Does Breakfast Make a Difference in School?

ERNESTO POLLITT PhD

E. Pollitt is a professor of human development in the Program in International Nutrition, Department of Pediatrics, School of Medicine, University of California-Davis, Davis, CA 95616, USA

Available online 8 May 2003.

Abstract

This article reviews selectively the literature on the effects of breakfast on cognition and school performance. The focus is on studies published in refereed journals after 1978 that tested those effects on well-nourished and nutritionally at-risk children. In at-risk subjects (defined by clinical history and anthropometry), a morning and overnight fast had adverse effects on cognition, particularly the speed of information retrieval in working memory. Contradictions in the data from different studies prevent definitive conclusions on whether well-nourished children experience similar functional deficits. Nonetheless, available information suggests that brain function is sensitive to short-term variations in the availability of nutrient supplies. Moreover, well-conducted evaluations suggest that the availability of feeding programs in public schools throughout the academic year increases the probability that children will eat breakfast and improve their educational status. J Am Diet Assoc. 1995; 95: 1134-1139.

Article Outline

• Theoretical Reasoning
• Metabolic Changes
• Nutritional Status Changes
• Programmatic And Design Issues
• Literature Review
• Experimental Studies
A 1978 critical review of the literature published in 1978 on the educational benefits of school feeding programs concluded that the available studies were characterized by the absence of well-defined hypotheses, ambiguity in the definition of variables, lack of data on the validity and reliability of the measures used, and a failure to account for potential confounders. No definitive conclusions were justified but some tentative inferences were made on the effects of short-term fasting. An overnight and morning fast had adverse effects on children's emotional status, test performance in arithmetic and reading, and physical work output as measured by an ergometer. The provision of breakfast seemed to benefit students emotionally and enhanced their performance on school-type tasks. The 1978 review also concluded that studies on the long-term effects of school feeding programs were weak and offered no basis for even tentative inferences. (For another review, see reference [2]).

The picture has changed over the past 17 years. New data are now available from experimental studies that assessed the effects of the timing and composition of meals on cognition and from well-conducted evaluations of school feeding programs. In addition, new studies have extended the search and investigated the relationships between metabolic (eg, glucose), physiologic (eg, cardiac acceleration), and functional (eg, attention) changes.

This article reviews studies that tested the effects of breakfast on cognition among children and adolescents and were published in refereed journals after 1978. Particular attention is given to the school breakfast program in the United States.

**Theoretical Reasoning**

Two biological mechanisms that can operate simultaneously underlie the postulated effects of breakfast on cognitive function. One involves short-term metabolic and neurohormonal changes associated with the immediate supply of energy and nutrients to the brain. The other involves the sustained contributions of breakfast to a person's health status over time. This second mechanism is particularly relevant for children whose daily dietary intake barely meets requirements.
Metabolic Changes
In a 24-hour period, the longest interval during which children lack an external supply of energy and nutrients is generally between the evening meal and breakfast the next morning. During overnight sleep, brain activity — except for periods of rapid eye movements — slows markedly, and regulatory mechanisms allow for a continuous supply of endogenous fuel to maintain cerebral metabolism. When the overnight fast is extended, the gradual decline of insulin and glucose levels, among other metabolic changes, could determine a stress response that interferes with different aspects of cognitive function (eg, vigilance, working memory). If these transitory metabolic changes were to occur frequently they would be likely to have cumulative adverse effects that place a child's school progress at risk. However, this issue has not been explored or discussed in the literature reviewed in the following sections.

Nutritional Status Changes
Breakfast contributes to the quality and quantity of a person's daily dietary intake. For children in particular, breakfast adds substantively to their total energy, protein, carbohydrate, and micronutrient intake and increases the likelihood of meeting nutrient requirements. In populations where children are nutritionally at risk, the availability of breakfast (eg, school feeding) may make it possible for a child to be well nourished over the long term and may prevent or reverse nutrient (eg, iron) deficiencies that affect cognition (3). A theoretical issue important to the understanding of the effects of an overnight and morning fast on cognition is whether a person's past or current nutritional status modifies such effects. It is plausible, for example, that the decline in cerebral iron level likely to result from a diet that is deficient in heme intensifies the stress associated with an overnight and morning fast. Thus, the cognitive effects from this interaction would be greater than those observed among iron-replete subjects who miss breakfast.

Programmatic And Design Issues
The following literature review does not make explicit the particular differences in the generalizability (external validity) of the findings from the studies under consideration. Differences in study design do, however, have different implications for policies and programs of food assistance in the schools. The two major designs of concern here are
experimental and field evaluations. Each design has its own theory and distinct advantages and disadvantages (eg, see reference (4)).

Most of the studies reviewed followed experimental protocols under laboratory-type conditions and are concerned with the proposition that breakfast makes a difference in cognitive function. Some of the studies test the efficacy of particular breakfasts used by specific national programs such as those in the United States and Peru. In general, the validity of experimental studies varies: on the one hand, their internal validity is high because of the tight control of confounders; on the other hand, their external validity is limited because they do not account for issues of program implementation and eligibility criteria.

Although Held evaluations of the short-term and long-term effects of food assistance programs lack the rigor of experimentation, they are the only way at present to test the effectiveness of school feeding. The data generated from well-conducted program evaluations are directly relevant and useful for policy makers concerned with programmatic activities. Effectiveness trials in particular can guide changes and improvements in these activities. This is not generally true for efficiency studies, whose main contribution is to test whether a particular treatment does indeed work.

**Literature Review**

The studies in this review are classified in two major categories: experimental and Held. Experimental studies that tested the efficacy of the breakfast provided in a particular school breakfast program (SBP) are classified separately from the remaining studies in the first category.

In populations where children are nutritionally at risk, availability of breakfast may make it possible for a child to be well nourished over the long term and may prevent or reverse nutrient deficiencies that affect cognition.

**Experimental Studies**

The studies of children and adolescents included in this section followed an experimental protocol and were conducted in either a research facility or a school setting. Two studies (S. Cueto et al, 1995, unpublished data, and reference (5)) are classified as studies of efficacy.
Crossover research designs were used in laboratory-type studies that exposed the same subjects to a breakfast and a no-breakfast treatment. This design allowed the investigators to bypass critical problems (eg, poor measurements of dietary intake) frequently found in SBP evaluations. These studies generally addressed the following questions:

▪ What effect does an overnight and morning fast have on cognitive function?
▪ Are these effects found across cognitive functions or are they restricted to particular processes?
▪ Are these effects modified by the nutritional status of the subject?
▪ Are there any physiologic or biochemical correlates to such effects?

Studies in Cambridge, Mass (6), and Houston, Tex (7), showed that an overnight and morning fast influenced the problem-solving performance of well-nourished, middle-class 9- to 11-year-old children. In both settings, after admission to a research center in the evening (6 PM) before the experiment, the children ate dinner (approximately 960 kcal). Later they either watched television or played table games before going to bed. At 7 AM the children were awakened and either ate breakfast (waffles and syrup, margarine, orange juice, and milk; 535 kcal) or drank a placebo (noncaloric, noncafeinated drink). At 11:30 AM they took a battery of psychological tests and were later discharged. After a week, they returned to the center and followed the same routine except for breakfast. Those who had eaten breakfast on the first admission were given a placebo on the second admission and vice versa.

In both studies the children committed fewer errors on the day they ate breakfast than on the day they did not eat breakfast in a test that required finding the exact match of a figure (eg, chair, hen, woman) among four or eight similar figures (Matching Familiar Figure Test). Further, in the Cambridge study, the subjects with the largest changes in glucose level (from the morning they ate breakfast to the morning they did not eat breakfast) were more likely to have an increased number of errors on the Matching Familiar Figure Test ($P<.05$). In Houston, subjects’ errors on the test were negatively associated with insulin ($r=-0.39; P<.01$) and glucose values ($r=-0.21; P<.10$) at noon time.

The studies in Peru and Jamaica confirmed what is generally believed to be an advantage of school feeding programs: they increase the attendance rate of children.
Consumption of breakfast (milk, cereal with sugar, egg, juice, and toast; energy and nutrient information not reported) also improved performance in a vigilance task (Continuous Performance Test) among well-nourished 9- to 11-year-old US children (8). At 9:50 AM, 11 AM, and 12:10 PM, fewer errors were made and performance was less variable under the breakfast condition than under the no-breakfast condition. At midmorning, fasting resulted in poorer performance in an arithmetic task. Breakfast reduced the amplitude of visual-evoked potential (an autonomous response) during administration of the Continuous Performance Test and reduced cardiac acceleration in response to atone (6-second, 1,500-Hz tone at 78 dB) after the administration of the test. These psychophysiologic responses are generally associated with improved vigilance and attention.

In Kingston, Jamaica (9), nutritional status (as defined by clinical history and anthropometry) modified the effects of breakfast (590 kcal) among low-income children. On the one hand, breakfast did not make a difference in cognitive test performance among children whose height and weight were normal for their age. On the other hand, nutritionally at-risk children improved their performance when they ate breakfast. This latter effect was particularly evident on the verbal fluency and digit-span-backward tests for children who were stunted (with or without wasting). Wasted and stunted children benefited on the Matching Familiar Figure Test and on an arithmetic test. In this study, breakfast was served at 8 AM and the children were tested 3 hours later.

Another study in Jamaica (10) was conducted in four rural schools attended by children of subsistence farmers. In contrast to previous studies that were conducted in research facilities, this project was conducted in the school setting. Two hundred children from the third and fourth grades were selected according to anthropometric criteria: half the sample (undernourished) were children with weight-for-age values less than −1 standard deviation (SD) of the US reference standards and the other half (adequately nourished) had weight-for-age values greater than 1 SD. These groups were matched for sex and grade level. The investigators used a crossover design within the school setting. The breakfast and placebo were given at 8:30 AM. Cognitive functions were evaluated from 9 AM to 12 PM. Breakfast consisted of 225 mL chocolate milk and a cheese sandwich; an
orange was given as a placebo. The battery of psychological tests included verbal fluency, digit span, visual search, and reaction time.

In agreement with the first Jamaican study (9), there was a significant interactive effect (treatment × nutrition status) on the fluency test. Briefly, performance improved with consumption of breakfast in the group with low weight for age, but not in the well-nourished group. In the control group, on the other hand, performance declined with consumption of breakfast. No other significant findings were observed.

A study in Chile (11) of nutritionally at-risk children enrolled in the third through fifth grades found no effects of breakfast (two sweet cakes and 200 mL milk; 394 kcal) on cognition. This finding is suspect, however, because the children stayed at home the night before the experiment, and the investigators had no control over their food intake. Although the children were instructed not to eat on the morning of the experiment, 23% of them reported having done so. Also, the interim between breakfast and cognitive testing was 1 hour, that is, about 2 hours less than in three of the four studies previously reviewed.

University students in Great Britain provide additional insight into the effects of breakfast. In one study (12), consumption of breakfast (nutrition information not reported) improved the students’ performance in spatial memory and immediate recall. Performance, in turn, was positively associated with blood glucose levels under the fasting and breakfast conditions. A more recent paper (13) reported the results of two experiments. In the first, no effects of breakfast (<25 g cornflakes, 150 mL semiskim milk, 2 tsp sugar, 1 slice whole-meal toast, 10 g polyunsaturated margarine, and 25 g marmalade) were observed in a simple reaction-time test, a serial response task, and a repeated-digits vigilance task. In the second experiment, breakfast affected two memory tests: free recall and recognition memory. A test of logical reasoning showed paradoxical effects, that is, subjects performed better under the no-breakfast condition.

Dickie and Bender (14) conducted a study in a boarding school in the United Kingdom to assess the effects of omitting breakfast on different aspects of cognition. Students (mean AGE=12.7 years) were randomly assigned to one of two groups and were tested on 3 consecutive days 5 weeks after the beginning of the intervention. One week later, the subjects were tested again on three consecutive mornings; however, in this second round
the subjects in the experimental group omitted breakfast but those in the control group followed the normal breakfast routine. Tests of short-term memory, serial memory, memeracy, and attention failed to discriminate between groups. Consumption of breakfast appeared to have no effect.

**Studies on efficacy** In 1993, the government of Peru implemented a school breakfast program targeting economically impoverished areas of the country with the intent of improving the nutritional status of elementary-school children. In association with the school breakfast program, two studies were carried out in Huaraz, a district in the central Andean region, to test the effects of the program on cognitive performance and educational achievement. An experimental study (S. Cueto et al, 1995, unpublished data) was conducted in the city of Huaraz, and a field trial was carried out among 10 rural schools (15).

The experimental study tested the interactive effects of breakfast and nutritional status on different cognitive processes. By design, the subjects were used as their own controls in a research center. Nine- to 11-year-old boys enrolled in the fourth and fifth grades were classified into one of two categories of nutritional risk. No-risk was defined by a height-for-age value less than $-1$ SD and weight-for-height value of 0 SD or greater than the standards of the US National Center for Health Statistics (16). Nutritional risk was defined by a height-for-age value $-1$ SD or less and weight-for-height value $-0.5$ SD or less. A battery of psychological tests was administered at 11:30 AM. Three tests were taken using paper and pencil (Number Discrimination, Peabody Picture Vocabulary, Raven Progressive Matrices) and three others were computerized (Reaction Time, Stimulus Discrimination, Sternberg Memory Search). The latter three tests are part of the Cognitive Abilities Test battery, which includes 10 tests of basic cognitive abilities and 1 defined as a progressive-matrices-type task (DK Detterman, unpublished data, 993).

Breakfast consisted of a small cake (80 g) and a glass of Amilac (Institute Investigacion Nutricional La Molina, Lima, Peru), a beverage similar in taste and color to milk (50 g). This composition was the same as that of the breakfast distributed by the national school breakfast program in Peru. A diet soft drink without caffeine was used as a placebo.

Two of the six tests showed the expected beneficial effects of breakfast. Scanning speed in the short-term memory test was faster under the breakfast condition than under the no-
breakfast condition. At-risk children were also prone to fail in the discrimination of geometric patterns when breakfast was omitted. In contrast to the results of previous studies (6 and 7), glucose level did not predict performance in either risk group.

Cromer and collaborators (17) also carried out a study on breakfast and cognition with 34 adolescents (mean AGE=14.2 years) in the United States. Their sample was selected from a predominantly white, middle-class population. Eighteen subjects (60% females) were randomly assigned to an experimental condition in which they consumed the meal given as part of the US school breakfast program; the remaining subjects (56%) consumed a low-energy breakfast. The government breakfast included a doughnut, chocolate milk, and orange juice, whereas the low-energy breakfast included diet gelatin and powdered milk. Subjects were admitted to a research center on the evening preceding the dietary experiment. They took a series of cognitive tests (Peabody Picture Vocabulary, Auditory-Verbal Learning, Matching Familiar Figure Test, Continuous Performance Test, State-Trait Anxiety Inventory) at 11 AM, about 4 hours after they had received either the government or a low-energy breakfast. None of the tests discriminated between treatments. Neither (β-hydroxybutyrate nor glucose determinations obtained at 8 AM and 11 AM predicted test performance.

An important difference between the study by Cueto et al in Peru and that of Cromer and collaborators in the United States is that the former was part of an evaluation of the national school breakfast program, whereas the latter was self-contained, independent of any other evaluation.

**Discussion of results of experimental studies** No matter what research setting was used, consumption of breakfast consistently benefited the cognitive performance of undernourished children, particularly in working memory tests. Consider, for example, the results of the digit-span tests in Jamaica and the speed of memory scanning test in Peru. However, the influence of breakfast was not restricted to memory: performance in the verbal fluency test was enhanced in the two Jamaican studies as was vocabulary in the Peruvian field study.

The experimental study in Peru was a test of the efficacy of the national school breakfast program and as such the data have direct programmatic relevance. If the program is well
implemented and reaches eligible children, it will give an educational advantage to those who are nutritionally at risk. Among well-nourished children, the data are not clear. Well-nourished, middle-class children and adolescents in the United States and Great Britain exhibited cognitive benefits from the consumption of breakfast. Conversely, well-nourished children in Jamaica and Huaraz, Peru, showed no effects. This discrepancy cannot be explained by the available data in the different settings. A speculative conclusion is that the children in developing countries were accustomed to missing breakfast and were free of stress. In some well-nourished, middle-class children in the United States and Great Britain, working memory was sensitive to the fasting condition. This finding concurs with the observations for at-risk subjects in Jamaica and Peru.

No definitive conclusions can be made on the relationship between glucose level and performance under conditions of an overnight and morning fast. The number of studies that found a significant association between these two variables is about the same as those that did not. Further research should shed light on this potentially explanatory variable.

**Field Studies — Evaluation of School Breakfast Programs**

The following three studies addressed the effects on cognition of the national school breakfast programs in the United States (18), Jamaica (19), and Peru (15). The US study determined the effects over a school year, the Jamaican study was concerned with the effects over 3 months, and the study in Peru tested for effects over 3 weeks. Ideally, in learning about the effects of breakfast consumption, we should be able to use data from past evaluations of the US school breakfast program. Surprisingly, no such data are yet available. The school breakfast program provides meals to students at full price, reduced price, or for free, according to uniform national eligibility criteria based on family income and size. For fiscal year 1994, the cost of the free breakfasts was $821,125,437 (20).

The authorization of the US school breakfast program did not include a prescription to monitor and evaluate its effectiveness. A national evaluation of the school nutrition program\(^1\), which did not include cognitive or educational outcomes and which included programs whether children participated in them or not, concluded that the school
breakfast program had no direct effect on the nutrient intake of the students (21). The results indicated, that the program did make a difference as to whether children ate breakfast at all. Where the program was available to them, students were more likely to eat breakfast than were those without access to the program. Furthermore, approximately 3 million children did not eat breakfast where there was no school breakfast program (22).

Data for the 1991-1992 academic year from the School Nutrition Dietary Assessment Study (23) showed that the school breakfast program was available to slightly more than half of the nation's students. However, fewer than 20% of those for whom breakfast was available participated. About 12% of the students did not eat breakfast, regardless of whether they were enrolled in the program.

A strong evaluation of the US school breakfast program was conducted by Meyers et al (18) in Lawrence, Mass. Lawrence is an ethnically diverse city with a high percentage of low-income families. The median household income ($11,980) at the time was below the median income for the US population. About 70% of the children in the school system were considered low income in 1986; 63% were members of minority groups. Six schools were chosen to participate in the evaluation. All children in grades 3 through 6 were considered eligible to enroll if they had qualified to receive free or reduced-price school meals and had been registered in the public school system for the second semester of both school years 1985-1986 and 1986-1987. The school breakfast program was implemented in late January, before the start of the second semester of the 1986-1987 school year. Children were considered program participants if they were recorded as having had the school breakfast on at least 60% of those days and nonparticipants if they were not recorded as having participated on any of those days.

Data suggest that brain function is sensitive to short-term variations in availability of nutrient supplies, particularly for at-risk 9- to 11-year-olds for whom omission of breakfast alters speed and accuracy of information retrieval and working memory. The Comprehensive Test of Basic Skills was used as the achievement indicator. Before program implementation, those who were to be enrolled in the program had significantly lower scores than nonparticipants in the total score for the achievement battery, as well as on the reading and mathematics subtests. Absence and tardiness rates for the second
semester (before implementation) did not differ between the groups. The improvements from 1986 to 1987 were significantly greater for participants than for nonparticipants in the total score of the Comprehensive Test of Basic Skills and in the language subscore. Tardiness rates decreased for participants and increased for nonparticipants. The program effects were clearest among boys and Hispanics.

Two design factors worked against a fair evaluation: the subjects were not assigned randomly to a breakfast and no-breakfast condition, and there were initial differences in performance between participants and nonparticipants. This difference in favor of the latter group could explain, in part, why the change in the group of participants was greater than that in the nonparticipants. In a nonrandomized study, those who attain lower scores may be jeopardized by a greater accumulation of error measurements within their group, causing a lower score than otherwise expected. However, there is no reason to suspect the presence of a regression to the mean in connection with the intergroup differences in tardiness and absenteeism, as the initial rates of these two variables were equivalent between the two groups.

Powell et al (19) conducted a careful evaluation of school feeding in Jamaica. They measured the effects of administering a standard government meal (milk arid either a banana cake or a pastry containing minced meat and vegetables) to a class of schoolchildren who were undernourished and had poor rates of school attendance and achievement. Mean age was 12.5 years for the 115 participants. Subjects received one of three treatments for about 3 months: breakfast, syrup, and no supplement. Consumption of breakfast had no effect on either weight or height. It did have significant effects on performance on an arithmetic test and on school attendance. The decline in truancy was explained simply by the availability of a decent daily meal for the child during the study period.

The second study conducted in Peru in association with the school breakfast program was a clinical trial with random assignment of schools (N=10) to one of two conditions: the school breakfast program was or was not available (15). This evaluation looked for improvements in daily nutrient intake, school attendance, and cognitive test performance. The interim between the pretreatment and posttreatment assessment was about 15 days. After introduction of the school breakfast program, the total dietary intake of the children
enrolled in the program increased significantly. The mean energy intake of the children in the program was 2,181 kcal, compared with a mean energy intake of 1,731 kcal among the control children \((P<.001)\). The difference in mean protein intake was 11 g \((P<.001)\). In addition, after the introduction of the school breakfast program, attendance at schools where the students received breakfast increased, but it dropped in the schools that did not implement the program \((P<.05)\).

Because of low test-retest reliability, digit discrimination and digit-span tests were excluded from the intergroup comparisons. Of the remaining four tests, one (on vocabulary) showed treatment effects. In particular, the interaction between breakfast and the residual of weight\(^2\) explained a statistically significant portion of the variability in the vocabulary scores in the posttreatment assessment. Paradoxically, among the children who received breakfast, those with the highest weight residual benefited most from the program. Among those who did not receive breakfast, the weight residual was inversely related to test performance. Furthermore, in separate analyses the weight residuals were negatively associated with performance in coding, reading, and arithmetic tests in the pretreatment evaluation.

To understand such unexpected findings it is useful to recall that, on average, the children were notably stunted and overweight for their height. This anthropometric pattern among poor children in populations where malnutrition is endemic in Peru has been interpreted \((24)\) as a sign of possible nutritional risk. Researchers have proposed that chubbiness indicates excess body water and could have adverse functional consequences. Under these conditions, breakfast ameliorated the functional deficit.

**Discussion of the effects of school breakfast programs**

The data from the three studies cited are insufficient to draw definitive conclusions regarding the educational benefits of school breakfast programs. Although these studies are stronger than those available previously, they are not immune to criticism. For example, as noted, the internal validity of the study in Lawrence, Mass, was limited because the subjects tested were not assigned randomly to a breakfast and a no-breakfast condition. Weaknesses in design, however, must be weighed conjointly with the strengths of the overall study. The validity of the study is strengthened by a well-designed inter-
group comparison of pretreatment and posttreatment scores generated from a standardized achievement test.

It is plausible that the observed cognitive and educational benefits of the school breakfast program in Lawrence were mediated by pretreatment-to-posttreatment changes in the nutritional status of the beneficiaries. However, the data do not permit us to conclude that such a change occurred and that it was a key explanatory variable. At issue is whether school progress can be improved by a school breakfast program even if the child's habitual nutrient intake, independent of the school breakfast program, meets the child's nutrient requirements. It is indeed plausible that the school breakfast program protects children from the cumulative limitations on learning resulting from daily attendance at school without eating breakfast. Consider that this would be the case for about 12% of schoolchildren in the United States.

The studies in Jamaica and Peru confirmed what is generally believed to be an advantage of school feeding programs: they increase the attendance rate of children. In addition, the study in Peru suggested that the benefits of breakfast are particularly noticeable among nutritionally at-risk children.

Conclusions

Most design and method limitations observed in the studies published before 1978 have been resolved in the research conducted since that year. In particular, study design has improved with the use of experimental, crossover strategies and strict control of confounders. Well-defined hypotheses regarding the nature of the effects and the mechanisms behind them have been indicated, and cognitive and educational outcomes have been measured by means of reliable tests. Nevertheless, some limitations prevail. For example, a previous review of the literature (1) suggested that an overnight and morning fast affected the emotional status of children; yet none of the new studies focused on this issue. Similarly, there is an absence of research on the relationships among fasting, activity level, and cognition. Moreover, questions about the role of age, sex, and body composition as effect modifiers were not raised in the past, and the most recent studies have not accounted for these important variables either.
Within the area of nutrition and behavioral research, perhaps the most important conclusion to be drawn at this time is that the data, as a whole, indicate that brain function is sensitive to short-term variations in the availability of nutrient supplies. This indication is particularly strong for nutritionally at-risk (defined by history and anthropometry) 9- to 11-year-old children. In these children, the omission of breakfast alters brain function, particularly in the speed and accuracy of information retrieval in working memory. The data suggest that these alterations occur not only under controlled laboratory conditions but also in the classroom. The mechanisms that explain these effects need to be delineated.

Although no definitive conclusions are yet justified, the evidence suggests that working memory in well-nourished children is sensitive to the effects of an overnight and morning fast. If this suggestion were to be confirmed, it would have strong implications for the role of nutrition intervention in school settings — not only for developing societies but also for the industrialized world. In other words, the omission of breakfast would make a difference in the schooling process.

Perhaps the widest gap in the present literature regards the effect that nutrition changes attributable to school breakfast programs may have on cognitive function and educational achievement. Data from other areas of nutrition and behavioral research suggest that highly prevalent nutrient deficiencies (eg, iron deficiency anemia) affect cognition, and that they can be prevented or remediated by a school breakfast program. Current evidence that breakfast makes a difference in school performance will be greatly enhanced by such new data.

References


National Data Bank, Food & Consumer Services, US Food and Drug Administration, Washington DC.


The national evaluation included three field studies: the Cross-Sectional Survey of Students (CSS), the Household Survey of Parents (HSP), and the Food Administrator Survey (FAS). The CSS used a nationally representative sample of public school students in grades 1 through 12. The HSP provided information on the families. These two surveys worked with the same sample because information was required for both students and their families (N=6,556 students and families). The FAS was designed to yield data on a nationally representative sample of public school districts and schools.

A weight residual was calculated because some of the extreme values in weight for height observed in the sample are not included in the reference anthropometric standards. Weight RESIDUAL = weight regressed on height and age for each subject.