

Breakfast and Learning: An Updated Review

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Abstract: Over the past five years, significant new evidence has documented the link between eating breakfast and learning. Recent studies show that skipping breakfast is relatively common among children in the U.S. and other industrialized nations and is associated with quantifiable negative consequences for academic, cognitive, health, and mental health functioning. When combined with new data on the prevalence and impact of hunger/food insecurity, the preponderance of recent evidence is that lack of optimal nutrition is a problem for millions of U.S. students and that increased breakfast eating could be part of a solution.

Literature reviews published in the late 1990's set the stage for understanding this new evidence by showing the associations between regular breakfast consumption/skipping and student outcomes. Research over the past five years has provided new evidence for these associations and definitive evidence for others: most notably that universally free school breakfast programs increase the rate of overall-breakfast eating and are judged to improve learning by teachers and school principals. These findings, along with accumulating evidence for the danger of nutritional risks, provide a clear rationale for continued efforts to promote breakfast eating for children, schools, and the nation as a whole.

Keywords: Breakfast, nutrition, cognition, academic functioning, children.

I. BACKGROUND

Given the recent and continuing strong interest in improving educational outcomes for U.S. students [1], a strand of research from the 1980's and '90's that showed the positive impact of breakfast-eating on academic and cognitive performance [2] has taken on increasing importance. This research has been made even more relevant by a separate strand of studies that show that a significant and growing percentage of U.S. children skip breakfast [3].

A third strand of studies over the same period of time showed that hunger, another nutritional risk, was also prevalent among U.S. children [4] and that it too had a negative impact on student academic outcomes, cognitive functioning [5] and health [4, 6]. And although the current national concern about obesity may make worries about getting *enough food* seem less important, it turns out that there is evidence that both skipping breakfast [7] and hunger [8] are associated with increased, not decreased obesity. Setting aside the topics of obesity and hunger until later, the first third (Section I) of the current paper is devoted to a review of the previous literature on breakfast with regard to its impact on learning. The second third (Section II) of the current paper reviews new findings from the largest study of breakfast and learning ever conducted. The third section discusses the implications of these new findings for an understanding of the relationship between breakfast and learning and for policies appropriate for this understanding.

One of the major implications that emerged from the confluence of the three strands of research mentioned above

was that expanded national, state, or district school breakfast programs might reduce breakfast-skipping and thereby lead to improved learning for students. And although the potential impact of feeding programs for children in the third world may seem obvious to most [9, 10], both the potential of and need for such programs as an aid to learning in the first world is not obvious to all [11].

Despite the skepticism of some, however, in the late 1990's a number of cities, states, and countries were convinced enough of the potential that school breakfast programs held for improving student outcomes that they set up demonstration programs making breakfast free to all students in some schools. This approach, called universal-free school breakfast (USB), was implemented in more than one thousand schools and a dozen school districts in the 1990's [12]. In the years that have passed, some of these initiatives have been evaluated with formal reports that shed light on the impact of breakfast on student outcomes. Additional light has been shed by more than one hundred studies about breakfast published in academic journals over the past five years. It is therefore an opportune time to survey the landscape to see what has been discovered about the relationship between breakfast and student outcomes since the late 1990's.

Of special note, in this regard, are the findings from the largest and most expensive breakfast experiment ever attempted. The School Breakfast Program Pilot (SBPP) demonstration project was conducted under the auspices of the United States Department of Agriculture and began in the year 2000, with evaluation results released in official reports produced in 2002 [13] and 2004 [14] and a reanalysis of the first year data by the Principal Investigator in 2004 [15]. Although not widely disseminated, these reports on the SBPP demonstration provide some of the strongest evidence

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to date on the viability of breakfast as an intervention that can help student learning. A review of what was known at the time that the USDA study was designed and what has been reported since then provides the background necessary for understanding the results of the SBPP demonstration and the answers it brings to an understanding of the contribution of breakfast to learning.

In preparation for its thirteen million-dollar SBPP school breakfast demonstration, the USDA contracted with a major research firm to conduct a thorough review of previous studies that had a bearing on relationship between breakfast and learning. This review was prepared by staff from Mathematica Policy Research [16] under contract with the USDA and is available on the USDA Website (see reference list for this and other web addresses of cited works). Because it provides a firm foundation for understanding the results of the massive experiment that was at the heart of the USDA demonstration, the research leading up to this 1999 *Review of Literature on Breakfast and Learning* will be examined in the first two subsections—one on overall breakfast (IA) and one on school breakfast (IB)—of the current review in some detail. The next two subsections update the literature on breakfast and learning, examining research on school breakfast (IC) and overall breakfast (ID) over the five years from 2000-2004. The second major section of the current paper reviews the results presented in the First Year Report on the SBPP (subsection IIA), the SBPP Final Report (subsection IIB), and a reanalysis of the first year SBPP data (IIC). Section III presents a discussion and conclusions based on the new and previous data.

IA. Previous Studies of Breakfast up to 1999

Before reviewing the literature on breakfast per se Briefel and her colleagues [16] placed this topic within the broader context of research on the impact of nutrition on child development and functioning. The authors summarized this work by stating that the consensus up until that time indicated that under-nutrition during any period of childhood, even for relatively short episodes, can have negative effects on cognitive development. The authors also reported on other studies that suggested that nutritional supplementation programs may be able to ameliorate at least some of the initial negative effects of nutritional deficits.

Although most of the previous work on the impact of nutrition on cognitive development had been based on laboratory studies and/or studies in the third world, the 1999 Briefel *et al.* review also noted a small but growing literature on another nutritional risk, the impact of hunger in low income populations within the United States. One study of hunger in the U.S. included findings from the Community Childhood Hunger Identification Project [17] that showed its prevalence and two studies [18, 19] documented the association between hunger as measured by CCHIP and poorer academic, health, and mental health functioning. As it turns out, research published in the five years since the Briefel *et al.* review has provided strong support for the notion that hunger and/or food insecurity is prevalent among poor children in the U.S. and has a negative impact on their cognitive development, learning, and health. These findings will be discussed in the second major section of this paper.

In their review, Briefel and her colleagues [16] cited more than sixty publications about breakfast, categorizing them according to three major areas: studies that assessed the impact of breakfast: 1) in general; 2) on nutrition and 3) on cognitive, academic, behavioral, health, and other outcomes. Subsection IA of the current paper reviews previous studies according to these categories in Sections IA1, IA2, & IA3. Briefel *et al.* used the same three categories again to review studies focusing more specifically or exclusively on *school breakfast* and these studies are briefly re-reviewed in the current paper in sections IB1, IB2, & IB3. Since the same three categories are helpful in understanding more recent research, they will also provide a structure for reviewing the post 1999 studies of breakfast and school breakfast in sections IC1-3 and ID1-3 (respectively) of the current paper.

Before going any further, the distinction between *school breakfast* and *overall breakfast* should be clarified. In this context, the word 'overall' is used to denote food eaten anywhere and any time in the morning. The adjective is necessary to distinguish *overall* (generic) breakfast from *school breakfast*. Since breakfast is available at most schools in the U.S., students in this country can eat at school, at home, or on the way to school. Food eaten at any and all of these locations any time in the morning is defined as overall breakfast. School breakfast is just that...breakfast served at school as part of the National School Breakfast program. For the most part, studies of school breakfast look at school-wide or individual student participation in the school breakfast program. As of this writing, most published studies focus on overall breakfast (regardless of location) and only a few on school breakfast. The current paper is one of the first to review studies on both types of breakfast for the same individuals and for this reason it is necessary to distinguish between *school* and *overall* breakfast.

IA1. Previous Studies Providing General Information on Overall Breakfast Until 1999

Briefel *et al.* [16] categorize previous general information studies of breakfast in terms of whether they examine the definition of breakfast, trends over time in breakfast-skipping and/or consumption, or demographic/socioeconomic factors related to breakfast consumption. Although they may not address the issue of the impact of breakfast on learning per se, these general studies do provide information that sharpens the concepts or elucidates the hypotheses needed to conduct meaningful research on the relationship between breakfast and student outcomes.

IA1a. Definition of Breakfast

One example is the fact that the rate of breakfast skipping found is highly influenced by the way breakfast is defined. This fact was made abundantly clear by an important but unpublished study commissioned by the USDA several years earlier and still available on its Website. Devaney and Stuart [20] explored the prevalence of breakfast skipping using multiple alternative definitions of its composition. Working from the dataset of one of the largest (N=3381) and most comprehensive studies of child nutrition and school meals done up until that time, the 1992 School Nutrition Dietary Assessment Study (SNDA-1; [21], showed that the definition of breakfast had a profound impact on the prevalence of

breakfast eating/skipping that was found. When breakfast was defined as eating anything at all, only 8% of U.S. elementary school students were found to have skipped breakfast on a target day, but when breakfast was defined more substantively as consisting of at least 10% of the RDA for energy and food from two food groups, then fully 29% of the students in the sample skipped breakfast [20]. The USDA had commissioned the Devaney and Stuart reanalysis because of discrepant and disquieting findings from the original evaluations of the U.S. National School Breakfast Program [21, 22]. These reports had come to the puzzling conclusion that despite the millions of meals served each day, the U.S. National School Breakfast Program did not appear to increase the likelihood that poor (or non poor) students would eat breakfast on any given day. Viewed from this perspective, it could have been argued that the National SBP was failing to achieve its most important objective...providing breakfast to students who otherwise would not get one. In the original analyses of the SNDA-1 data [21] there had been no evidence that the National SBP was actually raising the rate of overall breakfast consumption, since the rate of breakfast skipping was no lower in schools in which the school breakfast program was available than in schools that did not have it.

As shown by the Devaney and Stuart [20] analyses, a big part of the reason for the lack of effect lay in the definition of breakfast...as well as in an understanding of the breakfast eating patterns of modern children. At the time of the original SNDA-1 reports [16] there was no commonly agreed upon definition of breakfast and for methodological simplicity, breakfast had been defined simply as any nutritional intake of 50 calories or more from the time of waking up until 45 minutes after the start of school.

Using this definition, as already noted, only eight percent of all elementary school students in the large nationally representative sample were found to have skipped breakfast on the day of their assessments and the rate of breakfast eating/skipping did not differ significantly whether or not a school had a breakfast program. Thus, the original analyses had (somewhat reluctantly) concluded that the National School Breakfast Program was not associated with higher rates of breakfast eating [21].

The reanalyses provided by the Devaney and Stuart [20] paper underscored how rare complete breakfast skipping was in current U.S. samples and how meaningless total abstinence as a definition of breakfast skipping could be. First of all, since almost no elementary school students ate absolutely nothing before school no matter how poor they were (even among the lowest income students, only 9% ate nothing in the morning), it was statistically very difficult for a program like the SBP to decrease the rate of breakfast skipping. Secondly, an 'anything goes' approach to the definition of breakfast undermines the validity of the concept... in much the same way that allowing ketchup to be counted as a serving of vegetables undermines the recommendation that children eat five or more servings of vegetables a day.

To get around these problems, Devaney and Stuart proposed several more substantive definitions of breakfast and explored their prevalence in the SNDA-1 data set. To

qualify as breakfast, their alternative Definition 2 required food from two or more food groups and equaling at least 10% of RDA for energy (about 200 calories; the equivalent of a bowl of ready to eat cereal and milk). Definition 3 was similar but required 15% of RDA for energy, etc. The discussion that follows will be limited to the findings with regard to Definition 2 although the Definition 3 findings showed similar patterns.

When Devaney and Stuart used Definition 2 as the standard for having eaten breakfast, the SNDA-1 data [20] showed that about 38% of all U.S. students (29% of elementary students, as noted earlier) failed to eat a substantive breakfast on any given day. Among elementary school students from low-income families, the percentage that reported skipping a substantive breakfast was significantly higher in schools that had no school breakfast program (38%) than in schools that did (23%). Among low-income secondary school students, the rate of substantive breakfast skipping was also significantly higher in schools without the SBP (56%) than with it (44%).

Therefore, using this alternative definition of breakfast supported the conclusion that a large percentage of U.S. students did begin the school day without a substantive meal and that when it was available, the National School Breakfast Program did in fact play its intended role of decreasing the rate of overall breakfast skipping, especially among poor children. The findings of the Devaney and Stuart paper also help to explain the relatively wide range in reported rates of breakfast skipping in many studies...even when exact intake is used as the basis of assessment as it was in SNDA-1, the determination of whether breakfast is skipped or not is relative to the definition used ...and this is often not specified. Depending on the definition of actual breakfast intake, the Devaney and Stuart paper illustrates that rates of breakfast skipping in U.S. children can range (as will be shown later in this paper) from nearly zero to more than fifty percent. With such high rates (29%-55%) of breakfast skipping evident even in U.S. samples when alternative definitions are used, the question of whether more substantive breakfast eating would lead to improved student outcomes—the main question of the current paper—becomes even more interesting and important.

IA1b. Trends in Overall Breakfast Consumption

Going back to the Briefel *et al.* review [16], the data regarding trends in breakfast consumption among children were clear at the time of the review, with national data showing declines in breakfast consumption (when defined as eating anything at all) over several decades, from about 95% in 1965 to under 87% in 1989-91 [23]. These authors had concluded that breakfast consumption declined predominantly because of behavioral changes and not the population's changing socio-demographic patterns. The authors also concluded that although the nutritional quality of foods consumed at breakfast had improved (less cholesterol and fat) from the 1960's to the 1990's, this was more than offset in a negative direction by the increase in breakfast skipping.

As shown in the same large national data set, trends for rates for breakfast skipping to increase as children got older were also found. For example among adolescents, the

decline was about 16 percentage points compared to declines of about nine percentage points in eight to ten year olds and five percentage points in preschoolers [24].

IA1c. Demographic/Socioeconomic Impacts of Overall Breakfast

As illustrated in the Siega-Riz [23] data and as already suggested in the review of the Devaney and Stuart paper, one of the strongest trends in previous studies is the declining rate of overall breakfast eating as children get older. In the Siega-Riz paper, complete breakfast skipping increased in the 1989-91 CSFII cohort from 7% for 5-7 year olds to 12% for 8-10 year olds, to 22% for 11-14 year olds, to 29% for 15-18 year olds [23]. The rate of breakfast skipping for older teens was therefore twice as high as for 8-10 year olds and four times higher than it was for 5-7 year olds [23].

With regard to other demographic and socioeconomic factors, research up to the end of the millennium showed a more mixed picture. Although none of the studies published up until that time had found a significant effect of child gender, the Siega-Riz *et al.* paper did note that the greatest decline in breakfast eating and the lowest rate of breakfast eating occurred in adolescent females. And although other large studies like the Child and Adolescent Trial for Cardiovascular Health [25] and Bogalusa Heart studies [26] had reported higher rates of breakfast skipping for minority *vs.* non minority students, the Siega-Riz *et al.* [23] study found no differences in breakfast consumption by race/ethnicity. The latter study did find significantly more breakfast skipping in single parent and in poor families. No data with regard to gender differences were presented in either the CATCH [25] or Bogalusa [26] study.

IA2. Previous Studies on the Impact of Breakfast Eating on Nutrition

As summarized by Briefel *et al.* [16] findings from previous research on the contribution of breakfast to overall nutrition were unequivocal that, "breakfast makes a significant contribution to nutrient intake over 24 hours. For children, analysis of data from the first National Evaluation of the School Nutrition Programs [21] showed that eating breakfast was significantly and positively related to the daily intake of all nutrients examined" (p. 26).

With regard to specific nutrients, another study showed that the largest differences between breakfast skippers and breakfast eaters were for calcium, phosphorus, magnesium, riboflavin, vitamins B and A, and folate [27]. The relationship between breakfast eating and the intake of other nutrients depends to a large extent on the foods consumed at breakfast. Some traditional breakfast foods such as eggs and pancakes are higher in fat than breakfasts of ready-to-eat cereal, low-fat milk, and fruit. Ready-to-eat cereals are a significant contributor to the daily total nutrient intake of U.S. children not only because of the intrinsic nutrient content of these grain-based products but also because most RTE cereals are fortified and because most are consumed with milk which is an added rich source of calcium and vitamins A and D [28].

With regard to breakfast skipping, Briefel and her colleagues [16] had concluded "Children who eat breakfast

have higher daily intakes of food energy and key nutrients than breakfast skippers. Breakfast skippers do not make up the difference in nutrient intakes at other meals during the day" (p. 28). This last sentence may summarize as well as possible what is known about the mechanism through which breakfast may make its strongest contribution to nutrition and thereby to learning. Over and above its importance as the first meal of the day and as a meal that breaks a long fast, breakfast is simply one of three main places and times during which individuals can obtain their daily nutritional requirements. To skip this meal is to diminish by one third the chance that the body's varied nutrient requirements will be met.

IA3. Previous Studies on the Impact of Breakfast on Cognitive and Other Outcomes

Returning to the main line of the previous (and current) review, Briefel and her colleagues [16] noted that since the 1970's a succession of increasingly well-controlled studies had demonstrated the impact of breakfast on mental performance, scholastic achievement, and mood in school age children and that "much of what is currently known... can be attributed to the work of Pollitt and his colleagues (p 29)". This work was summarized in a 1998 review by Pollitt and Mathews [2]. A review of their conclusions provides the basis for understanding the research in this area that had been done up until that time as well as in the years since.

Pollitt and Mathews [2] summarized the research up until the late 1990's on the impact of breakfast on cognition in this way:

- I. "No definitive conclusions can be drawn from the existing data on either the a) long- and b) short-term benefits of breakfast on cognition or c) the mechanisms that mediate this relation.
- II. The data strongly suggest that a) omitting breakfast interferes with cognition and learning, b) an effect that is more pronounced in nutritionally at risk children...
- III. At the very least, breakfast consumption a) improves school attendance and b) enhances the quality of the students' diets." [p 813S; numbering and formatting added for ease of discussion that follows].

With regard to # II in the quotation above, the authors' statements that the data suggest that omitting breakfast interferes with cognition and learning, especially in nutritionally at risk children, were widely disseminated and were among the findings that provided the strongest impetus for the many national [29] state [30] and city [31] universal free school breakfast demonstration projects that followed in the late 1990's and early 2000's.

Another point made by Pollitt and Mathews [2] (Ia in the quotation above) bears special emphasis in considering the previous literature. According to the authors, studies on the impact of breakfast could be conceived of theoretically as examining either of two types of mechanism: short- versus long-term. The authors noted that virtually all of the studies of breakfast and learning done up through the late 1990's had been on the impact of short-term (24 hour) breakfast skipping and that 'long-term' assessments of breakfast

omission and cognitive function have not been conducted' (p. 808S, emphasis supplied). As will be shown later in this paper, this is something that has changed since the Pollitt and Mathews [2] review. So too has the dearth of studies of the impact of breakfast in two other areas: mood and health.

As noted by Briefel and her colleagues [16] reports of improved mood and behavior as well as improved cognitive and physical performance resulting from breakfast go back more than forty years to the Iowa Breakfast Studies [32, 33]. More recently, a study by Wyon and his colleagues [34] found that significantly fewer children reported feeling 'bad' and hungry during the morning at school following a high-energy breakfast. A study by Smith and his colleagues [35] reported improved mood following breakfast in a group of university students. A paper by Murphy, Kleinman and their colleagues [36] reported significant associations between school breakfast skipping and behavior problems using several different standardized measures.

The Briefel *et al.* [16] review also expanded the heavily cognitive focus of the Pollitt and Mathews [2] review to include a consideration of health as well as mood, behavior, and mental health variables as important for the understanding of breakfast's impact on learning. Research published by the end of the decade had linked breakfast skipping to higher rates of chronic disease [37], obesity and physical inactivity [38]. As the Briefel review also noted, one of the largest and longest running studies of adult health ever done in the U.S. [39, 40] had shown better health outcomes over many years in association with the habit of regular breakfast eating. A review of this study is necessary for understanding the school breakfast studies discussed later in this paper.

The Alameda County Study had shown that adults who skipped breakfast had poorer overall health [39] as well as higher rates of mortality cross-sectionally [41] and over 5.5 years [42] and mortality and disability over 17 years [43, 44] than did adults who reported eating breakfast every day. Most of the major findings of the ACS, including those on breakfast, have been replicated in other states [45], and countries [46, 47]. And although cognitive and academic outcomes were not examined in the ACS sample of adults, a number of ACS analyses did show that breakfast-eating and the other health habits were related to improved mental health and mood [48]. Not smoking, not drinking excessively, sleeping 7-8 hours per night, exercising regularly, not being over- or underweight, and avoiding snacks between meals were the other six health habits studied.

It is also important to note that the Alameda County study of adults has shown that the magnitude of the impact of breakfast eating on health is somewhat smaller than the impacts of several of the other health habits. For example, the ACS found that the health habit with the largest impact on mortality was 'not smoking' and for men, its absence (smoking) was associated with an overall age adjusted mortality rate that was more than twice the mortality rate found in non smokers (12.8 vs. 5.5 deaths per hundred; [42]; p. 81). In contrast, breakfast skippers had a mortality rate that was only 15% higher than breakfast eaters (9.9 vs. 8.7 deaths per hundred; p. 89). In fact, the authors of a book based on the 9.5 year follow up data noted that the two ACS

health habits related to eating (skipping breakfast and between meal snacking) "do not carry as important a mortality risk in the age group studied as the other five practices..."(p 90). It should also be noted, however, that in the next round of longitudinal follow ups, the two health habits based on eating were again found to be significantly predictive of better health [49].

Far stronger than any single health habit however was the cumulative impact of having many vs. few health habits. For example, the age-adjusted mortality rate for women with at least four of the seven health habits (3.9) was only about one third the rate for women who had two or fewer health habits (11.9). The pattern for men was essentially the same [42].

The main conclusion of the Alameda County Study has always been that individual health habits do make a significant difference in health but that the overall pattern of many health habits rather than the presence or absence of any single health habit is what is most important for healthier outcomes from a public health point of view. This conclusion fits squarely with the current thinking of investigators from the U.S. Centers for Disease Control and Prevention [50] and other health authorities [51], who now estimate that more than half of all deaths and illnesses in the U.S. are due to lifestyle (preventable) behaviors and that removing these behaviors would lead to improved health for individuals as well as the population as a whole.

According to the CDC authors, the top three preventable causes of death in the U.S. are tobacco, poor diet and physical inactivity, and alcohol use and that "poor diet and physical inactivity may soon overtake tobacco as the leading cause of death" [50]. Other researchers conclude that 'diet/physical activity patterns are now in fact likely greater contributors to mortality than tobacco is...' [51] (p. 1264; emphasis supplied).

Thus, while not of quite the same magnitude in its impact on health as smoking in the 1970's and 1980's when most of the ACS research was done, diet (and within that category, breakfast skipping), has always made the 'short list' of non genetic and therefore actually changeable habits that can influence the health of adults and may now in fact have achieved the same importance as tobacco use as a cause of health problems in post industrial societies. Later in this review, data on the relationship between breakfast skipping and obesity will be discussed. Until the USDA SBPP evaluation, no studies of the long term impact of health habits (including breakfast) comparable to the ACS had been done with children.

IB. PREVIOUS STUDIES OF SCHOOL BREAKFAST UP TO 1999

Returning to the Briefel *et al.* review, as noted earlier, the authors used the same three categories (general, impact on nutrition, impact on other outcomes) for reporting on studies of school breakfast as they did for overall breakfast and their summaries of the research on school breakfast up until 1999 will be reviewed briefly in this section. Briefel and her colleagues begin this section of their review by noting that school breakfast studies often use school-wide outcome variables as opposed to the individual outcome variables

usually used in the overall breakfast studies. A distinction needs to be made, for example, between data based on individual student school breakfast consumption (e.g. “55 of the 100 subjects reported eating school breakfast on the day of their interviews”) and school-wide data on participation (e.g. “the school breakfast participation rate at the MLK school increased from 19% to 37% after the free school breakfast program was introduced”). Although within any given school the two sources of data on school breakfast participation should produce similar figures, they usually come from different sources (subject reports on interviews or surveys *vs.* school food service staff counts or billing reports) and they are usually linked to different types and metrics of data.

Schools routinely keep track of and report on school wide absence and tardiness rates and on the percentages of students passing math, reading, and other competency tests. These data are usually available to the public as well as to the school district administration and are meaningful to all groups considering the effects of programs at the school level or higher. So too, are data on school breakfast and lunch participation. For this reason, school breakfast researchers often have access to these data and in large studies like the USDA School Breakfast Program Pilot; school-level as well as individual-student-level data were analyzed in an effort to assess the impact of free school breakfast programs.

In the Murphy *et al.* [36] school breakfast paper, changes in outcomes for individual students were assessed for those who did or did not increase their individual school breakfast participation. This study did not assess changes in school-wide outcomes, although the SBPP evaluation did (monitoring for example, changes in attendance rates for whole schools or groups of schools) as well as changes in attendance for students who participated in the interviews.

IB1. Studies Giving General Information on School Breakfast

According to the Briefel *et al.* review [16], approximately 19 percent of the students who attend schools offering the SBP program participate in it. SBP participation rates are highest among students who are eligible for free or reduced-price meals [25]. According to the Food Research and Action Center, a food advocacy group that monitors the SBP, in fiscal year 1998, over seven million children and 68,426 schools participated in the SBP [52]. The FRAC report also showed that more than 80% of all SBP participants are eligible for free or reduced-price meals and thus by definition are from poor or low income families. One consequence of this fact for research is that school breakfast participation and poverty are confounded.

Switching the view on school breakfast slightly, data from 1991 [53] showed that, among a sample of third-graders, about 13 percent of the children who ate breakfast did so at school, compared to 84 percent who ate at home and 3 percent who ate at both home and school. A study based on data from the predominantly low income Bogalusa, Louisiana public schools, found that the introduction of the SBP dramatically reversed a trend of breakfast skipping

among elementary school-aged children [26]. The authors projected that 3 million children in the United States would skip breakfast if no SBP were available.

IB2. Previous Studies of the Impact of School Breakfast on Nutrition

All public and (nonprofit) private elementary and secondary schools in the United States are eligible to participate in the National School Breakfast Program. To participate, schools must make breakfasts available to all students and the breakfasts must meet federal nutrition standards. The U.S. SBP is highly regulated and closely monitored by the United States Department of Agriculture [16].

USDA regulations require that school breakfasts provide one-quarter of the Recommended Dietary Allowance (RDA) for food energy and several other important nutrients (protein, calcium, iron, vitamin A, and vitamin C). In addition, regulations now require that all school meals meet the recommendations of the 1995 Dietary Guidelines for Americans [54] including lowered fat, saturated fat, cholesterol, and salt; with as many servings of vegetables, fruits, grain products and fiber as possible.

Although some studies have shown that many schools fall short of these goals [25], most studies have concluded that the SBP consistently provides high quality nutrients [55] that successfully mitigate the effects of poverty on nutrition [56]. In addition, findings from SNDA-1[57] showed that SBP participants had significantly higher intakes of energy, protein, thiamin, riboflavin, phosphorus, magnesium, and calcium than non-participants. From 1981 to 1988, the percentage of calories from protein and carbohydrates increased in school breakfasts, while the percentage of calories from fat and cholesterol decreased [26].

IB3. Previous Studies of the Impact of School Breakfast on Outcomes

Although the previously mentioned caveat about the confounding of poverty and school breakfast participation needs to be kept in mind, it is still true that school breakfast programs can provide an opportunity to study the impact of overall breakfast eating in large samples, under real world conditions, especially, as noted earlier, as they affect long-term outcomes. In addition to the three school breakfast program evaluations that were known to Pollitt and Mathews [2] (Lawrence, Massachusetts; Lima, Peru; Jamaica), Briefel and her associates [16] reviewed preliminary findings from seven other U.S. programs (Philadelphia, Minnesota, Maryland, Rhode Island, New Jersey, Baltimore, Boston). Final or long term reports on most of these programs have become available in the years since the Briefel, *et al.* report and will be summarized in a later section of this paper.

The programs described by Briefel *et al.* ranged from 1 to 151 schools at the time of review. Most of these programs were just getting started in relatively small numbers of schools at that time, with a modal size of six schools per district and a total of 215 schools in all. Updates on these and other programs five years later will be presented in the next section.

IB3a. Impact of School Breakfast on Academic and Cognitive Outcomes

The fact that early reports on these and previous school breakfast program evaluations had shown decreased rates of absence and tardiness established for Briefel *et al.* in 1999 [16], as they had for Pollitt and Mathews in 1998 [2], the probability that these two student outcomes were among those that were most likely to be improved by school breakfast programs.

More limited information was available on the impact of school breakfast programs on other student outcomes. Briefel *et al.* noted a study by Murphy and his associates [36] that showed significantly greater improvements in math grades for students who increased their school breakfast participation following the start of a universal-free school breakfast program. The sample was 133 elementary school students from inner city schools in Philadelphia and Baltimore. Another study of six schools in the state of Minnesota reported improvements in other, related areas like teacher and parent perceptions of the learning environment [58].

An earlier study in another low income sample from the U.S. had reported significantly higher scores on the Comprehensive Test of Basic Skills (CTBS), a standardized academic achievement test, in three schools in Lawrence, Massachusetts [59] that had adopted a universal free approach to school breakfast. Several studies in the third world [60-63] had found some significant relationships between breakfast program participation and arithmetic and verbal fluency test scores but even in third world samples such findings were not consistently in the hypothesized direction [2].

IB3b. Mental Health and Behavior

Studies of the impact of school breakfast on mental health and behavior had just begun at the time of the Briefel *et al.* review. Murphy and his colleagues [36, 64] had reported significant associations between frequency of school breakfast participation on the one hand and standardized measures of behavior problems, anxiety, hyperactivity, and childhood depression, on the other in two different inner city samples in the U.S. Wahlstrom and her associates [58] had found decreases in teacher reported behavior problems in the six schools that piloted a USB program in Minnesota.

IB3c. Health

Although there were no studies exploring the relationship between school breakfast and health *per se*, the Minnesota and Maryland evaluations produced data suggesting that the implementation of USB programs was associated with a decrease in visits to the school nurse [58, 65, 66] a possible indicator of improved health.

IB4. Methodological Issues in Previous Studies

After reviewing previous studies, Briefel and her colleagues [16] summarized what they believed were the methodological issues noted in the school breakfast research up until that time. The most salient issues included limited attention to any one outcome (only attendance and tardiness had been commonly examined in multiple studies),

differences in breakfast program intervention (some were universal free programs, others were not), non-experimental designs (more potential for selection bias), small sample sizes, and what they called inappropriate statistical tests (use of multiple significance testing without corrections).

With these issues in mind, the Briefel, *et al.* report sketched the measures and methods that could be used to assess the impact of universal free school breakfast programs on learning with the greatest accuracy and power. Measures included: administrative data (school breakfast participation, attendance, tardiness, standardized test scores, nurse visits, disciplinary incidents), height/weight (Body Mass Index; obesity) surveys of school staff, parent reports of student mood and behavior, teacher reports of student behavior, cognitive tests administered to students, and parent, student, and staff ratings of satisfaction with the SBPP and other implementation data.

A companion document [29] to the Briefel, *et al.* report was an overview also prepared by Mathematica Policy Research, that would use the measures described above in an experimental design that would test the impact of a universal free school breakfast program on learning. A cornerstone of the design was that schools were to be randomly assigned to either a universal free breakfast program or the traditional school breakfast program.

This design was fleshed out in an even more detailed evaluation proposal that was eventually implemented by Abt Associates under contract with the USDA [13]. Before reviewing the design and findings from the School Breakfast Program Pilot (SBPP) project, the results of other breakfast studies that were published after the original review by Briefel and her colleagues and before the release of the SBPP Final Report will be reviewed.

IC. CITY, STATE, AND NON U.S. SCHOOL BREAKFAST STUDIES FROM 1999 TO 2004

As noted above, during the late 1990's, the governments of several countries (U.S. and England) and a number of states (Minnesota, Maryland, Massachusetts), and cities (Baltimore, Boston) set up large-scale universally free school breakfast programs, often citing the evidence presented by Pollitt and others [2] on the need for and potential educational benefits of such programs. In England and Canada, which do not have official national school breakfast programs, smaller scale "breakfast club" programs have been set up in individual schools and districts and evaluated, in keeping with observations on the prevalence of under-nutrition and/or hunger among the poor in those countries [67, 68]. Although the U.S. is still the only country with a national school breakfast program, in England and Canada there have been repeated calls to start such programs and Wales has just started a pilot program [69] which could become one.

By the end of 2004, most of the state and city programs cited above had continued to operate, although two of the national demonstration programs (U.S. and England) and two of the state (Minnesota & New York) programs have ended. Just in the past few years, however, additional state (Ohio), city (New York City) [70, 71] and, as just noted,

country [69] efforts have begun. In 2004-2005 the Welsh government began a universal free school breakfast program in its fifty poorest primary schools, with a planned expansion to all of the country's primary schools over several years. Researchers from Cardiff University are conducting an evaluation [72].

During the 2004-05 school year, universal free school breakfast program were operating in more than two thousand schools in New York City, Philadelphia, Baltimore, Massachusetts, Maryland, California and Ohio [73], some for more than a decade. These facts alone attest to the perceived success of as well as of the perceived need for such programs. Although few of the studies of universal free school breakfast programs have been published, most are available as monographs from governmental agencies or research institutions. These monographs are reviewed (below) for this paper using the three categories employed by Briefel *et al.* [16].

IC1. Recent Studies Providing General Information on School Breakfast

In addition to the USDA National School Breakfast Program Pilot, the free school breakfast programs in England, Wales, in the states of Minnesota, Maryland, Ohio, New York, and in the cities of Baltimore and Boston partnered with academic institutions to conduct formal evaluations of their universal-free programs. All but the just-started Welsh program have produced reports documenting their evaluations [73-82].

IC1a. Definition of Breakfast

All of the U.S. program evaluations examined school-wide school breakfast participation rates before and after the universal free school breakfast programs were started, and breakfast was defined as school breakfast, usually based on standard meal reporting data. The Ohio state program and evaluation [73] actually had an even larger scope as well: documentation and evaluation of breakfast participation increases for a statewide expansion of school breakfast (both universal free and traditional). The Ohio program will be discussed in more depth below.

Three facts make research on school breakfast relevant to a consideration of the overall impact of breakfast. The first is that this research describes real world actions whose consequences can be studied in the real world (as opposed to laboratory studies in which the breakfast served and the outcome observed may or may not have relevance when brought into the real world). The second two facts are methodological: school breakfast programs are based on meals as defined by the U.S. School Breakfast Program—which has very rigorous standards for meal components, portion sizes, and accountability—and that these meals are counted routinely as a part of reimbursement procedures. Thus, evaluations of school breakfast program expansions in the U.S. are based on relatively standard 'doses', which can be measured with relatively good accuracy.

For English and Canadian school breakfast program evaluations, the specifications for breakfast were less precise because what constituted the breakfast meal was defined by each site [74-76, 83] and requirements for counting and

claiming reimbursement are not as rigorously regulated. Separate studies have examined the nutritional composition of English [84, 85] and Canadian [83] breakfast club meals.

Outside of the USDA SBPP evaluation, none of the foreign and only one of the U.S. local school breakfast evaluation studies assessed overall (school + home) breakfast consumption [64] by assessing these components separately and together. The rest of the evaluations used school breakfast itself as the defined breakfast. The Maryland Meals for Achievement Year 1 report [64] showed that 80% of the students who ate overall breakfast never or rarely prior to the start of the USB program showed a 51-100% increase in school breakfast eating after the start of the program, suggesting that the new free school breakfast program was having the desired effect of increasing overall breakfast eating.

IC1b. School Breakfast Studies Exploring Trends in Participation Over Time

The SBP has shown steady growth in participation since its inception in 1966. The annual FRAC School Breakfast Scorecards have provided a yearly snapshot of SBP participation for the past fourteen years. The most recent (2004) report [71] notes that the current average of 8.7 million breakfasts per day is more than double the average in 1990. It is important to note, however, that this figure, although growing, is still only about one third of the 28 million school lunches served on any given day. Using a nationally representative sample collected from 1998-1999, one study found that on the day of assessment 15.5% of students ate school breakfast compared to 50% who ate school lunch [86]. Using a slightly different time frame, another national study reported that 22% of all students ate school breakfast during a target week compared to 60% who ate school lunch [87].

Almost all of the U.S. state and city USBP evaluations specified the rate of school-wide school breakfast participation prior to the start of their programs. By and large, data from the state [77, 80, 88] and city [31, 82] USBP programs showed that school breakfast participation rates were relatively low to begin with (generally in the 23-39%) range. These rates are higher than the national averages for school breakfast participation just cited because most of the USBP programs have been implemented in schools with high poverty rates, which generally means rates of school breakfast participation that are higher than average... but still only a fraction of what they could be.

All of the state and city USBP evaluations [77, 78, 89] also showed that participation rates increased significantly (generally ten to fifty percentage points) to the range of 43-87% after universal free school breakfast programs were started. All of these reports confirmed that it was possible to implement universal free breakfast programs in a wide range of schools and to sustain them over a period of many years.

More specifically, pre-USBP rates ranged from 23% in New York to 29% in Maryland, to 32% in Boston and Baltimore, to 39% in Minnesota. In all sites, the rate of school breakfast participation rose substantially and significantly to 58% in New York [80] to 71% Maryland

[78], to 43% in Boston [82], to 87% in Baltimore [31], to 54% in Minnesota [88].

In districts with multi-year evaluations, rates of participation were found to remain about the same or to keep increasing over time. For example, in Minnesota, the Fast Break to Learning USB schools increased from 39% to 42% to 49% to 56% to 57% over the first four years of the program compared to control schools which increased only from 17% to 21% over the same period [77]. In Maryland, even three years into the program, schools generally maintained high (70%+) participation rates, losing only one to two percent points of participation after three years [78].

IC1c. Demographic/Socioeconomic Factors Related to School Breakfast Consumption

Gleason and Sutor [86] reported that the school breakfast participation rate was significantly higher for Hispanics, Blacks, and rural areas as well as for children from poor or low income families. Poverty is and has always been the strongest predictor of SBP participation. The FRAC 2004 Scorecard [71] notes the widely recognized fact that that most (82%) participants in the U.S. SBP are from poor or low income families. Poor or low-income students make up a substantially smaller portion (59%) of school lunch participants [71].

All public schools in the U.S. collect data on the family economic situations of all students each year to determine whether they are eligible for free or reduced price meals. Students are categorized as to whether they are eligible for free meals at school (family incomes at or below 130% of the official U.S. poverty line) or reduced price meals at school (family incomes between 130% and 185% of poverty). Students whose family incomes are greater than 185% of poverty have to pay full price for their meals at school [71].

A recent national study [87] reported that the SBP participation for students approved for free meals was 39% compared to a participation rate of 20% for students approved for reduced price meals and only 8% for students who were not approved for school meal benefits. In comparison, for school lunch, the participation figures were 80%, 69%, and 48% for the three eligibility groups respectively. It is important to note a little known fact about child poverty in the U.S. that is illustrated in the CSFII report, namely that 38% of all U.S. children (more than one third) live in families with incomes that are categorized as poor or near poor (up to 185 percent of poverty) [86].

The impact of billing approach as well as poverty is evident in the free, reduced, and paid category participation rates just discussed, with higher rates of participation for students who pay less for their meals. Another billing approach that affects participation rates is the provision of meals that are universally free to all students. Universal free approaches increase school breakfast participation even for students already eligible for free and reduced price meals and universal free meals served in the classroom increases participation even more [82].

Given these differentials, some authors have speculated that the stigma attached to taking free food at breakfast is a

deterrent [90] to participation and others have noted the burden of paperwork that the SBP requires [91]. Another factor influencing participation is the fact that meals are often scheduled prior to the start of the school day when bus schedules and late arrivals can work against participation [79].

Problems with stigma and paperwork are two of the main reasons for the spread of universal free approaches to school breakfast billing [29]. In contrast, under universal free approaches, there is no stigma since all students in a given school may receive a breakfast without cost, including students who would normally pay full or a reduced price. Paperwork is reduced because under current USDA policies once the percentage of free and reduced eligible students in a given school established in a baseline year, there is no need to collect financial information for parents for the next three years [91].

Early demonstrations with Universal Free school breakfast programs showed that such programs did result in gains in participation [91]. Although not dramatic in terms of gain in percent participation, given the low rates of participation at the time, these gains were still substantial enough to lead to a doubling of participation rates (from 15% to 27%) [36] and to dramatic time and money savings because of reduced paperwork [91]. Later demonstrations showed that by making breakfast a part of the school day [65] and even more importantly by serving breakfast in the classroom, it was possible to obtain huge increases in school breakfast participation, resulting in participation in the range of 70-80%...comparable to the rates usually found only for school lunch [66, 80, 92].

Similar to the finding that overall breakfast skipping increases with child age is the well-established fact that school breakfast participation rates decrease as students get older. For example a recent national study reported that 26% of elementary students participated in the SBP during a target week, compared to 16% of middle school students and 11% of high school students [87].

It should be noted that all of the universal free school breakfast demonstration programs have been aimed at poor or predominantly low income schools. For the Maryland Meals for Achievement program, a requirement was that applicant schools had to have 50% or more of all students eligible for free or reduced price meals [93]. For the Minnesota Fast Break program, the cut off was 40% free and reduced [30]. New York City was the only major program that made breakfast available to all students in all schools [71] ...but it should be noted that the district itself is almost exclusively made up of schools with high poverty rates (the district average of 70% F&R is one of the highest in the country) [94].

IC2. Impact of School Breakfast on Nutrition

One recent study [86] reported on data collected in the mid 1990's. The 1994-1996 CSFII (Continuing Survey of Food Intake by Individuals) collected dietary intake and other data from a nationally representative sample of non-institutionalized residents of the United States. The analysis was conducted by researchers from Mathematica Policy

Research for the USDA, using data from nearly 2,700 children ages 6 through 18 years who completed two non-consecutive days of dietary intake interviews. Their report concluded that the SBP did have a positive impact on overall nutrition since “significantly larger percentages of SBP participants than non-participants have observed single-day intakes that meet the dietary standard for four micronutrients: (1) vitamin C, (2) vitamin B₁₂, (3) thiamin, and (4) calcium [86] (p 147).

The authors also concluded that the SBP had a positive effect on overall breakfast eating. Gleason and Sutor reviewed the patterns reported by Devaney and Stuart [20] in this different data set and reconfirmed their findings. When breakfast was defined more substantively as at least 10% of the REA for food energy, students in schools with a school breakfast program were indeed significantly more likely to eat overall breakfast. But, as in the original Devaney and Stuart [20] report, if breakfast was defined as eating anything at all, overall breakfast eating was not higher in SBP schools. It is also important to note that the authors concluded that “on any given day, breakfast skipping is common, with anywhere from one-fifth to one-third of children not eating breakfast depending on which definition is used” [86] (p 142).

Another recent study used an unusual statistical analysis technique in a large, nationally representative sample to address the question about the impact of school breakfast on nutrition. Working with data from the National Health and Nutritional Examination Survey (NHANES III) Bhattacharya and his colleagues [95] found that children in schools in which the SBP was available were significantly less likely to have low serum levels of Vitamin C, vitamin E, folate, iron, and other micronutrients. SBP availability did not increase the percentage of calories from fat nor total number of calories. The authors concluded that the availability of the SBP led to improved diets for the students in the SBP schools and for their parents and preschool aged siblings as well.

IC2a. U.S. Studies of USBP and Nutrition

Of the recent U.S. city and state universal-free school breakfast evaluations, only the Boston and Maryland evaluations examined the impact of school breakfast participation on nutrition variables. In the Boston evaluation [82, 96], school breakfast participation was significantly associated with decreased nutritional risk (defined as no more than one micronutrient at less than 50% of RDA and total energy intake not less than 1500 Kcal). In the Maryland program, students who participated in school breakfast most often were the least likely to be at nutritional risk [66].

IC2b. English Studies of Breakfast Clubs and Nutrition

Although, as noted earlier, many industrialized nations have national school *lunch* programs, until now the U.S. has been the only country with a national school *breakfast* program. In Canada [97] and in England [98], the lack of a national school breakfast program has been compensated for to some extent through the start of ‘breakfast clubs’ which are locally funded and implemented. Targeted at children from low income families and aiming to improve learning as well as nutritional outcomes, these programs cite studies of

poverty and hunger in the United Kingdom [68] and Canada [97] as well as the same studies that show the link between breakfast and learning in the U.S. to show the need for school breakfast programs.

Breakfast clubs typically meet other needs like childcare and the provision of some academic and social services. They are usually run by volunteers and although some recent papers [83, 99], have pointed out the ways in which some of these programs appear to have lost sight of their original objectives (providing nutritious breakfasts for children who might not get them) they do appear to meet those objectives even as the debates over whether to start full fledged national school breakfast programs continue [69].

Only a few studies have examined nutrition in breakfast club participants and the conclusions have differed. A national breakfast club evaluation concluded that students in schools with a breakfast club were significantly more likely to get a serving of fruit for breakfast [75] and that the program was successful in decreasing overall breakfast skipping... but that the quality of the foods provided was not consistently high [98]. Similarly, in a study of students from three schools in England, Belderson and her colleagues [85] found that children who attended breakfast clubs had significantly greater intakes of fat, saturated fat and sodium than control subjects who did not and concluded that in the schools studied, breakfast-club participation was not associated with superior nutrient intake or improvements in dietary pattern. In sample of elementary school children in London, Waddington and associates [84] concluded that the food offered at breakfast clubs could contribute substantial nutrients to a child’s daily intake but that there was significant variation among sites.

IC3. Impact of School Breakfast on Student Academic, Cognitive, Behavioral, and Health Outcomes

The Minnesota, Maryland, Baltimore, New York, Ohio, and Boston evaluations explored the impact of *school-wide* changes in the school breakfast program on school wide absence rates and the first three also explored the impact on school-wide standardized test scores. As will be reviewed below, in Maryland, Minnesota, and Boston, *individual student data* were also examined.

Outside of the SBPP, the largest USBP evaluations were conducted in Minnesota, Maryland, and England. The Minnesota evaluation went through two distinct phases as the USB program there grew from a three year Universal Breakfast Pilot Study [58] in six schools to a four year Fast Break to Learning program that ran in as many 422 schools [77]. Evaluation reports were prepared after each year by the Center for Applied Research & Educational Improvement of the University of Minnesota [30, 58, 77, 88, 100, 101]. The Maryland Meals for Achievement Program grew from six schools in 1997 to about one hundred in 2001 where it has remained ever since. An evaluation report was written each of the first five years of the program [31, 64, 66, 81, 82, 92]. The National Evaluation of School Breakfast Clubs [98] in England began in September of 1999, with 43 schools randomized to start or not start school breakfast clubs. As of this writing, analyses of the cognitive, educational, nutritional, health, social and economic outcomes associated

with availability of school breakfast clubs have been published in three papers [74-76] and summarized in a report [98]. Findings from these studies will be reviewed below.

IC3a. SB Effects on Cognitive Functioning

Although none of the U.S. city or state breakfast programs evaluations used standardized cognitive tests in their evaluations, the English breakfast club evaluation did. More than 6000 students participated in the English study which found that three months after the start of the intervention, students whose schools had been randomly assigned to breakfast club availability had significantly better scores on a cognitive test of concentration than students in the control group whose schools did not have breakfast clubs available [102].

Another way to assess the impact of school breakfast on concentration is to have teachers rate the students in their classrooms. Following the lead of the original Minnesota USBP evaluation [58], several of the U.S. state and city evaluations asked teachers to provide global ratings of student concentration or attention after universal free breakfast programs had been set up. The Maryland evaluations made extensive use of surveys and teachers, principals, students, and parents to solicit their opinions on the impact of the school breakfast program on student attention. Evaluations from the first three years of the program found significant impacts of the program on attention. For the Maryland Year 1 evaluation [64], 180 teachers and other staff from the six USB schools were significantly more likely to report improvements in attention among students over the past year (65%) than were 153 staff from five matched comparison schools, (only 38% of whom reported improvements). In the Year 2 MMFA evaluation [66], more than 300 teachers from the 12 MMFA and 12 matched comparison schools were asked if there had been a change in student attentiveness from before to after the USB program started. Teachers in the USB schools were significantly more likely to report improvements in students' attention (73%) than were teachers in the comparison schools (44%).

The MMFA Year 3 evaluation [92] collected data from an even larger number of staff from an even larger number of USB schools. Although no comparison schools were studied in Year 3, more than 1000 teachers and other school staff completed survey forms. Again it was clear from the responses that a very high percentage (73%) of educational staff believed that student attentiveness had improved. In the fourth year Fast Break evaluation [77], twenty-four teachers from a sub-sample of participating schools were surveyed and an even higher percentage (83%) reported that students who participated in school breakfast were more attentive in class.

IC3b. SB Effects on Test Scores and Learning

Even more to the point of the current review is the question of whether the USB programs had any impact on more direct measures of learning. There are a number of different ways of approaching this question. The most obvious is to examine standardized test scores or grades from participating and non-participating schools. Less obvious but possibly just as valid is to ask teachers and

principals to provide their assessments of the impact of USB on learning.

Reports on the Baltimore [31], Maryland Year 3 and 4 evaluations [92, 103], and Minnesota programs [77, 88, 101] tracked standardized test scores and attendance. For some of these reports the samples of universal free schools in the design were quite large (thirty-nine in Baltimore, fifty-five in Maryland and more than three hundred in Minnesota).

All of these evaluations, found statistically significant improvements in standardized test scores in at least some of the comparisons. The Baltimore evaluation reported significantly greater increases in School Performance Index scores (the single bottom line number permitting evaluation and comparison of schools in terms of a weighting of test scores and attendance) for the 29 Baltimore USBP schools in comparison with the rest of the schools in the system [31].

The Maryland Year 3 report found a significant improvement in standardized test scores (the Maryland School Performance Assessment Program or MSPAP which was the state administered competency test for that state up until 2002) for the ten schools compared to ten matched controls in the second year design [92]. The Maryland Year 4 report [103] found continued improvements in test scores in these schools and in the 39 schools added in the fourth year of the program although these changes were only statistically significant in some analyses.

In Minnesota, which had the largest and best controlled sample of schools of all of the state USB program evaluations, the four yearly program reports described a similar pattern, with many of the analyses showing statistically significant improvements in standardized test scores in most tests (the Minnesota Comprehensive Assessment tests of reading, writing, and mathematics) for most of the grades (3rd, 5th, 8th) although the Final Report [77] failed to establish an overall statistically significant improvement in test scores.

It is important to note that although the Minnesota sample was the largest and probably most rigorously analyzed of the city and state program evaluations, the increase in school breakfast participation was one of the smallest found in the state evaluations (just 25 percentage points over four years) and the percentage of students eligible for free and reduced meals was among the smallest (more than three quarters of the schools in the design were less than RF&R rates of less than 50% [100]).

Other facts that become evident when the Minnesota reports are reviewed are, as already noted, that the schools targeted for the USB programs there and in other states like Maryland [92] are generally the poorest, with the highest rates of special education, Limited English Proficiency, new arrivals to the school district, etc. These schools are, therefore, among the worst performing in their districts [77] to begin with. For schools with so many challenges, it is not clear that even a good program would be able to show an immediate upward effect against the downward pull of so many other negative factors.

As suggested above, when considering the differing findings regarding test scores in some of the evaluations, it may be important to note the differing characteristics of the samples. As noted, Minnesota probably had the smallest

percentage of very low income schools. Only 8% had free and reduced price meal eligibility rates of 70% or higher [30] compared to 16% of the schools in the U.S. SBPP sample [13], 27% of the Maryland Meals for Achievement schools [64] and 60% of the Baltimore schools in the evaluation sample reports [31]. It seems reasonable to assume that the impact of a universally free school breakfast program would be greater in schools with more students who were at greater nutritional risk as well as in schools that have the largest increase in breakfast participation.

A recent report from the New York state universal free school breakfast program confirmed that both of these patterns had significant effects on the degree of impact of a universal free breakfast program [89]. Although the state and city school breakfast evaluations used naturalistic rather than experimental designs, it is important to note that all three large state program evaluations used comparison groups of similar local schools and that all found that standardized test scores improved more in USBP schools than in the controls...although these differences failed to reach statistical significance in some comparisons.

It is also important to note that the greatest gains in test scores were found in the programs with the highest percentage of poor students, in other words, in areas where the need was presumably the greatest. In Baltimore, where the overall score on the state competency test (MSPAP) increased significantly more in the sample of 39 schools in the design than in the comparison group of 15 similar schools, the percentage of students eligible for free or reduced price meals at school was 78% [31]. It is also important to note that the Baltimore program was based on a universal free classroom breakfast model and that the increase in participation had been quite large (increase of 55% points in ADP from 32% pre to 87% post-USB).

Although the fact that in all of the major city and state evaluations conducted thus far, students in the universal free breakfast schools often showed greater improvements in standardized test scores than students in comparison samples, it is also important to note, as the authors of the Minnesota reports do, the limitations of using standardized test scores for assessing educational progress in general, and for assessing the impact of a school meal programs in particular. For example, the Minnesota authors conclude their Final Report [77] by stating that "Fastbreak schools made greater gains in these areas [test scores] than control schools generally" (p 51) but that these greater gains might or might not be due to factors other than the universal free school breakfast program.

The authors note the methodological complexity of using test data but do point out the generally positive results with regard to standardized test scores as well as the results of surveys of teachers and administrators who confirm these results. In fact, according to the authors, unpublished data from the Fast Break evaluation showed statistically significant gains in school level achievement test and attendance data in secondary schools where breakfast was served compared to schools where breakfast was not offered (K. Peterson, personal communication, 2005). Secondary schools had been added to the Fast Break program several years after it began and the data had not been analyzed at the

time that the program stopped. The authors of the Minnesota reports also pointed to the fact that teachers and principals alike believed that academic achievement had improved since the start of the USB program [77].

For these reasons, the authors of the Minnesota reports [77] concluded in their Final Report that the data did suggest that test scores (and more importantly other educational outcomes) improved more in USBP schools than in controls although the influence of confounding variables could not be ruled out. The Maryland evaluation came to the same conclusion, based on the fact that 80% of the 865 USB teachers and 91% of the 317 USB principals and other school staff surveyed indicated that they believed that the program had had a positive academic impact [92].

Even more partial support for this view comes from an even more direct review of student academic achievement in schools that start USB programs. The evaluation of the Boston USB program [82] investigated changes in grade point average for five academic subjects for individual students. Examining official school records for 76 interview sub-sample subjects from the year before to the first full year of the USBP in three schools, students who increased their school breakfast participation showed a significant increase in overall math grades compared to students who did not increase their breakfast participation...a finding that replicated an earlier study by the same research group [36] in a different sample. As in the original study, overall GPA did not improve or differ significantly based on changes in breakfast participation.

IC3c. SB Attendance and Tardiness

The Boston USB evaluation [82] also showed statistically significant improvements in attendance in the interview sub-sample. Students who increased their school breakfast participation showed improved attendance, gaining about 1.5 days of attendance more over the previous school year than students who did not increase their school breakfast participation. Students in the first year of the Maryland evaluation showed a similar pattern, with those whose school breakfast participation increased showing an increase in attendance of 1.5 days over the fall term. Students who did not increase their school breakfast participation decreased their attendance by about 3 of a day [64]. In the English evaluation, students in schools in which a breakfast club was made available were significantly less likely to report skipping school in the past month [76].

The Baltimore evaluation contrasted the change in school-wide attendance rates over three years for 31 schools that had a USB program for one or two years with the change for 17 very similar schools and found a statistically significant net improvement of about one percentage point (from about 93% to 94%), the equivalent of about 2 days per year. The Ohio evaluation tracked an even larger number of schools (nearly four thousand) and found that statewide from one school year to the next, schools that increased their school breakfast participation also showed a statistically significant improvement of about one percentage point in attendance, compared to schools that did not increase their school breakfast participation. The attendance gains in secondary schools were larger than the attendance gains in

elementary schools [73]. In New York State [80] and in the third year of the Maryland program [92], the attendance rates improved somewhat in the USBP schools but the increase was not statistically significant.

The Minnesota USB program evaluation also failed to find a statistically significant impact on attendance in any of the four years [30, 77, 88, 101]. The failure to find an improvement in attendance elicited the caveat from these authors that in these often middle class elementary schools, attendance rates were already 95%+ and thus very hard to improve upon. As noted earlier, according to one of the authors, however, preliminary analyses did show statistically significant gains in attendance in secondary schools (where attendance rates are lower) where breakfast was served compared to schools where breakfast was not offered.

The Minnesota, Ohio, and Baltimore evaluations did not have access to data on tardiness but the New York state sample of 18 schools [80] and the third year Maryland sample of 55 schools [92] did. In both of these samples, tardiness declined significantly. Although the Boston evaluation did not have access to school-wide data on tardiness, it was possible to obtain individual student data from before and after the USBP on the 97 students who participated in an in depth interview study. Students who increased their school breakfast participation showed a statistically significant decrease in tardiness [82]. A similar design using individual student data was employed in the first year of the Maryland evaluation [64] and in this study too, students with large increases in school breakfast participation showed statistically significant decreases in tardiness from the fall term the year before USBP to the fall term the first year of the USBP.

IC3d. SB Effect on Behavior and Mood

As just noted, the Boston program evaluation used an in-depth interview study to assess the impact of the USBP on outcomes not available in school-wide data. Findings from this evaluation were published by Kleinman *et al.* [96] as well as summarized in an unpublished report [82]. The findings showed significantly larger decreases on the student self report version of the Pediatric Symptom Checklist (a standardized measure of behavior problems) for students who had the biggest gains in school breakfast participation. The same group of investigators used a similar design in a cross sectional analysis in the first year Maryland evaluation [81]. In this study, students who ate school breakfast most often had significantly lower behavior problem scores on the parent report version of the PSC.

The authors of the English school breakfast club evaluation reported “a mixed picture of benefit and apparent disbenefit” which included ‘a higher proportion of breakfast club attendees [with] borderline or abnormal ...scores’ on standardized behavioral measures ([76]; p. 418). This finding however contrasted with qualitative data from teaching staff which suggested that students may have become more energetic in a positive way as well as more difficult to control as a result of attending the breakfast clubs.

The use of teacher and principal ratings to supplement or stand in for standardized behavioral questionnaires had gotten its start from the Energizing the Classroom pamphlet

that summarized the first Minnesota demonstration [65]. This document and the technical report that it was based on [58] noted substantial declines in teacher ratings of student behavior problems as well as in student referrals for discipline as reported by principals in participating schools. The use of surveys to obtain data from teachers and principals was necessary because many areas of interest like student behavior are not assessed uniformly in different schools or districts and not summarized in official district reports.

As noted earlier, several of the Maryland evaluation reports [64, 66, 92] also asked principals to summarize behavioral data from office records, as did the New York USB evaluation [80]. Some of these studies involved relatively large samples. For example, the Maryland third year report described results of a survey of principals in forty schools that showed a statistically significant decline in disciplinary suspensions from the fall before the USB program started to the first fall of the program [92]. Referrals to the office for more minor behavioral incidents also declined, although this difference failed to reach statistical significance. In the New York State evaluation, office referrals for discipline did show a statistically significant decline [80].

In a somewhat more indirect way, surveys have been used to ascertain stakeholders’ assessments of changes in student behavior in general. In surveys collected for the second year Maryland evaluation [66], educational staff members in the USB schools were significantly more likely to report improved behavior over the year or two since the start of the program than were educational staff in comparison schools [92]. Although there was no comparison group or significance testing for this in the third year evaluation, a survey of more than one thousand staff in USB schools showed that almost three quarters (72%) rated student behavior as better or much better than the year before compared to 22% of these teachers who rated student behavior as unchanged and 6% who rated student behavior as having gotten worse [92].

As noted earlier, the Maryland first year evaluation [64] was the first to assess the impact of *overall* breakfast eating on student behavior. In an interview study of ninety-one students, information on school and home breakfast eating were combined to come up with a coding of overall breakfast eating. Analyses showed students who ate overall breakfast never or rarely had significantly more problems on the parent-report version of the Pediatric Symptom Checklist.

IC3e. Impact on Health

Although none of the school breakfast evaluations assessed the relationship between breakfast and health directly, the New York evaluation [80] and the third year of the Maryland evaluation [92] followed the lead of *Energizing the Classroom* [65] and assessed the impact of USB programs on visits to the school nurse. Both evaluations found a decrease in the number of visits to the school nurse from pre- to post-USB, although neither finding was statistically significant. The first year Maryland evaluation did find that teachers in USB schools reported that there had been significantly fewer complaints of

tiredness, aches, and pains than in matched comparison schools [64].

The English breakfast club evaluation asked if the student had had any visits to a physician in the past month and if the student had had an accident requiring medical attention in the past six months. Neither of these health indicators showed a significant relationship with breakfast [76].

There has only been one study that looked at the relationship between *school breakfast* and obesity. Jones and her colleagues [104] found that girls from food insecure families who participated in school breakfast and other food assistance programs were less likely to be overweight than girls from food insecure families who did not participate in food assistance programs. A recent review [105] commissioned by the USDA could find no published evidence of a relationship between the school breakfast program and obesity.

IC3f. SB Impact on Hunger

The Boston evaluation [82] was the first to document the negative association between school breakfast eating and hunger, noting that students in the interview sample who increased their school breakfast participation showed significantly greater decreases in self reported hunger than did students who did not increase their school breakfast eating. This study also investigated this relationship cross-sectionally and found that students who ate school breakfast most often were least likely to be hungry by child or parent-report, although the differences were not statistically significant [82].

The first year of the Maryland evaluation also showed that teachers were significantly more likely to report a decrease in complaints of hunger after the start of a USBP program in their schools than were teachers in matched comparison schools [64]. During the third year of the MMFA program the evaluation found that teachers in schools that had had the USB program for two or three years were significantly less likely to report student complaints of hunger than were teachers in first year USB schools [92].

IC3g. SB Effect on Student, Parent, and Staff Satisfaction with Program

As noted above, the first three years of the Maryland [64, 66, 92] evaluation made extensive use of surveys of principals and teachers. Parents and students were also surveyed during those years and in addition to assessments of hunger and behavior, questionnaires were also used to assess the satisfaction of these stakeholders with the USB program in a number of ways. All of these studies reported high rates of overall satisfaction with the program among all stakeholder groups as well as a belief that the programs had led to improved learning and behavior.

For example, teachers in the third year Maryland evaluation [92] overwhelmingly (91%) responded that they thought that the USB program should continue and most of them (73%) indicated that they did not mind the slight increase in work that the program entailed. These findings echoed those reported in the original Minnesota evaluation [58] and were replicated in New York as well [80].

IC4. General Methodological Issues re School Breakfast

As noted above, all but one (New York City) of the major city, state, and national universal free school breakfast program demonstrations from the late 1990's and early 2000's had an evaluation component and most of these evaluations overcame some if not most of the evaluation challenges that had been noted by Briefel *et al.* [16]. Most of these evaluations examined a core of outcomes that are now becoming almost standard in studies of this type, including attendance and tardiness based on official school records, standardized academic test scores, disciplinary incidents (either referrals to the school office and/or suspensions from school), and visits to the school nurse and for those that tracked individual student data, standardized measures of nutrition (24 hour recall), hunger (CCHIP hunger survey or USDA Food Security Survey), and behavior problems (Pediatric Symptom Checklist, Conners Teacher Rating Scale).

The types of breakfast program intervention were also becoming more standardized. Most of the programs evaluated were universal free enhancements of the standard U.S. national program which uses a free/reduced/paid approach to billing (although in Ohio the intervention was simply an expansion of the SBP itself). The options for coding the locations for eating (home vs. school vs. other) and serving (school cafeteria vs. classroom) breakfast were becoming more standardized as well.

Many of the more recent school breakfast evaluations used larger samples sizes (from 10 to 420 schools and from 70 to tens of thousands of students) and more appropriate statistical tests than earlier evaluations. Although none of the U.S. city and state programs used experimental designs, several (Minnesota, Maryland, Baltimore, Boston) made use matched comparison samples. The English breakfast evaluation did use a randomized controlled trial methodology as well as observational analyses [76] and an RCT is planned for the Welsh evaluation [106].

As noted by the authors of the English evaluation [76], studies that attempt to discern the impact of school meal programs must cope with all the messiness of the real world, including confounding variables, sites that change from control to treatment group in mid design, etc. However, although the study of breakfast in the real world makes evaluation more difficult, as noted earlier, it also carries a benefit, namely that it is the study of what actually happens when new approaches are tried, a claim that more carefully controlled laboratory studies usually cannot make.

ID. REVIEW OF PUBLISHED STUDIES ON OVERALL BREAKFAST FROM 1999-2004

In addition to the many reports on school breakfast demonstration projects, the years since the publication of the Briefel *et al.* review have seen the publication in more than two hundred studies that pertain to the relationship between breakfast and learning in more traditional academic journals. Using the key word "breakfast" in a Medline search from 1999 to 2004 produced nearly one thousand citations. For the purpose of the current review, following a strategy based on attempting to find studies that had a clear and direct bearing

on the impact of breakfast on student outcomes, papers that referenced breakfast as a delivery venue related to illness management were excluded, cutting the number of relevant studies approximately in half. Excluding studies not available in English and dissertations that might not be easily available narrowed the list even more. Of the remaining three hundred or so papers, the primary intent was to focus only on empirical studies, although several reviews or commentaries that provided material not available elsewhere were included. The current review excluded papers already reviewed in Briefel *et al.* except where they needed to be re-cited for the current discussion. Several papers published in 1999 or earlier but omitted from the Briefel *et al.* review were included. Similarly, when the completion of the current paper was delayed until 2005, several relevant studies published in 2005 were added although a new general search for 2005 was not conducted. Unlike the Briefel *et al.* review, the current paper includes studies of adults where the findings might relate to the central topic of learning through a clear mediating variable (e.g. the relationship between breakfast skipping and health or obesity). What follows is a brief summary of what the recent published literature has shown using the three Briefel *et al.* categories.

ID1. General Information on Breakfast

ID1a. Definitions of Breakfast

Since, as the Pollitt and Mathews [2] review pointed out, prior to the late 1990's there had been virtually no studies of the impact of usual breakfast eating in children, this distinction had not been necessary in the previous research with children or in considering research on the relationship between breakfast and learning. In the context of *usual breakfast*, breakfast skipping may be defined as missing this meal one or more times a week (or missing it often, sometimes, or never). In the context of *breakfast on a target day*, failing to consume a certain quantity or quality of breakfast (eg, as eating nothing at all or nothing substantial on the morning of assessment) can be defined as breakfast skipping [86].

Most of the studies reviewed by Briefel and her colleagues and many of the studies conducted over the ensuing five years were based on a *target day* definition of breakfast. But over the past few years a number of large studies of children and/or adolescents have explored for the first time the impact of *usual breakfast* by asking the parent or the child about the frequency of usual breakfast eating (never *vs.* 1-2, 3-4, 5-7 days per week [7]; daily *vs.* not daily [107, 108] missing *vs.* not missing breakfast [109]; usual *vs.* not [110, 111]; regular eating *vs.* not [112]; lack of breakfast [113].

Other recent studies of children and/or adults have used a *target day* approach to the definition of breakfast. These studies have assessed the impact of breakfast composition based on a target day's report of breakfast consumption, then re-coded these reports as adequate *vs.* inadequate (equal to or greater than 20% of total daily energy intake; [114]; equal to or greater than 10% of REA for energy [86]; greater than 25% of RDA for energy *vs.* 15-25%, *vs.* less than 15% of RDA for energy [115]; good, fair, poor, very poor quality in terms of the inclusion of dairy, cereal, or fruit food groups

[110, 111]. A few studies have employed both usual and target day measures of breakfast eating but the relationship between these two constructs has not been explored [110].

Another definitional distinction that has been used in studies with regard to target day breakfast consumption has to do with 'type of breakfast'. As summarized below, distinctions have been made between high and low energy, cereal *vs.* other types of foods, whole grains *vs.* other, although the concepts and studies overlap somewhat. Nearly a dozen studies have focused on the impact of glucose and/or high glycemic index foods at breakfast [116-126] usually examining whether high glycemic index breakfasts provide more energy or better mood.

Another major differentiation in type of breakfast is cereal *vs.* other [127-129], with some studies showing that consumption of cereal breakfast is related to weight loss [111, 115, 128, 130-133] presumably due to cereal's ability to impact the feeling state of more satiety/less hunger [118, 123, 134]. A number of authors have reported a similar impact of complex carbohydrates [117, 122, 127], and/or whole grains [135-138]. Somewhat related distinctions with regard to breakfast type have to do with fortification and supplementation. In the U.S. and some other countries, most breakfast cereals and other grain products are fortified with vitamins and minerals [139] which affects their impact on nutritional intake and possibly other outcomes. Other countries have not adopted the practice of fortification [139] And in the U.S., nearly half of all children consume vitamin and mineral pills or other supplements [140], often along with their breakfasts, which makes it important to control for supplementation when doing studies of breakfast.

Another type of food distinction that can be drawn for breakfast based on the above considerations is the degree to which nutrients come from 'natural' *vs.* processed/fortified/supplemented sources. General arguments for consumption of more natural *vs.* more highly processed food have been made for decades. One of the most influential works is *Diet for a Small Planet* [141] which has been continuously in print since 1971. This book argues that whole grains and other plant-based foods are a remarkably efficient form of nutrition which makes them a good choice ecologically as well as economically. Although these issues may seem far removed from the question of breakfast and learning, the hypothesized correlation between the 'cheap calories' [142] that underlie fast food and the explosion of childhood obesity and its negative health consequences make the case for the importance of food choices for breakfast and other meals in a broader context.

More specifically with regard to the focus of this paper, among U.S. children and teens, calcium is now thought of as one of the most important but also one of the most frequently missing micronutrients and breakfast is one of the most important meals for meeting the need for calcium [143]. Low calcium intake has been found to be related to colorectal cancer, osteoporosis, obesity, and neurological impairment [144]. Declining rates of calcium consumption have been linked to declining rates of milk consumption and increasing rates of soft drink consumption [144]. Some writers have expressed a belief that making up for this and other missing micronutrients through foods rich in this nutrient rather than

through supplements or additives is a better solution [144]. The same argument can and probably should be made with regard to any or all nutrients.

ID1b. Trends in Breakfast Consumption

Recent studies have continued to illustrate how large an impact the definition of breakfast skipping can have, even within the same sample. For example, as might be expected, absolute breakfast skipping on a target day is less prevalent than partial breakfast skipping. In a study of overall- as well as school-breakfast eating reviewed earlier in this paper, Gleason and Sutor [86] used data from a nationally representative sample of children aged 6-12 gathered in 1994-96. The authors reported that the rate of breakfast skipping was 19% when defined as eating nothing at all but 33% when defined as eating less than 10% of the REA for energy. Another recent study illustrates the way in which the obtained prevalence of breakfast skipping varies depending on whether lack of regularity or lack of quality is used to define skipping. In a large (N=3534) Spanish sample of children and young adults, Aranceta *et al.* [110] reported that although only 8% of the sample usually skipped breakfast, 50% had a very poor or poor quality breakfast (no fruit or dairy) on the target day.

ID1c. Secular Trends

More than a half dozen papers published since the Briefel, *et al.* review have presented data on secular trends in breakfast skipping for children in the U.S. and all of the published reports agree that breakfast skipping increased over the 1970's and 80's and has probably remained the same or increased even more since then. As noted earlier, in 1998, Siega-Riz [23] and her colleagues had reported that between 1965 and 1991 breakfast consumption in the United States had declined in elementary school children from over 95 percent to about 86 percent [23]. For adolescents, the decline was even greater: from about 87 percent in 1965 to under 70 percent in 1989-1991. Using data from a later (1994-1996) cohort of the same study (Continuing Study of Food Intake by Individuals) and reporting five years later, Gleason and Sutor [86] found that breakfast eating had decreased again slightly to 69% for older teens.

Nicklas and her colleagues have published several papers that examine secular trends in breakfast skipping in a series of samples of ten year olds from Bogalusa, Louisiana [3, 145, 146]. This sample had much higher percentages of African-American and poor children than national samples and it is interesting to note that although the authors had found the same increases in breakfast skipping over the 1970's, they noted that in the early 1980's in their sample, breakfast skipping actually declined when the school breakfast program began in Bogalusa... only to rise again by the mid 1990's [3].

ID1d. 2 Demographic, Socioeconomic, and Other Factors that Relate to Breakfast Consumption

Secular trends have actually shown a complex pattern of interaction with poverty and the expansion of national food assistance programs in their influence on breakfast eating while other factors appear to provide unmitigated effects. As illustrated by the studies by Nicklas and her colleagues just

cited, with the expansion of School Breakfast and the other food assistance programs in the U.S., the relative impact of socioeconomic status on breakfast skipping has declined.

The interpretation that food assistance programs are now such a major source of nutrition for school aged children in this country that they have erased some of the differences between rich and poor children is provided by a study by Bhattacharya and his associates [147]. Using a large and nationally representative dataset, this study found that *preschool aged children* and adults who are poor had significantly lower quality diets and higher rates of obesity than preschool aged children and adults who were not poor. These patterns were not found among *school- aged children*, possibly because they had access to the school breakfast and lunch programs. Further support for this interpretation is provided by recent studies done outside the U.S. in countries without school breakfast programs. These studies continue to show higher rates of breakfast skipping among poor children [108, 110].

In terms of other factors associated with breakfast consumption, recent studies continue to show the relationship between older age and female gender on rates of breakfast skipping. Child age remains one of the strongest predictors of breakfast skipping, with usual intake breakfast skipping increasing significantly by age group. The rate of complete breakfast skipping was 8.5% for 6-8 year olds, 14.5% for 9-13 year olds, and 31% for 14-18 year olds [86]. The rates of skipping a more substantive breakfast rose from 19.5%, 28.5%, and 47% for the aforementioned age groups and study. The same trend for breakfast-skipping to increase with age has been shown in Canada [108], Spain [110], and Saudi Arabia [10].

In the Gleason and Sutor [86] study, as in other U.S. [7, 148-150] and non U.S. [10, 108, 110, 151] samples, females were more likely to skip breakfast than males in all age groups, with the pattern becoming more pronounced in the teenage years. Knowledge about breakfast and nutrition can affect the type of breakfast eaten. In a Swedish study, researchers found that children who were informed about fiber content and its health benefits were more likely to consume fiber-enriched products at breakfast and had a more accurate understanding of what a healthy breakfast contained [152].

A study of French families [153] demonstrated that children's breakfast eating patterns were influenced by their parents and siblings due to both genetic and environmental factors. A recent large U.S. study [149] also demonstrated the influence of parents, with lower rates of breakfast skipping among adolescents who ate meals with their families regularly.

The impact of costs on breakfast consumption represents another area that has received some attention recently, although for the most part it is outside of the scope of the current review. An analysis of nutrient-to-cost comparisons in breakfast consumption in ninth-graders found that food choices among this population were not efficient in terms of nutrients per dollar spent [154]. Ready-to-eat cereal and other breakfasts such as bagels, toast and yogurt, provided more energy, carbohydrate, fiber, sugar and protein

compared to fast-food breakfasts. Thus, not only do cereal and high-fiber and grain breakfasts provide a number of health benefits, but they may also be a better economic choice for breakfast for families and school districts. From a different perspective, as noted earlier, the relatively lower costs of grains and other plant-based foods may make them a better choice ecologically as well as economically [141].

ID2. Nutritional Benefits of Breakfast in Studies from 1999-2004

It is impossible to understand the nutritional benefits of eating breakfast without first defining what will count as a breakfast. In laboratory studies of breakfast this is relatively easy since the nutritional content of the breakfast is specified in advance. In real world studies, however the lack of an accepted definition of breakfast makes this kind of study much more difficult. As discussed earlier in this paper, Devaney and Stuart [20] described a debate as to what should be considered 'breakfast' that took place in conducting real world studies like SNDA-1 of target day nutrition. The initial definitions (any caloric intake at all or intake of 50 calories or more) in the original publications [22, 155] on this national study, gave way to subsequent analyses that explored definitions of breakfast as 10%, 15%, 20%, or 25% of RDA for energy, or food from two or three of the main food groups, or some combination of food energy and food groups [20]. More recent large-scale governmental studies like CSFII [86] have begun to report on breakfast skipping according to more *substantive* (e.g., 10% of RDA for energy) as well as less substantive definitions. As will be discussed in the next section, in its *studies*, the USDA appears to be settling in on a definition that encompasses at least 10% of RDA for energy and food from at least 2 major food groups [13]. Interestingly, in the distinct realm of its breakfast *programs*, the USDA also uses both food groups and nutrients to define breakfast in its standards for school menu planning...although a different standard is used (food from 2-3 groups and nutrients totaling $\geq 25\%$ of RDA for total calories, protein, and certain vitamins and minerals). Outside the U.S., there has also been support for using higher standards for what should be considered a breakfast, with some researchers requiring food from three food groups [110] for a breakfast to be considered 'good' quality or for twenty to twenty-five percent of total daily energy intake [114, 156].

A number of studies over the past five years have assessed what people actually eat for breakfast, often exploring the relationship between type of breakfast and nutritional outcomes like degree to which intake standards for vitamins and minerals [115] or cholesterol or total calories from fat [132] are met. But type of breakfast has also been examined in terms of its impact on obesity [129], and other health habits like smoking [157].

As noted earlier, the connection between breakfast skipping and increased overall nutritional risk were well established in the past [21, 26, 27] and has been demonstrated recently as well [145, 150]. In the most recent paper, Nicklas and her colleagues [145] concluded that 'breakfast consumption is an important factor in the nutritional well being of children, adolescents, and young adults. The

omission of breakfast contributes to dietary inadequacies that are rarely replenished by other daily meals" (p. 35). In a large European sample, Serra-Majem and his associates [111] found that children and young adults who consumed a 'low quality breakfast' were more likely to be at overall nutritional risk (i.e. lacking in key nutrients and micronutrients) than those who ate higher quality breakfasts. Kleinman and his associates [96] found that school breakfast skippers were significantly more likely to be at overall nutritional risk than students who ate school breakfast regularly. The same study also found that students who increased their school breakfast participation showed significantly decreased nutritional risk.

Breakfast skipping has been shown to have a negative relationship to the intake of many if not most vitamins and minerals as well as positive association with the intake of fat and saturated fats. For example, Nicklas *et al.* [145] reported that a significantly higher percentage of children who skipped breakfast did not meet two thirds of the RDA for vitamins A, B6, and D, calcium, magnesium, riboflavin, folacin, zinc, phosphorus, and iron compared to those who consumed a breakfast. Nicklas and her colleagues [150] also studied a sample of 711 ninth grade students from New Orleans and found that the percentage consuming at least two thirds of the RDA for 14 of the most common vitamins and minerals was significantly lower for those who skipped breakfast.

Preziosi and her colleagues [115] conducted a study of more than 1000 adults and children who were representative of the French population southeast of Paris. Children who ate bigger breakfasts (15-25% or $> 25\%$ of daily energy allowance) reported significantly higher levels of calcium, phosphorus, magnesium, and Vitamins B1 and B2 than children who ate smaller breakfasts. The authors also noted that children who were Ready-to-Eat-Cereal breakfast consumers reported significantly higher intakes of calcium, phosphorus, iron, thiamine, and riboflavin than children who did not consume RTE cereal.

In terms of specific nutrients, a study conducted in Saudi Arabia found that iron-deficiency anemia was more prevalent in children who skipped breakfast [10]. Another study found that daily total calcium intake is to some extent dependent on total calcium intake at breakfast.... and that total calcium intake at breakfast is related to the intake of milk [143].

Perhaps the best summary of the research on the impact on breakfast on nutrition is from Nicklas and her associates [145]: "It is reasonable to assume that the promotion of breakfast consumption could have a substantial effect on the overall nutrient adequacy of the total daily intake of children, adolescents and young adults" (p. 35).

ID3. Impact on Learning and Other Outcomes in Studies from 99-04

Evidence that breakfast-eating/skipping has an impact on learning and other student outcomes has continued to build over the past five years. After reviewing new findings utilizing the classic fasting vs. experimental breakfast designs that assess the effects of specific types of breakfast

on various cognitive abilities, designs new for children that explore the impact of routine breakfast eating/skipping on student outcomes will be reviewed.

ID3a. Impact on Cognition

In a sample of 144 English university student volunteers, Smith and his colleagues [158] found that those who were randomly assigned to a cereal breakfast did significantly better on a test of spatial memory than those who fasted. Several studies demonstrating the impact on cognition of glucose at breakfast were published in the late 1990's and early 2000's. Benton and his associates published papers showing that low glycemic index foods given at breakfast improved memory in humans [116], that lower blood glucose was associated with better memory [159] and that higher levels of blood glucose specially influenced tasks placing higher demands on the brain [126]. Another group of investigators led by Wesnes [127] reported that 'a typical breakfast of cereal rich in complex carbohydrates can help to maintain attention and memory over the morning' based on a sample of 29 English school children. A review of the impact of macronutrients on mental performance by Dye and her associates [117] concluded that 'the clearest and most reliable effects have been observed for the beneficial action of glucose on cognitive performance...' (p. 1021).

Moving away from the classic experimental designs, Lopez-Sobaler and associates [114] were the first to report on the relationship between what they called 'habitual breakfast' and intellectual performance. In a sample of 180 Spanish children aged 9-13, those who reported eating an adequate breakfast (> 20% of daily energy intake) over a period of seven days showed significantly better logical reasoning on a standardized test of mental functioning than children whose habitual breakfasts provided a lower percentage of daily energy. As the authors note, this was one of the first studies to demonstrate the intellectual benefits of breakfast in a non-poverty and thus presumably well-nourished sample of children.

ID3b. Impact on Academic Functioning

The past few years have produced several of the strongest reports to date on the impact of usual breakfast eating/skipping on academic outcomes. Two recent studies (Kim's sample of 6,463 teenagers from Korea [112] and Abalkhail's sample of 800 students (aged 9-21) from Saudi Arabia [10]) have reported that breakfast skippers--as indicated by less than regular daily breakfast eating--had significantly lower school grades than breakfast eaters. A similar study of 1971 twelve year olds from Malaysia by Boey [109] reported that breakfast skippers were significantly more likely to have below average scores on a standardized school achievement test. Somewhat more subjectively, Berkey and her associates [7] found that children who skipped breakfast at least once a week were significantly less likely to rate themselves as doing well in school than more regular breakfast eaters in a large (n=14,586) sample of U.S. 9-14 year olds. Rates of breakfast skipping in the above samples ranged from 15% (Abalkhail) to 24% (Berkey), to 40% (Kim) to 78% (Boey).

ID3c. Impact on Body Mass Index and Obesity

Previous studies had shown that breakfast skipping is related to higher rates of obesity and/or higher body mass index scores [160]. For the most part, recent studies have provided further confirmation of these findings. Perhaps the most definitive report to date is a 2003 paper by Cho and her associates that used measured height and weight from a large (N=16,000+) representative U.S. sample of adults interviewed in 1988-94 [129]. Findings showed that 20% of the subjects skipped breakfast (defined on the basis of a target day 24 hour recall) and that breakfast skippers had significantly higher BMI's (based on measured height and weight) than breakfast eaters...even though their energy intake was lower than all breakfast eaters. A large (N=4320) study of school children from England also used measured height and weight and found that overweight children were significantly less likely to eat breakfast every day than children of normal weight, even controlling for demographic and other eating behaviors [151]. Another study [161] that relied on measured height and weight involved a somewhat smaller (N=1131) sample of children and adults from Australia. This study also showed a significant relationship between breakfast skipping and overweight, with subjects who were at the > 84th percentile of BMI based on measured height and weight significantly more likely to skip breakfast some or most days than non overweight children and teens. A study by Ma *et al.* [162] found a fourfold increase in the probability of obesity among 499 U.S. adults who reported skipping breakfast 25% of the time on four 24 hour recalls over a one year period based on measured heights and weights.

For the most part, studies using self-reported height and weight have produced similar findings. A very large (N=10,000+) population-based sample of adolescents and their parents from Finland showed that for both adolescents and adults, those who skipped breakfast some or most days of the week were significantly more likely to be overweight or obese than breakfast eaters, based on self reported height and weight [163].

Three different large (N=8000+) U.S. studies have also shown that breakfast skippers are more likely to self-report being overweight [7, 149, 164] or obese [164]. It may be important to note, however, that longitudinal data in the Berkey *et al.* study [7], suggested the possibility of a more complex relationship between breakfast skipping and body mass index, since non overweight children and teens who skipped breakfast reported *more weight gain* over a two year period but overweight youngsters who reported skipping breakfast reporting more weight loss.

ID3d. Impact on Health and Health Habits

The past few years have produced a number of reports linking breakfast eating to better health. Kimura *et al.* [165] reported that eating breakfast regularly was significantly related to better health-related quality of life in a sample of 779 Japanese adults. A study of 189 young adults (aged 19-21) from England [166] found that both regular breakfast eating and cereal breakfast eating were significantly

associated with fewer symptoms of physical distress. This study replicated an earlier study by the same authors [167] of 262 older adults which had found that those who ate breakfast cereal everyday reported significantly fewer physical health problems than those who ate cereal breakfast occasionally or never. In two smaller samples (N=38 & 23) of English adults, Smith & Rees [168] reported that the number and severity of symptoms of upper respiratory illness were significantly smaller for subjects who ate breakfast most days when compared to subjects who ate breakfast less regularly.

A number of other studies have also documented the relationship between breakfast skipping and specific illness conditions. In a sample of Saudi children, teens, and young adults, Abalkhail [10] demonstrated that breakfast skippers had a higher prevalence of anemia than regular breakfast eaters. In a sample of 450 Japanese women aged 18-20, those who skipped breakfast had more symptoms of dysmenorrhea than those who ate breakfast regularly [169]. A large Malaysian study reported that children with recurrent abdominal pain were significantly more likely to skip breakfast than were children without abdominal pain [109]. Using data from a large sample representative sample of the U.S. population, Dye and her associates [170] reported that 2-5 year old children who skipped breakfast were nearly four times more likely to experience dental caries than children who ate breakfast regularly. Breakfast skipping has also been found to be associated with high levels of self-reported stress [151] and cereal breakfast eating with lower levels of stress [166].

A large and growing number of studies have shown the relationship between regular breakfast skipping and health risk behaviors like smoking [107, 108, 163, 171, 172] in children and adolescents as well as in adults [173, 174]. Breakfast skipping has also been found to be related to adolescent drinking [163], lack of regular exercise in adolescents [107, 163] and adults [163], lack of daily vegetable eating [108] in adolescents, sleep problems in adolescents [113, 175] and lack of regular tooth brushing in adults [176].

ID3e. Impact on Mental Health, Mood, and Behavior

The past few years have also provided continuing documentation of the relationship between breakfast skipping and poorer mental health/behavior. Allgower and her associates [177] replicated earlier work by Ezoe and Morimoto [178] that had shown a strong and significant relationship between breakfast skipping and depression as measured by the Beck Depression inventory. The Allgower study used a large (N > 5000) sample of young adults from Europe and found that the breakfast/mental health relationship was one of the strongest among the nine health habits studied and held for both males and females.

Working with another large sample involving nearly 5000 secondary school students from the U.S. [179] Fulkerson and her colleagues also found a significant relationship between breakfast skipping and depression. In this study, students who reported high and moderate levels of depression ate breakfast significantly fewer days each week than students with low levels of depressive symptoms. In a

smaller sample (N=189) from England, Smith [166] found that young adults who had breakfast and/or cereal breakfast regularly were less depressed and less anxious than those who ate less regularly. An earlier study by the same author [167] of somewhat older English adults had found similar effects on depression, anxiety, and emotional distress using daily vs. occasional vs. irregular cereal consumption as the dependent variable.

Switching from studies of the impact of regular breakfast eating on behavior to those assessing the impact of specific breakfast contents, there have been more than a half dozen studies documenting the rather obvious relationship between fasting and poorer mood. The Iowa Breakfast studies of the 1960's [33, 180] had been the first to document these patterns and the Briefel *et al.* [16] and Pollitt [2] reviews had summarized more recent studies by Wyon [34] and Smith [35] that had found significant relationships between breakfast skipping/fasting and poorer mood, although a least one study [181] had failed to replicate these findings.

The relationship between breakfast skipping and negative feeling states have been demonstrated in a number recent studies using experimental designs. Using a 2-day open, randomized, crossover trial in a Dutch sample of 24 adult men, Pasman *et al.* [122] reported lower rates of fatigue and greater feelings of satiety after a complex (vs. a simple carbohydrate) breakfast. Smith and his colleagues [158] used a similar experimental design and reported that young adults who had breakfast reported a more positive mood one and three hours later than those who skipped breakfast. Benton *et al.* [182] used an experimental design with 150 female English undergraduates and found that breakfast and a snack in mid morning led to improved mood, although breakfast alone did not (after two hours).

ID3f. Breakfast, Hunger, and Food Insecurity

Many of the same studies that assessed mood also assessed short term feelings of hunger vs. satiety. Luch and colleagues [183] used a repeated measures design with 11 healthy adults and reported greater satiety following a complex carbohydrate breakfast. Similarly, Ball *et al.* [119] reported greater satiety following a low glycemic index breakfast in a randomized design with 16 U.S. adolescents and Holt *et al.* [121] reported greater satiety following a high carbohydrate breakfast for 14 young adults from England. Warren *et al.* [123] replicated these findings with thirty-seven 9-12 year old children in a longer term trial over five weeks using a crossover design. Benton and colleagues [159] reported that adults who ate breakfast and/or a snack reported less hunger and that the larger the number of calories, the less reported hunger.

The relationship between breakfast eating and longer term hunger/food insecurity has been addressed in only one published paper and one USBP report. In a sample of inner city middle school students, Kleinman and associates [96] reported that students who improved their nutrition as a result of increased breakfast consumption showed significant decreases in self reported hunger. As noted earlier in this paper, Murphy and his colleagues [82] had found a significant relationship between breakfast skipping and child-reported hunger in the Boston USBP evaluation.

ID4. Recent Research on Other Nutritional Risks: Hunger/Food Insecurity

As noted at the outset of this paper, if skipping breakfast can be viewed as one form of nutritional risk that affects millions of U.S. children, hunger/food insecurity can be viewed as another. As also noted, the spread of universal free school breakfast programs described in the next section of this paper received a great deal of impetus from an independent body of work that suggested that hunger was prevalent and had negative effects among poor children in the U.S. Although research on hunger is somewhat outside of the scope of this paper, a brief review is included here because of its importance in understanding the SBPP results presented in the next section.

Modern research on hunger began in the late 1980's, when Wehler and her associates [17] began conducting large and methodologically rigorous surveys in more than a dozen states, eventually estimating that 8% of all children in the U.S. experienced hunger and that an additional 21% were at risk for hunger. Translated into numbers, the Community Childhood Hunger Identification Project (CCHIP) studies suggested that more than twelve million U.S. children under the age of eighteen were nutritionally at risk (either hungry or at risk for hunger). CCHIP studies had also suggested that children from families that were hungry or at risk for hunger experienced poorer health and achievement [17]. The CCHIP studies were cited in Senator Timothy Johnson's original legislation proposing the program that eventually became the USDA School Breakfast Program Pilot Project [184].

By the late 1990's a number of the main CCHIP findings had been replicated or expanded by other groups of investigators. Kleinman *et al.* [18] and Murphy *et al.* [36] demonstrated the reliability and validity of the original CCHIP hunger survey as well as its negative association with academic and psychosocial functioning in children. And the CCHIP findings about the prevalence of hunger/food insecurity were supported by two other groups of investigators working independently using two different measures in different nationally representative samples beginning in the late 1990's [4, 185].

The latter group of investigators had worked closely with the United States Department of Agriculture and researchers from other Federal and private agencies to construct a standardized 18 item Food Security Scale which has since been administered to tens of thousands of respondents as a part of regular national data collections including the Current Population Survey of the U.S. Census Bureau [185]. Reports from the CPS surveys [186] found that the overall rate of food insecurity to be 16.6% in households of U.S. families with children (3.7% in households that were food insecure with hunger and 12.8% in households that were food insecure without hunger)--lower than the rates estimated by the CCHIP studies-- but still a large enough number to be a public health concern, with about eight million children in these families affected. Since these data are based on households and households with children have more individuals than households without children, the point prevalence for food insecurity among U.S. children in 2002 was estimated to be 18.1% (rate of food insecurity with hunger not given) [186].

In the late 1990's another group of investigators began to publish results [4] based on a single question measure of food insecurity that had been included in another large governmental survey NHANES III (National Health and Nutrition Examination Survey). Their estimate that six percent of all U.S. children under the age of 17 come from homes that experienced food insufficiency was also in the same range as the CCHIP/CPS estimates. Going beyond mere prevalence, Alaimo and her colleagues showed that food insecurity and hunger in children were associated with an increased risk of a number of problems including health, mental health cognitive, and academic difficulties [5, 6, 187]. More recent studies by other investigators have confirmed the negative association between food insecurity and health-related quality of life [8, 188].

As already noted by the late 1990's, preliminary studies had suggested that millions of U.S. children experienced hunger and/or food insecurity and that this nutritional risk was associated with a wide range of negative outcomes. From the strands of research reviewed earlier in this paper, it also seemed that millions of U.S. children did not get a substantive breakfast each day and that universal-free school breakfast programs could raise school breakfast participation rates. It therefore seemed possible but was by no means certain that U.S.B programs would lead to higher rates of overall breakfast eating and thus possibly to improved academic outcomes through improved nutrition, health, and cognitive functioning.

As noted earlier, based on evidence like this, professional organizations like the American School Food Service (which had long advocated for making school breakfast universally free in the U.S.) and other groups were able to convince the Federal government to fund the School Breakfast Program Pilot, the largest breakfast experiment ever conducted (E. Cooney, personal communication, 2005).

II. THE SCHOOL BREAKFAST PROGRAM PILOT PROJECT

The SBPP experiment was designed to explore a potential new approach to billing for the U.S. National School Breakfast Program that had the potential to increase overall breakfast eating and to improve educational outcomes among poor and possibly non-poor children as well. In this new approach, school breakfast could be offered free to all students regardless of their family's income...in contrast to the current SBP approach in which students from poor and low income families may apply to receive breakfast at school for free or for a reduced price, and students from more advantaged families may obtain breakfast at school if they pay full price. For readers not familiar with the concepts, it is important to stress that the SBPP demonstration project involved only a change in the approach to billing not a change in the type of food and not even necessarily in the number of students who ate breakfast or school breakfast.

The essence of the experiment was that school breakfast was made available for free to all students in participating schools. The experiment was not conducted in order to study the impact of breakfast per se, although the data from the study can be used to explore this and other questions, but rather to explore the feasibility and outcomes of a potential

new policy. It is also important to point out that the first year [13] and final [14] reports that were written by Abt Associates were produced under contract with the United States Department of Agriculture, subject to all of the political pressures that a government program that was expected to cost one to three billion dollars per year might engender.

As noted earlier, preliminary results from the evaluation of first year of the SBPP program were released in a report in 2002 [13] and a Final Report [14] on all three years of the study was released in 2004. Both of these reports are book length documents over five hundred pages in length with main reports of more than 100 pages of text followed by several hundred pages of appendices.

A paper exploring the impact of breakfast skipping on student outcomes in the first year data was written independently of the USDA and Abt by the Principal Investigator of the first year evaluation in 2004 and submitted for publication in 2006 [15]. Since, as of this writing, results from the 2002 and 2004 reports have not been published in academic journals, they will be reviewed here in some detail. The three breakfast research categories used to structure earlier sections of this report will again be used. The 2002 and 2004 report reviews will be followed by a review of the 2006 breakfast skipping paper.

IIA. The SBPP First Year Report

The center of the SBPP project was a three school year (2000-1, 2001-2, 2002-3) demonstration of universal-free school breakfast that was implemented in 79 schools from six states, comparing results in these schools with those from a matched group of the about same number of schools that had been randomly assigned to continue the regular school breakfast program. The SBPP project was successfully completed and a comprehensive evaluation report on the first year of the demonstration and its findings prepared by Abt Associates under contract with the USDA [13] was released and is available on the USDA Website. The data set from this study was released to the public in late 2003 and an article describing additional analyses based on the data set has recently been completed [15].

The four main objectives of the USDA SBPP demonstration and evaluation were to assess the feasibility and effect on participation, costs, and outcomes of a universal free school breakfast program that could be provided to all the nation's elementary schools. The SBPP evaluation design used an experimental method in which whole schools were assigned to either a universal free or a traditional school breakfast program in order to test whether the availability of this kind of breakfast program was associated with improved outcomes in the schools with the program.

The SBPP evaluation report [13] and its companion summary brochure [189] clearly show that a universal free approach to school breakfast was feasible (relatively easy to implement and very popular with students, parents, and teachers) and produced significant cost savings (due to economies of scale) as well as an increase in school breakfast participation. The next section of this paper reviews the official published main findings with regard to

the impact of availability of a universally free school breakfast program in terms of the three main categories (general considerations, nutrition, and other outcomes).

IIA1. General Impact of Availability

IIA1a. Impact of Availability on Definitions of Breakfast

As noted earlier, in the most general sense, two different types of definitions of breakfast have been used in recent studies, those based on overall frequency over time (regularity of breakfast) and those based on actual consumption (usually a single target day). In the SBPP evaluation, both regularity and actual consumption of breakfast were examined, both overall and specifically at school. Additionally, for school breakfast eating, data were available at the school-wide as well as the individual-student level. School wide data on breakfast and some academic outcomes were available on the 153 schools' full enrollment of about 75,000 students. Individual level data were available on a sub-sample of more than four thousand students who participated in personal interviews.

IIA1b. General Findings with Regard to the Impact of Universal Free Availability on School- and Overall - Breakfast Consumption

School-wide data on the total number of breakfasts served in all treatment and control schools were available for the year before (baseline) and during each of the three years of the SBPP demonstration. Comparing the participation rates from the baseline to the first year of the demonstration made it possible to calculate the change in breakfast participation rates. The experimental design showed that making the universal free program available led to a seventeen percentage point increase in school-wide school breakfast participation in the treatment schools (from 19% to 36%). In the control group, participation increased by one percentage point (from 19 to 20 percent). The authors of the SBPP first year report concluded that the overall impact attributable to the model was therefore a net increase of 16 percentage points.

Interviews with individual students and their parents about what they had eaten for breakfast during a target day toward the end of the first year of the demonstration (and whether this was at home, at school, or elsewhere) allowed a coding of the breakfast meal in terms of its content and location. Using the random assignment design to analyze the data on location of breakfast eating showed that most of the students who increased their school breakfast participation appeared to have simply switched where they ate from home to school. For example, in the intervention schools, 49% of the students interviewed reported eating any breakfast at school compared to 27% of students in the control schools...a 22% difference in school breakfast eating attributable to the intervention. Conversely, however, 69% of the control school students reported eating a breakfast at a location other than school, compared to 48% of intervention group students who reported eating breakfast outside of school...a 21% decrease in out of school breakfast eating attributable to the intervention. Only 3.4% of all intervention students reported eating no breakfast at all, compared to 3.6% of all control students. Taking into account the location

switch, on first glance it appears that very little change appears to have occurred.

When the actual content of the target day's breakfast was considered, however important differences between the experimental groups did emerge. Although the prevalence of complete breakfast skipping (absolutely no food or beverage except water) was very low in and not significantly different between treatment and control groups (only 3% and 4% respectively), when a more substantive definition of breakfast was used, the difference was significantly larger (breakfast skipping rates of 20% for the treatment group vs. 24% for the control group respectively). Following the Devaney and Stuart analyses [20], a more substantive breakfast was defined as food from at least two (of five) major food groups and greater than 10% of the RDA for energy. To restate the findings of these experimental analyses, there was a statistically significant decrease in overall (school, home, or any other location) substantive breakfast skipping of 4% that can be attributed to the intervention [13].

Although these findings about the significant increases in both school and overall breakfast eating may seem expectable given that breakfast was made available for free to all students, the findings are very important for several reasons. First of all, the experimental design of the SBPP confirms reports from the non experimental state- and city-wide universal free breakfast program evaluations [30, 31, 64, 73, 92] and provides definitive proof that the availability of universal free school breakfast programs leads to statistically and clinically significant increases in school breakfast participation.

Secondly, the SBPP evaluation [13] shows that school breakfast participation approximately doubled (from 25% to 48%) among children who were already eligible for free and reduced price breakfasts at school as well as among those who were newly eligible for free meals. Among students who would have had to pay full price formerly school breakfast participation nearly quadrupled (from 8% to 31%; page 79). Thus the universal free approach that was piloted in this study did in fact get more school breakfasts to the low income students the National School Breakfast Program was created to reach.

The third major finding of the SBPP evaluation is that making a universal free school breakfast program available to all students leads to a significant increase in substantive- (not just school-) breakfast eating...only the second study to provide such evidence. Taken together these three findings show definitively that universal free school breakfast programs have a major impact on school breakfast participation and result in improved student nutritional intake: more students eat (fewer students skip) breakfast. Although children from non-poor families showed the greatest gains in participation, the poorest children also gained. The premise of universal free programs is that aiding more advantaged students is an effective way to aid the poorest students and this premise was supported by the findings from the SBPP. Results from the SBPP confirmed that universal free school breakfast programs increase the percentage of poor and low-income students who receive a substantive breakfast in the morning.

It is important to highlight these strong and statistically significant findings in the first SBPP report about the impact of universal free school breakfast on school and overall breakfast eating since the failure to find an impact on standardized academic test scores and cognitive tests in the first year evaluation report received most of the attention in the program summary (see FRAC website [190] for a critique of the 2002 USDA report) and in the briefings that the USDA provided to members of Congress in 2003. Interpreting the results as suggesting that the program had no impact is to ignore its single strongest finding: a universal free approach to school breakfast leads to more students eating a substantive breakfast each day, most of them poor or low income children.

And although the SBPP First Year Report [13] concludes that "there was no consistent pattern of positive effects on student outcomes associated with the availability of universal free school breakfast" (p. 127), a careful reading of the published report shows that this is not an accurate conclusion. There were in fact twelve additional statistically significant differences noted or implied in the body of the report and ten of them showed a positive effect for the intervention group in a pattern that was consistent with previous research as well as consistent internally. These differences will be described below.

IIA2. Impact of Availability on Nutrition

The most powerful findings have to do with the positive impact on nutrition of making school breakfast available for free to all students. The SBPP report (page 91) shows that the breakfast intervention had small but statistically significant positive impacts on daily *nutritional intake at breakfast* for three essential micronutrients. Comparing interview sub-sample students from the intervention and control schools, average levels of calcium and phosphorus were higher and average levels of cholesterol were lower for students in the treatment schools. The 2002 report notes these significant differences in text (p 90) and table (p 91) but dismisses them by saying that "they may or may not be nutritionally important" (p. 92).

Another way of viewing the nutritional impact of the SBPP is to look at mean *food group servings* consumed at breakfast. The report notes that "Statistically significant differences were found in the mean numbers of servings of fruits, dairy products, and meat and meat substitutes (red meat and eggs in particular) consumed by students in treatment schools compared with their controls" (p. 92). The report also dismisses these six statistically significant differences by stating that they "were extremely small in magnitude" (p. 92).

There were also significant differences between the SBPP treatment and control groups for *nutrition over 24 hours*. As shown in the table on page 95 of the first year report, the intervention group had lower levels of cholesterol over 24 hours and (on page 96) lower rates of consumption of white potatoes and eggs than the control group. No mention in text is made of these findings at all, a surprising omission given the role that cholesterol plays in heart disease, the number one cause of death in the U.S. [50]. In summary, the random assignment design of the SBPP

evaluation provides definitive evidence that making breakfast available for free for all students results in small but statistically significant improvements in nutrition as well as in overall substantive breakfast eating.

IIA3. Impact of Availability on Other Outcomes

The first year report completely fails to mention in text (on page 39 where the other findings of the surveys of school principals are discussed) three statistically significant and potentially important findings that are presented in tables (Exhibit A-32) in the appendices. The principals of all 152 participating treatment and control schools were interviewed and their responses indicated that principals in the treatment schools were significantly more likely than principals in the control schools to report that the rates of tardiness and school absence had decreased. These principals were also significantly more likely to report a decline in the number of disciplinary incidents. Although based on smaller numbers than the student level data, the principal surveys are nevertheless interpretable within the framework of the experimental design and show that principals in the treatment schools were more likely to report that student attendance, punctuality, and behavior had improved in their schools than were principals in control schools. As will be discussed later in this paper with regard to the data presented in the Final Report (Bernstein, 2004), the vast majority of principals in the treatment schools believed that the SBPP had had a positive impact on their schools and students.

Surveys completed by a sub-sample of 54 teachers also found that those in the treatment schools were significantly more likely to report a change in student attitude or behavior than were teachers in the control schools (Exhibit A-71), a difference that is again omitted completely from the section that reports on the teacher surveys [13]. As in the principal surveys, teachers in the treatment schools were more likely than those in the control schools to rate student attendance, punctuality, and discipline to have improved, although these differences failed to reach statistical significance in the small sample of teachers (Exhibits A-72 & A-73).

The first year report does note in text two other statistically significant differences between the treatment and control groups but these are differences that suggest more favorable outcomes for the control group. The first was that logs kept by the school staff for the purposes of the evaluation showed a significantly higher average number of disciplinary incidents during the first year of the demonstration for the treatment rather than the control schools (1.8 vs. .9 incidents per day) [13]. The second was that on the Conners Teachers Rating Scale which was completed by more than 800 teachers whose students participated in the interview study, the behavior of the treatment group was rated as being worse on one of the four subscales (Oppositional subscale of (52.3 vs. 51.5; p 109).

These possibly discrepant findings were the subject of additional survey questions for principals during Years 2 and 3 and as summarized in the Final Report ([14] pp 40-42) the patterns suggested that they were anomalous, possibly due to higher rates of disciplinary problems in schools in which breakfast was served in the classrooms and the fact that these

schools in turn had much higher percentages of students from very low income families.

Other than the differences noted above, the assessment of other outcome measures revealed no significant differences between the treatment and control schools. Both school level and individual student level data on attendance and tardiness from school records were examined and revealed no statistically significant effects in any of the main or subgroup analyses. Individual level data involving three different cognitive tests (visual discrimination, memory for digits, verbal fluency), parent- and teacher-rated psychosocial problems, academic achievement test scores for math and reading, family food insecurity, body mass index (obesity) and health, all failed to show any statistically significant differences between treatment and control schools. The number of subjects varied considerably depending on measure, from more than 4200 on student-only administered measures of (like cognitive tests and BMI), to about 3700 on school record measures of attendance to 3300 on measures requiring parental input like 24 hour recall and psychosocial functioning, to about 2400 on the achievement test data to about 2000 on tardiness. On some of the longitudinal test score analyses, the N was less than 1300. Data on disciplinary incidents and visits to the school nurse were collected on a school wide rather than individual student basis.

Although the relative lack of statistically significant differences between treatment and control schools on the other outcome measures was interpreted by the first year report as showing “no consistent pattern of positive effects on student outcomes associated with the availability of universal-free school breakfast”, the report does provide a number of caveats (p. 129). These and other methodological considerations will be discussed in the section that follows.

IIA4. Methodological Points Related to the First Year Reports on the SBPP

The USDA provided thirteen million dollars for the SBPP demonstration and evaluation in the hope of overcoming the limitations of previous studies in assessing the implementation and impact of universal free school breakfast. In terms of the weaknesses of previous USB evaluations, the SBPP used an experimental design and statistically rigorous methods to test in a moderate sized sample of schools the impact of a standard intervention (making a universally free school breakfast available to all students) on a set of outcomes that had been assessed in other studies and were themselves becoming increasingly becoming standard.

The demonstration was a clear success in that it proved definitively that the availability of a universal free school breakfast program could produce relatively large gains in school breakfast participation in an operationally feasible, cost-effective program. The experimental design also provided definitive evidence that overall breakfast eating increases as a result of making a universal free school breakfast program available. The study proved that school and overall breakfast eating increased even among the poorest students who were already eligible for free or reduced price meals, as well as among students from families

who currently have to pay full price. There were a dozen other statistically significant findings related to the experimental design and most of these suggested that the intervention had led to better overall nutrition, both at breakfast and over 24 hours.

The study had a number of important limitations with regard to the major question addressed by the current paper, namely the relationship between breakfast and learning. Probably the most important limitation was that the SBPP experimental design only tested a specific intervention (availability, not consumption, of a universally free breakfast) in a specific population (a geographically and economically diverse group of *elementary school* students from mostly non-poor schools. Because of these limitations, the SBPP evaluation provided neither a large increase in overall breakfast eating nor a population at high nutritional risk. For these reasons, the SBPP as implemented could not answer the questions of what the impact of the program would have been in an exclusively low-income and/or in secondary school sample. These questions could however be answered relatively easily in future studies by using the same general design in a high poverty and/or secondary school sample.

Several more detailed methodological concerns also affect the interpretation of the results from the first year sample. The three most important caveats about the study noted in the discussion section (p. 129) of the first year (2002) report are that its conclusions were based on 1) an assessment of only a single academic year's data; 2) on a purposefully selected, non random sample; 3) under the constraints of a methodological challenge the study designers labeled the 'dilution effect'. For this reason, the results of the first year of the SBPP evaluation are generalizable only to the sample studied and may have only limited relevance to other important samples of U.S. children. As noted on the first page of the executive summary (p. i), the pilot was 'not intended to evaluate the current SBP or the value of consuming breakfast', both of which could be assumed to be important without further evaluation.

As for the fact that the first year evaluation examined the impact of only a single year of the program, it is important to note that the design called for two additional years of data collection on some of the measures. Although a number of the state and city USB program evaluations had found significant effects after a single academic year, it was assumed that in a broad national sample, important effects might only be evident after multiple years. It was for this reason that the study used three-year longitudinal analyses when it was possible to do so without great expense. These data and some additional analyses of the first year data were summarized in a Final Report that was released in December of 2004. This report is discussed in the next section.

With regard to the second caveat about the study's limited generalizability, although the report is based on a sample that was a 'mix of varying economic and other demographic characteristics' it is important to note that the sample of six school districts in the demonstration was not intended to be nationally representative. Instead, six school districts were selected by the USDA from a pool of 386

districts that applied to be in the demonstration according to a large number of criteria [13]. Among the most important were that the six districts were chosen because they could provide standardized achievement test scores and computerized data on school wide school breakfast participation over a multiyear period. As such, the obtained sample may be under-representative of certain types of school districts, especially of those which do not keep good records.

The first year report presents basic demographic background data on the school districts and schools included in the design. Although the percentage of students eligible for free meals (37%) in the SBPP sample [13] was roughly the same as the rate (36%) for U.S. elementary schools reported on a recent national study [87], the SBP sample may nevertheless under-represent students from the lowest income school districts. Although data were not presented in the McLaughlin *et al.* [13] report, a review of the public use dataset shows that only 3.1% of the schools in the SBPP sample were from very high poverty areas (80% of students eligible for free or reduced price meals), compared to 21% of the schools in the Maryland Meals for Achievement sample and 73% of the schools in the Baltimore USB sample (Murphy 2005 personal communication). High poverty schools make up a large percentage of the schools in inner city areas and their students constitute a very high-risk subgroup of U.S. children, but it appears that these types of schools were underrepresented in the USDA sample.

The last page of the First Year evaluation clearly acknowledges that "to appropriately address whether different outcomes would be obtained within ...[different] types of schools or students, an experimental study with that focus would have to be conducted" [13]. As noted above, one of the recommendations of this paper is that another universal free school breakfast demonstration be conducted in secondary and elementary schools with very high free and reduced eligibility rates.

A third challenge noted in the conclusion of the SBPP first year report was labeled the 'dilution effect' and it was anticipated by the evaluation designers. As explained in the design document that guided the evaluation [29], a number of characteristics of the population studied imposed some limitations on the power of the design to detect the true impact of the availability of universal-free breakfast. First of all, since only 25% of all students in the design were expected to increase their *school* breakfast participation when school breakfast was made universally free (in reality the actual figure was only 17%, even lower), the 'noise' created by the other 75% (83%) of all students (who did not change their school breakfast eating) as a result of the demonstration made detecting effects in the group as a whole even more difficult.

Even worse, since as it turned out only 4% of all students increased their overall substantive breakfast eating (whether consumed at school, home, or elsewhere), the 'dilution effect' was even stronger than had been anticipated. In the SBPP design, only about one in twenty students in the sample actually received the equivalent of an additional substantive breakfast...and for these students the increase was only from a 'less substantive' to a 'more substantive' breakfast rather than from nothing at all to a full breakfast.

So the intervention, as delivered, was quite small, with whatever gains made by the 4% of students who changed their breakfast consumption patterns diluted by the other 96% of the students who did not.

As the design document also makes clear, the detection of changes in outcomes for these students was made even more difficult by the fact that the randomization and thus the unit of analysis-- and statistical power--of the SBPP design was limited by the number (153) of schools in the design. Because an N of 153 schools is only a moderate sized sample, the power of the experimental analyses in the SBPP design was actually relatively limited. Randomizing subjects on the basis of school rather than student permitted the use of an experimental design but the trade off was accepting a higher probability of Type II error (failing to find an effect that was actually present) in order to insure a lower probability of Type I error (interpreting the findings as showing an effect, when in fact it was actually due to chance). As noted above, conducting a demonstration and evaluation in a sample that was more nutritionally at risk (high poverty and/or secondary school age) is one method that could be used in future pilot studies. In the meantime, using non experimental analytic techniques which allow the use of much more powerful statistical tests is a method that can be used with the data already collected and will be explored in the final section of this paper.

Given these and other anticipated challenges, it is important to note that the architects of the design had thought even before it was implemented that it was unlikely that the SBPP would be powerful enough able to detect changes in standardized test scores [29] and that it was just barely likely that the design would be able to detect changes in nutrition (micronutrient consumption) although it was very likely that the design would be able to detect changes in school breakfast participation. For these reasons, the original design called for non-experimental analyses that could be used to model the impact of breakfast eating and other conditions using a correlational rather than an experimental approach. The relatively large number of students in the interview sub-sample made it possible to perform analyses with more statistical power. These analyses along with analyses of the findings from the second and third years of the evaluation are presented in the SBPP Final Report [14] and will be discussed in the next section of this paper.

IIB. The SBPP Final Report

The Final Report reviews results from the experimental analyses from Years 2 and 3 and then presents additional, non-experimental results from Year 1. The current report reviews these findings as they relate to the three research themes used to structure this review.

IIB1. General Findings Presented in Final Report

Additional data on school breakfast participation, test scores, attendance, tardiness, disciplinary visits and school nurse visits were gathered on a school wide basis for Years 2 and 3 of the demonstration (and on an individual student basis for all but the latter two variables) and these data were analyzed using both experimental (treatment vs. control) and non experimental analyses. No new interviews

or other data on nutrition, cognition, or psychosocial functioning were conducted after the first year of the demonstration. Another round of interviews with school principals and food service staff (Implementation Study) were conducted at the end of Year 3 about the final two years of the demonstration.

The results of the new experimental analyses presented in the Final Report clearly showed that overall school breakfast participation stayed at about the same high levels it had achieved by the end of the first year...both treatment and control schools showed about a one point continuing gain over the participation at the end of the first year of the demonstration. The overall gain continued to be largest for students who formerly had to pay full price for their meals (their school breakfast participation quadrupled from 9% to 36%) but students who were already eligible for free or reduced price meals still doubled (from 25% in 1999-2000 to 50% in 2002-2003) their participation.

IIB2. Findings Relating Breakfast Eating and Nutrition in Final Report

The Final Report does not include any new data on nutrition but it does present the results of a major set of non-experimental analyses exploring outcomes for substantive vs. non-substantive breakfast eaters. As noted earlier, following the Devaney and Stewart [20] definition of substantive breakfast eating (food from at least two of five food groups and greater than 10% of RDA for food energy), the First Year Report had shown that about 22% of the 3347 students interviewed failed to consume a substantive breakfast on the day of their 24 hour recalls. The Final Report presents non-experimental analyses of the nutritional correlates of substantive breakfast eating/skipping.

The Final Report clearly shows that substantive breakfast skippers reported consuming significantly lower mean intakes of all twenty plus vitamins, minerals, and other nutrients assessed...both for the breakfast meal and for nutrition over 24 hours.

The Final Report also clearly shows that breakfast skippers consumed significantly fewer servings of grains (both whole and non whole grains) and fruits (and total servings of fruits and vegetables) over twenty-four hours than did non-breakfast skippers. This was the first report to assess the nutritional consequences of substantive breakfast skipping as defined by Devaney and Stuart [20] and the evidence for the negative impact of substantive breakfast skipping on nutrition is very strong.

The SBPP Final Report [14] does not explore the impact of substantive breakfast skipping on the cognitive, academic, and health outcomes assessed in the study. Instead, the report switches to two more restrictive definitions of breakfast skipping in order to explore the impact of breakfast skipping on other outcomes. In terms of breakfast based on *target day* intake, the SBPP Final Report created a definition of target day breakfast skipping that identified the very small (122/3347; 3.6%) percentage of students who ate essentially nothing at all (or more precisely, no more than about a bite [45-63 calories, depending on age and gender]; page 91). In terms of *usual* breakfast skipping, the analyses were also based on a very restricted sample (172/3421; 5%) of students

whose parents reported that their children ate breakfast *fewer than three days per week*.

Using the restrictive definition of *usual* breakfast skipping, the SBPP Final Report presents conflicting data. Although the authors interpret the results of their analyses (Exhibit 6.8) as showing that usual breakfast skippers are no less likely to meet standards for dietary adequacy than non-breakfast skippers (when 80% of the RDA for each nutrient is used as the standard), the next table in the report (Exhibit 6.9) clearly shows that breakfast skippers are significantly less likely to be in the 50th percentile for food energy, protein, and calcium than usual breakfast non-skippers. The SBPP Final Report did not present dietary adequacy analyses for the impact of a substantive breakfast on a target day.

IIB3. Findings Relating Breakfast Eating to Other Outcomes in Final Report

In terms of other outcomes and still looking at the non-experimental analyses of the first year data, even defined very restrictively as missing more than 3 breakfasts per week, usual breakfast skippers were shown to have significantly *higher* BMI percentile scores (were more obese) than breakfast non-skippers. And although all fourteen of the other behavioral, health, and hunger measures showed better functioning for usual breakfast non-skippers, BMI percentile was the only variable that was statistically significant. Analyses presented only in the appendices (Exhibit G12) examined cognitive test scores and target day breakfast skipping and found no significant differences favoring breakfast non-skippers or skippers.

The Final Report also presented data from the second and third years of the demonstration and three or four year (pre implementation year to implementation Year 3) longitudinal data on a number of the outcomes assessed via school records or schools, providing an answer to perhaps the most frequently asked question with regard to USB programs; what happens to standardized test scores, attendance, and tardiness when such programs are implemented?

The Final Report presents both *school wide* data on standardized test scores (based on tens of thousands of students in the SBPP demonstration schools) and data on *individual students* from the interview sub-sample (based on about 1200 students who had data from all four years) which were analyzed in terms of the experimental design. The report further breaks down the test score findings for math vs. reading, for different grades (2nd-6th), and time periods (baseline to Year 2, Year 3, etc). The SBPP Final Report also lists data on school wide and individual student attendance and tardiness, and school wide disciplinary incidents and visits to the school nurse. These data will be reviewed below.

IIB3a. Standardized Test Scores

Although none of the main effects for test scores were statistically significant, the overall pattern of data supported the interpretation that there were small but positive impacts on test scores for the schools in which the USB program was made available. As shown in the figure on page 68 of the Final Report, school-wide math scores in the 76 treatment schools at baseline started out slightly lower than such scores

in the 74 control schools but by the end of Year 1 were higher and remained more than one half of a normal curve equivalent higher for Years 2 and 3. Although this difference failed to reach statistical significance in the full sample, the improvement in standardized math scores was statistically significant in the largest school district (N=120 schools; Exhibit D-14b). A similar analysis of the school wide data for reading test scores over three years showed a somewhat smaller gain of about one quarter NCE point for the treatment schools. Examination of the much smaller set of data on individual student achievement scores revealed no statistically significant differences overall or for any individual school district (Exhibits D6-b & D10-b) on the standardized math or reading tests.

IIB3b. Attendance and Tardiness

The same pattern of improved but statistically non-significant outcomes in school wide data was found with regard to both attendance and tardiness. For the 69 control schools with longitudinal data, average daily attendance declined from 94.1% to 92.9% (-1.2%) from the year before to the third year of the demonstration. For schools in which the USB program was made available however, average daily attendance declined less...from 93.9% to 93.2% (-.7%). These numbers would equate to the difference of one more day of attendance per student per year in the treatment schools. Students in the control schools decreased their attendance two days from an average of 169 days per year to 167. Students in the treatment schools decreased only a single day, from 169 to 168 days of attendance per year.

Only a fraction of the schools were able to provide data on tardiness but among those that did, schools in which the USB was made available showed a greater decrease in the number of days tardy per year (-.27) than did schools with only the current SBP (-.19). None of the individual student level data analyses for tardiness or attendance were statistically significant and the patterns were mixed.

IIB3c. Visits to the Health Office and Principal's Office

All schools participating in the SBPP demonstration were asked to keep logs of visits to the school nurse/health office and referrals to the office for disciplinary incidents over the three years of the demonstration. Data were available on a school wide basis only. The first year SBP report had shown a slightly but not significantly lower number of health office visits in the treatment schools (3.9 visits per day per 100 students) than in the control schools (4.0 visits per day). As noted in the SBP Final Report, the mean number of visits to the health office was lower in the treatment schools in the other two years of the demonstration too and this difference did reach statistical significance in Year 2 (3.3 vs. 4.0 visits per day). In both of the last two years, the difference was especially pronounced and did reach statistical significance in the morning in either all or at least one of the school districts (Exhibits D-31a & D-31b).

The data on disciplinary incidents were more mixed. As noted earlier, during the first year of the demonstration the treatment schools had reported a small (1.1 incidents per day per 100 students) but significantly *higher* number of disciplinary visits than the control schools (.9 incidents per day). Treatment schools continued to have a slightly higher

number of disciplinary incidents in Years 2 (1.2) and 3 (1.1) than the control schools in Years 2 (.8) and 3 (.9) although the differences failed to reach statistical significance. As noted earlier, a set of additional questions were asked of all school principals during the third year implementation study and results suggested that the apparent disbenefit of the USB program on discipline may have been due to a higher percentage of very low-income students in the classroom breakfast sites.

Following the hypotheses of the original design document [29] almost exactly, the design as implemented was powerful enough to detect the impact of the SBPP on school and overall breakfast consumption, just barely powerful enough to detect its impact on nutrition, and not powerful enough to detect any main effects on standardized test scores or other academic, cognitive, and psychological outcomes.

The authors of the First Year report were careful to begin with a note that the experimental analyses were “*not intended to evaluate the current SBP or the value of consuming breakfast.*” (p. i, emphasis in the original). For these questions, a different type of analysis was possible with the data and the results of these are listed below.

IIB3d. Methodological Considerations; Correlational (Non Experimental) Analyses in the SBPP Reports

As the architects of the evaluation had pointed out in their original evaluation planning document [29], although the design chosen for the USDA SBPPP is a good one for seeing if a universal free school breakfast program would lead to measurably better student outcomes over a single school year in an economically and geographically diverse sample, the design was actually a poor one for assessing the impact of breakfast skipping due to the small N of schools in the randomization design and to what the evaluation design authors called the “dilution effect”. Fortunately the large number of students in the interview study sample made it possible to use much more powerful statistical techniques in non experimental analyses that explored the impact of breakfast eating/skipping in a reanalysis of the SBPP first year data.

IIC. Findings from a Reanalysis of the SBPP First Year Data

As noted earlier, the dataset for the first year of the SBPP evaluation was made available to the public in August of 2003. As of this writing, the dataset on the Year 2 and Year 3 samples has not been released. One of the authors of the original SBPP design document [29] and first year evaluation report [13] obtained the data from the USDA and analyzed the non experimental data that was most relevant to examining the relationship between breakfast skipping and student outcomes. The findings from these analyses have been submitted for publication [15]. All of the major outcome variables used in the study except for those related to nutrition and standardized test scores were examined. Non-experimental analyses relating to the latter two types of data had already been presented in the Final Report [14] and have already been reviewed in this paper.

As also noted earlier, although the relationship between breakfast skipping and nutrition was examined extensively in

the 2004 Final Report, the relationship between breakfast skipping and other outcomes was not. The Murphy *et al.* [15] paper used logistic regression to examine the relationship between learning related outcomes and two different definitions of breakfast skipping: target day substantive breakfast skipping and regular breakfast skipping (failing to consume breakfast one or more of the past five days). These findings will be reviewed in sections based on the three categories used throughout this report.

IIC1. General Findings from Non Experimental Analyses

As presented in the Murphy, *et al.* [15] paper, *substantive* breakfast skippers were significantly more likely to be female (56.1%) than were non breakfast skippers (50.9%). *Substantive* breakfast skippers were significantly older (9.9) and from higher grades (4.3) than non-breakfast skippers (9.8 & 4.2 respectively).

Usual breakfast skippers were also significantly older and from higher grades than non-skippers. They were also more likely to be female, although this difference failed to reach statistical significance. *Usual* breakfast skippers were significantly more likely to be from minority groups and from food insecure families than were non skippers and there was a marginally significant ($p < .10$) trend for usual breakfast skippers to be more likely to be from free and reduced eligible families than were non skippers (55.3 vs. 50.1).

This was the first study ever to assess the relationship between the two different definitions of breakfast skipping. Forty percent of the students who skipped a substantive breakfast on the target day of their interviews were usual breakfast skippers compared to 18% of the students who ate a substantive breakfast. Twenty-three percent of the students who were usual breakfast skippers did not eat a substantive breakfast on the target day. In contrast, only 5% of the students who were usual breakfast eaters failed to eat a substantive breakfast on the target day. The association between the two types of breakfast skipping was highly ($p < .0001$) significant.

As noted above, the Devaney and Stuart [20] analyses of the SNDA-1 data was the first to operationally define the components of a ‘more substantive’ breakfast (vs ‘any food or beverage at all’). The first year SBPP evaluation [13] was the first to replicate the use of these alternative definitions and this replication both confirmed and extended Devaney and Stuart’s [20] original conclusions: when nothing at all was used as the standard for breakfast skipping, the breakfast program showed no effect on overall breakfast eating. When breakfast was defined more substantively, the breakfast program did lead to significantly more breakfast eating.

Although it is not really valid to compare rates in the SBPP data with rates found in nationally representative samples, it is interesting to note that in the SNDA-1 subsample most comparable to the SBPP sample (elementary school students in schools that have a school breakfast program), the rate of Definition 2 breakfast skipping was 21% in the 1989-91 SNDA-1 sample [20] and 24% in the 2001 SBPP control group [13], possibly suggesting a higher level of substantive breakfast skipping in 2001 than had been found a decade earlier. Illustrating the importance of the

definition of breakfast however, the rate of *complete* breakfast skipping among elementary students in schools with the SBP may have *decreased* ...from 5% in 1992 to 3.6% in 2001. Thus absolute *quantity* of nutrition may have increased somewhat while *quality* of nutrition may have actually declined.

IIC2. Impact of Breakfast on Nutrition

Although the Murphy *et al.* [15] report on breakfast skipping did not examine its impact on nutrition, as already noted the 2004 Final Report did and the results showed significantly lower mean intakes of all vitamins, minerals, and macronutrients for substantive breakfast skippers.

IIC3. Impact of Breakfast on Other Student Outcomes

The Murphy *et al.* [15] paper on the SBPP data reported on significant associations between both target day substantive and usual breakfast skipping on virtually all individual student outcomes examined. Same day substantive breakfast skippers were significantly less likely to be in excellent health (82.8% vs. 86.5%) and had significantly lower rates of school attendance (95.4% vs. 95.7%) and higher rates of tardiness (1.5 vs. .9 days per year) than substantive breakfast eaters. Usual breakfast skippers were significantly less likely to be in excellent health (79.0 vs. 86.8%), to have significantly lower rates of attendance (95.2% vs. 95.9%) and higher rates of tardiness (1.5 vs. .8 days) than usual breakfast eaters. Usual breakfast skippers were also significantly more likely to be overweight (20.6% vs. 16.1%), at risk of overweight (37.7% vs. 31.6%) and to have higher BMI percentiles (63.8% vs. 63.0% for age/gender), more behavioral problems (total score of 10.4 vs. 9.8 on the PSC) poorer short term memory/attention (scaled score of 9.1 vs. 9.4 on Digit Span) and less verbal fluency (total VF score of 29.4 vs. 30.3) than usual breakfast eaters. Virtually all of these associations were significant even after controlling for potentially confounding background factors (age, gender, school meal eligibility status, minority group status, parent education, parent marital status, and food insecurity).

As the report also notes, the logistic regression equations for most of these outcomes confirmed the separate and statistically significant impact that multiple nutritional risk factors had on outcomes. For example both types of breakfast skipping significantly predicted school attendance even after the significant impacts of food insecurity, obesity, and poverty had been controlled for. Overall health was also predicted significantly by breakfast skipping, food insecurity, and being overweight in addition to poverty.

A final table in the Murphy *et al.* paper examined the impact of breakfast skipping on attendance and health problems for three separate high risk groups (those eligible for free and reduced price meals at school, those from food insecure families, and those who reported a total caloric intake of less than 1500 Kcal per day). Students who had each of these risk factors were significantly more likely to have attendance and health problems than students who did not...and within each of these high risk subgroups, students who were usual breakfast skippers were significantly more likely to have attendance and health problems than breakfast non skippers. In most cases, each additional risk factor

approximately doubled the risk of a poor health or attendance.

These findings from the Murphy *et al.* 2004 [15] report strongly support the 1998 conclusions of the Pollit and Mathews [2] paper that skipping breakfast interferes with cognition (Digit Span, Verbal Fluency) and learning (attendance, tardiness), and that the effect is more pronounced in nutritionally at risk children:

IIC4. Correlational Analyses Relating Food Insecurity/Hunger to Student Outcomes

Other findings from the USDA evaluation that have a bearing on the understanding of the impact of nutritional risk on student outcomes are the data on food insecurity. This SBPP evaluation provided the first time ever point prevalence of food insecurity/hunger using the Food Security Scale in a large and reasonably representative group of U.S. elementary students. As noted earlier, the USDA usually presents its findings on hunger as a prevalence of hungry families, leaving it to appendices and the reader's calculations an estimate of the prevalence of hunger/food insecurity among individual children.

Previous studies by the USDA [191] had found that 4% of the households with children reported hunger and another 13% reported food insecurity (17% hungry/food insecure). In the SBPP sample, 7% of the students came from families that reported hunger and that an additional 16% came from families that were food insecure (23% hungry or food insecure). As noted earlier, although this was not a nationally representative sample, it was close to the national average in many respects. Assuming for sake of argument that the sample is representative, the finding that food insecurity/hunger affects nearly one quarter of all U.S. children underscores the magnitude of nutritional risk as a problem in this country.

The Murphy *et al.* paper [15] also found that although students from food insecure families were significantly more likely to skip regular breakfast than were students from food secure families in the sample as a whole, in the intervention group schools, the gap in regular breakfast eating between food insecure and food secure students was smaller (11.3% vs. 9.7% skipped breakfast) than it was in the control schools (where 17.4% of the students from food insecure families and 13.3% of the students from food secure families skipped regular breakfast). This finding suggests that USB programs may be effective ways to decrease breakfast skipping in food insecure families.

When linked with findings from other studies [5, 6, 18, 19] that showed that hungry/food insecure children are more likely to need special education and mental health services, to stay back in school, and to have health problems, the fact that students from food insecure families were more likely increase their overall regular breakfast eating suggests that increasing school breakfast participation could be a viable way to improve academic outcomes for such children.

IIC5. Methodological Points Related to Subsequent Year Reports on the SBPP

The USDA Final Report and the Murphy *et al.* [15] reanalysis paper provided a direct assessment of the impact

of breakfast skipping on student outcomes using the largest U.S. sample to date. Results showed clearly that breakfast skipping was related to significantly poorer student academic, cognitive, health, and weight outcomes, and that these poorer outcomes were significant even when student background factors were controlled for. Furthermore, the analyses also showed that food insecurity and obesity were also quite prevalent and exerted separate independent and statistically significant effects on student academic and health outcomes. All of the nutritional risk factors were more prevalent in children from low-income families but less prevalent in schools in which a universal free school breakfast program was made available.

Results from the experimental analyses of the second and third years showed that the availability of a universal free school breakfast program continued to result in the same higher rates of school breakfast participation in a program that remained feasible, cost effective, and popular with all stakeholder groups. Principals continued to rate the program as beneficial to students and schools.

III. DISCUSSION

Over the past five years, half a dozen new studies from the U.S. and other countries have shown that students who eat breakfast regularly have significantly better academic outcomes. The samples used in these studies were large (from 800 to more than six thousand) and the academic measures included standardized achievement and cognitive test scores and school grades. Not only have these studies of individual students shown the positive academic impact of breakfast eating, but a number of large intervention projects that provided breakfast universally free for all students at school have shown that school wide test scores and attendance rates have improved significantly after the start of such programs although not in all instances.

Research published over the past five years has also demonstrated a significant association between usual breakfast skipping and poorer mental health and health in children. The findings about the connection between breakfast skipping and poorer mental health and behavior replicate several previous studies of children and adults. The findings about the connection between breakfast skipping and poorer health are new for children although they replicate previous research with adults. Breakfast skipping has also been shown to be related to a number of specific illness conditions (like dysmenorrhea, dental caries, bowel and sleep problems) and to health risks like smoking, drinking, lack of exercise, and stress.

Within the broad category of health, the specific connection between breakfast skipping and greater risk of being overweight is especially important. Not only has this connection been supported by more than a half dozen new studies, several of them based on huge nationally representative samples of children and adults and based on measured height and weight, but the connection takes on even greater importance given the fact that some of the country's leading public health authorities now rate poor diet and physical activity as the leading cause of preventable death in the U.S., more dangerous even than smoking.

Recent research has also shown that other nutritional risks like food insecurity/hunger and micronutrient deficiencies are also present in a substantial portion of U.S. children and that these risks have a similar association with negative child academic and health outcomes. All of these nutritional risks are more prevalent in low-income populations and when breakfast skipping is combined with food insecurity, the risks of poor health and/or poor school attendance increase from two- to seven-fold.

Although it is still not possible to draw definitive conclusions about the short-term benefits of a single breakfast on learning it does seem likely that they are there. As for long-term benefits of usual breakfast consumption, the evidence for a connection between breakfast eating and both academic and health outcomes is now very strong. The evidence that regular breakfast eating is associated with better nutrient intake is even stronger.

Recent findings showing the positive impact of breakfast on energy, combined with those about health habits and the overall nutritional contribution of breakfast point to a more complex but hopefully more comprehensive model for the mechanisms through which breakfast provides its impacts. First of all, for a number of key cognitive processes, eating breakfast provides energy that is available both immediately and over the course of the morning. Second of all, as a health habit, eating breakfast is associated with having other health habits, the combined total of which can have a profound impact on health. Third of all, same day breakfast eating is correlated with and a component of the habit of regular breakfast eating and fourth, it is one of just a few opportunities to obtain a full range of nutrients.

Over the short term, breakfast skippers have somewhat less energy available, and over the long term they tend to be somewhat less well nourished. They are more likely to feel hungry and irritable and they are less likely to be energetic. Their attention on some tasks may actually be better due to increased arousal but overall they probably have fewer cognitive resources available for memory and attention. They certainly have less energy. Given their lower level of energy, breakfast skippers may be somewhat easier to manage behaviorally but they have less energy available for learning.

The studies reviewed here have policy implications on a number of fronts. Although the USDA SBPP demonstration did not show improved attendance, standardized test scores, or health after a single year, some of the subgroups within the first or subsequent years' samples did show these improvements. Some of the other national and state/local demonstration projects have shown statistically significant positive impacts in these areas. Even though the design of the SBPP demonstration made the detection of some of these findings unlikely, the evaluation did confirm that universal free school breakfast programs leads to increased school- and overall-breakfast eating and that this in turn led to small but statistically significant improvements in nutrition. Past research cannot answer the question of whether a universal free school breakfast program targeted at schools with higher levels of need like those in low income areas or with older students would find better outcomes using an experimental design but large scale evaluations using non experimental

designs in the states of Maryland and Ohio and in the cities of Boston and Baltimore have already demonstrated such outcomes. An evaluation currently underway in the country of Wales may provide a more definitive answer.

With regard to universal free school breakfast programs as a policy option for improving the nutrition of at-risk youngsters, it is important to note the bottom line assessments of principals in the 79 treatment schools at the end of the third year of the demonstration. Eighty-six percent of these principals rated the overall impact of universal free school breakfast on their schools as positive or very positive and over 90% of the principals rated it as having had a positive impact on students.

Since it now seems likely that establishing a habit of eating breakfast every day has clear benefits in terms of long term health, psychological well-being, and obesity prevention, school based programs take on increasing importance for encouraging the formation of daily breakfast eating habits by providing quality nutrition in pleasant environments. Programs that expand and enhance school breakfast participation should continue to proliferate and to expand in the years to come. As shown by several recent studies, perhaps just as important in the long run is for parents to help their children to develop the habit of eating a good quality breakfast at home. With research documenting the long-term persistence of and family basis of breakfast eating habits, much more work can and should be done in this area.

In summary, recent research has provided definitive evidence that breakfast eating has significant associations with positive student academic and health outcomes. Although these effects may be too small to be detected when relatively small samples of schools are randomly assigned to conditions that provide small increases in breakfast eating, the effects are large enough to show significant effects in larger samples and over larger periods of time. Several studies now show that regular breakfast eating results in an increase of about one day per year in school attendance or a decrease of 60-70% in the probability of fair/poor health. While effects of this size are not huge, there are few if any other interventions for students that have demonstrated any larger effects.

Recent research with students confirms the findings and models created by the Alameda County Study with adults beginning four decades ago. Regular breakfast eating is one of a half dozen or so health habits that have been shown to have small but additive effects on overall health. Individuals who have many health habits are two or three times more likely to be and stay healthy than individuals who have few or no health habits. The fact that this model has now been confirmed in a large sample of U.S. children underscores its importance for health as well as academic outcomes for students.

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