nourished</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight and age</td>
<td>−1.5 ± 0.3</td>
<td>0.1 ± 0.6</td>
</tr>
<tr>
<td>Height and age</td>
<td>−1.1 ± 0.7</td>
<td>0.4 ± 0.9</td>
</tr>
<tr>
<td>BMI (in kg/m²)</td>
<td>14.6 ± 1.1</td>
<td>16.2 ± 1.4</td>
</tr>
<tr>
<td>Age (y)</td>
<td>9.7 ± 0.9</td>
<td>9.1 ± 0.8</td>
</tr>
<tr>
<td>Uniform rating</td>
<td>4.0 ± 1.7</td>
<td>4.7 ± 1.8</td>
</tr>
<tr>
<td>Housing rating</td>
<td>4.5 ± 1.5</td>
<td>4.6 ± 1.6</td>
</tr>
</tbody>
</table>

‡ $x ± SD.$

### Table 2

Test-retest reliabilities of the cognitive tests

<table>
<thead>
<tr>
<th>Test</th>
<th>$r$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual search</td>
<td>0.77</td>
</tr>
<tr>
<td>Digit span</td>
<td>0.80</td>
</tr>
<tr>
<td>Verbal fluency</td>
<td>0.80</td>
</tr>
<tr>
<td>Information processing</td>
<td>0.74</td>
</tr>
</tbody>
</table>

‡ $n = 20$ children.
cant differences among schools in four of the seven analyses and several significant treatment × school interactions. Because these interactions occurred in more than half the analyses, it is highly unlikely that it was a chance finding.

During instruction, the children’s attention to task in school A increased significantly with breakfast ($P < 0.005$) (Figure 3), whereas their attention at the other schools did not change significantly. Similarly, when the children in school A had breakfast, their gross motor behavior declined ($P < 0.05$), whereas they did not change in the other schools (Figure 4). Contrary to our expectations, the behavior of the children in two schools deteriorated after they received breakfast: the children in school B talked more to their classmates during instruction ($P < 0.05$), and children in schools B and C were less attentive at the set task ($P < 0.01$ and $P < 0.02$, respectively). There were no significant changes in behavior with breakfast in school D.

### DISCUSSION

Cognitive function improved in the undernourished children when they received breakfast, but not in the adequately nourished children. These findings replicate those of the previous study on the effects of missing breakfast (16), which was conducted under more controlled conditions. In the present study, categoric fluency was the only test that showed a benefit from breakfast and that showed the interaction between missing breakfast and undernutrition most clearly in the previous study. The finding that undernourished children were more detrimentally affected by hunger than were adequately nourished children was replicated in a study in Peru, where different tests of cognition were used (26). Thus, it is reasonably well established that cognitive functioning is more vulnerable to the effects of short-term food deprivation in undernourished than in adequately nourished children.

It may also be important that the children in the present study were only mildly undernourished. It is likely that in populations in whom undernutrition is more severe, the benefits to children’s cognitive functions of providing breakfast would be greater. This suggests that school feeding programs should have a greater effect on children’s school performance in developing than in developed countries.

The findings from the classroom behavioral observations are more complex and suggest that the quality of the school itself may modify any benefit from school feeding. It has been shown in developed countries that school inputs can have a major effect on both children’s behavior and their attainment levels after the child’s ability and behavior on entering school were controlled for (27). The schools in the present study served similar poor, rural communities. However, they differed somewhat in their physical facilities. One school (school A) was much better equipped than the other three. It had recently been built to the specifications of an international agency. Each class had a separate room and every child had a desk and chair. There was adequate room between desks, which were arranged in rows, and the atmosphere was reasonably orderly. In the other schools, two or three children shared a desk, two or more classes often shared a room, and classrooms were very noisy. The children in the best school (school A) did the least amount of talking and fidgeting and paid the most attention during instruction, and they were the only children who showed improvements after eating breakfast. In contrast, the children’s behavior in two of the other schools actually deteriorated after they received breakfast: they paid less attention to the set task and talked more in class.

To return to the original research questions, although the undernourished children’s cognitive function improved, changes in their behavior seemed to depend on the school structure and facilities. There is evidence from developed countries that desk arrangement

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**FIGURE 2.** Children’s scores on the fluency test after receiving a slice of orange (placebo) or breakfast. Adequately nourished (■); undernourished (●).

**FIGURE 3.** Mean number of observation periods when children were predominantly on task, during instruction, and after receiving a slice of orange (placebo) or breakfast, by school: school A (▲), school B (●), school C (▼), school D (■).

**FIGURE 4.** Mean frequency of gross motor behaviors in children during instruction period after receiving either a slice of orange (placebo) or breakfast, by school: school A (▲), school B (●), school C (▼), school D (■).
can affect children’s classroom behavior (28). In a review of studies of the determinants of school attainment, Fuller (29) reported that school facilities were more important in developing than in developed countries. It may be that, below a certain threshold level, small differences in facilities become critically important. If so, the superior facilities at school A would most likely facilitate learning and improve attainment levels, even for the undernourished children. However, in the inferior schools, it is uncertain whether improvements in cognitive functioning would have led to an improved level of attainment. The findings suggest that, if we desire maximum benefits from school feeding programs, we should link them with educational improvements wherever necessary.

There is currently a reasonable amount of evidence that children’s cognitive functions are enhanced if they eat breakfast, especially if they are undernourished. However, we cannot be certain that this will lead to better attainment levels. Sound, long-term studies are required—with larger samples and a random assignment of subjects to breakfast and placebo—to determine how and to what extent the regular provision of breakfast influences children’s scholastic achievement. With this information, we will be better equipped to address policy questions.

REFERENCES