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**Universal-Free School
Breakfast Program
Evaluation Design Project**

**Review of Literature on
Breakfast and Learning**

Final Report

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I. INTRODUCTION

The School Breakfast Program (SBP), authorized by the Child Nutrition Act of 1966, started as a pilot program to provide funding for school breakfasts in poor areas and areas where children had to travel a great distance to school. The intent was to provide a nutritious breakfast to children who might otherwise not receive one. The importance of a nutritious breakfast is supported by several studies that appear to have linked breakfast to improved dietary status and enhanced school performance. More recent research suggests that providing school breakfasts to low-income children is associated with greater likelihood of eating a substantive breakfast and improved school attendance and decreased tardiness. Less is known about the effects of school breakfast on children's cognitive functioning and academic achievement, although some studies suggest that school breakfast may lead to improvements in these outcomes.

In response to the body of evidence suggesting educational and dietary benefits from school breakfasts, many observers have urged that the availability of school breakfasts be expanded. Within this context, Congress passed Section 109 of the William F. Goodling Child Nutrition Act of 1998 (P.L. 105-336), which authorizes the Secretary of Agriculture, through the Food and Nutrition Service (FNS) of the U.S. Department of Agriculture (USDA), to conduct a demonstration and evaluation to rigorously assess the effects of participation in the Universal-Free School Breakfast Program (USBP). A broad range of outcomes are to be considered, including academic achievement, school attendance and tardiness, dietary status, program participation, and student functioning in the area of cognition, behavior, and attentiveness.

FNS has contracted with Mathematica Policy Research, Inc. (MPR) to develop a comprehensive and rigorous study design for evaluating the USBP pilot programs. The design project has three primary components. The first is a literature review that summarizes current knowledge about the relationship

between breakfast and learning, identifying strengths and weaknesses of past studies and the implications for the evaluation design. Under this component we are also preparing a report that identifies and discusses key evaluation design issues that a rigorous evaluation must address, including recommending feasible design alternatives. The second component entails consulting with FNS staff and a panel of six experts on design issues and alternative designs. The third component involves developing a final, comprehensive evaluation design.

This report is the project's literature review. It provides a thorough examination and synthesis of current knowledge about the relationship between breakfast and learning, including breakfast consumption patterns of children, the relative contribution of breakfast to dietary intake over 24 hours, and the impact of breakfast consumption on cognitive and school outcomes. By summarizing what is known about the role of nutrition in the cognitive and physical development of children, as well as what is known from detailed studies of breakfast consumption and its impacts, this literature review lays the foundation for both the design issues report and the final recommended evaluation design. The rest of this chapter provides some background information on the SBP, a description of the study objectives, and an overview of the report.

A. OVERVIEW OF THE SCHOOL BREAKFAST PROGRAM

The SBP is a federal program that provides states with cash assistance (and commodities) for breakfast programs in schools. Originally, it was a pilot program that targeted children from low-income school districts. With the 1975 amendments to the Child Nutrition Act of 1966, the SBP became permanent. The objective was to make the program “available in all schools where it is needed to provide adequate nutrition for children in attendance.” The program is administered at the federal level by FNS and at the local level by state education agencies and local school food authorities.

All public and (nonprofit) private elementary and secondary schools in the United States are eligible to participate in the SBP. To do so, schools must make breakfast available to all students, and the breakfasts must meet federal nutrition standards. SBP breakfasts are required to provide approximately one-fourth of the Recommended Dietary Allowance (RDA) for important nutrients over a period of time (protein, calcium, iron, vitamin A, vitamin C, and calories). In addition, regulations now require that all school meals meet the recommendations of the *1995 Dietary Guidelines for Americans*.¹

To achieve both the RDA and the Dietary Guidelines standards, schools may use several methods for planning menus. One way is to prepare meals using food-based menu planning. A school breakfast using the food-based menu planning approach must contain, at a minimum, the following food components:

- C A serving of fluid (whole or low-fat) milk served as a beverage or on cereal or used in part for each purpose
- C A serving of fruit or vegetable or both, or undiluted fruit or vegetable juice
- C Two servings from one of the following components--bread/bread alternate or meat/meat alternate; alternatively, there can be one serving from each component

The USDA subsidizes schools for each eligible breakfast served. Schools submit a claim to their School Food Authority (SFA), which submits a claim to the state agency, and the USDA reimburses the state, which in turn reimburses the local school food authority and then schools. The cash reimbursements vary according to whether students qualify for free, reduced-price, or full-price meals. To be eligible for free meals, students must have a family income less than or equal to 130 percent of the poverty level. To

¹The applicable recommendations of the *Dietary Guidelines* are (1) eat a variety of foods; (2) limit total fat to 30 percent of calories; (3) limit saturated fat to less than 10 percent of calories; (4) choose a diet low in cholesterol; (5) choose a diet with plenty of vegetables, fruits, and grain products; (6) use salt and sodium in moderation; and (7) eat a diet rich in fiber.

be eligible for reduced-price meals, students must have a family income between 130 and 185 percent of the poverty level. For the 1999-2000 school year, the reimbursement in “non-severe need” schools (schools that do not have a large proportion of needy students) in the contiguous United States is \$1.09 for free breakfasts, \$0.79 for reduced-price breakfasts, and \$0.21 for full-price breakfasts. For schools with a large proportion of needy students (“severe needs” schools), reimbursements are \$0.20 higher for free and reduced-price breakfasts.²

SBP participation grew rapidly from 1970 to 1980, but more modestly through the 1980s (Kennedy and Davis 1998). Participation has grown dramatically over the past decade. The number of schools offering the SBP increased from 46,100 in fiscal year 1991 to 68,718 in fiscal year 1997, an increase of almost 50 percent. It is estimated that nearly three-quarters of schools that offer a school lunch also offer breakfast (Marcotte 1999).

Despite the increase in the number of schools offering the SBP, the percentage of students eating school breakfasts is considerably lower than the comparable percentage eating school lunches. Moreover, compared with students eating school lunches, those eating school breakfasts are more likely to be poor and to qualify for free or reduced-price meals. Because students who participate in the SBP are more likely to be low-income, it is possible that there is reduced participation in the SBP due to a perceived stigma associated with free and reduced-price school meals.

²Reimbursement rates for all meals are also higher in Alaska and Hawaii.

B. THE DEMONSTRATION AND EVALUATION

In response to the concerns of low participation by eligible students mentioned above, the 1998 Child Nutrition Reauthorization Act called for a demonstration to evaluate the effects of providing free breakfasts to elementary school children, without regard to family income. Key features of the demonstration are:

- C It will be conducted in elementary schools in not more than six SFAs.
- C SFAs will be purposively selected so as to obtain representation of pilot projects by urban and rural elementary schools, and schools of varying family income levels.
- C It will last three years.

The legislation authorizing the USBP demonstration pilot projects also requires an evaluation. The evaluation will address four primary research objectives:

1. Assess the effects of USBP participation in elementary schools on selected student outcomes, including academic achievement, school attendance and tardiness, classroom behavior and discipline, and dietary intakes over the course of a day
2. Compare the characteristics and outcomes of USBP participants with those of nonparticipating children
3. Describe the children participating in the USBP and compare them with children participating in the regular SBP
4. Assess how the USBP affects participation in the school breakfast program and simplifies paperwork and other administrative procedural participation requirements

Authorization extends through September 30, 2003. Preparation for the legislative proposal for the next reauthorization will begin in spring 2002. This means that an interim evaluation report will have to be submitted at that time to inform the reauthorization hearings. The final evaluation report is due at the completion of the pilots, in September 2003.

C. OVERVIEW OF THIS REPORT

An underlying premise of the SBP is that it provides nutritious breakfasts to children who might otherwise not eat breakfast and would therefore arrive at school without the proper nourishment needed to learn. A significant body of literature underlies this basic policy premise. The literature for this design project is reviewed along three broad areas: (1) the link between nutrition and cognitive development of children; (2) the contribution of breakfast to children's dietary intake and behavioral and cognitive development; and (3) the relationship between school breakfast, dietary status, and school performance and achievement. Since a broad range of factors may affect dietary intake, nutrition, behavior, and academic performance, all related factors must be carefully considered and addressed in the design of a school breakfast evaluation study. While the available information on nutrition and cognition is based primarily on data from developing countries, the literature review on breakfast patterns and the affect school performance focuses on data for U.S. children, since these studies are more directly applicable to this study's design. Table I.1 lists the sources that have been abstracted for the literature review and summarizes the broad topics they cover.

Chapter II of this report presents evidence on the link between nutrition and cognitive development. The first section includes a discussion of causal models of why and how nutrition affects growth and cognitive development; the second section presents findings from previous studies based on data from developing countries. Chapter III presents literature on the contribution of breakfast in general, including trends in breakfast consumption of children, the contribution of breakfast to the nutrient intake of children, the effects of eating breakfast on behavioral and cognitive outcomes, and implications of these findings for the design of the USBP evaluation. Chapter IV presents evidence on the contribution of school breakfast in particular, including the role of the SBP

TABLE I.1

ISSUES COVERED BY SOURCES ABSTRACTED FOR
USBP DESIGN PROJECT LITERATURE REVIEW

Citation (Author and Year)	Dietary Focus		Design		Data Collection				Outcomes			
	Break- fast	SBP/USBP Breakfast	Experi- mental	Non- Experi- mental	Dietary Intake	Admin- istrative Records	Cognitive Tests	Surveys of Children, Teachers, or Parents	Dietary Intake/ Status	Behavior/ Cognition	Achievement/ Academic Tests	Nutrition/ Health Status
Abell Foundation 1998		X	X			X	X			X	X	
American Dietetic Assoc. 1999		X							X			X
Benton and Parker 1998	X		X		X		X			X		X
Brown and Pollitt 1996*(***)			X				X			X	X	X
Brown and Sherman 1995*										X		X

*—Review or Summary Article

**—National Study

***—Longitudinal Study

TABLE I.1 (continued)

Citation (Author and Year)	Dietary Focus		Design		Data Collection				Outcomes			
	Break- fast	SBP/USBP Breakfast	Experi- mental	Non- Experi- mental	Dietary Intake	Admin- istrative Records	Cognitive Tests	Surveys of Children, Teachers, or Parents	Dietary Intake/ Status	Behavior/ Cognition	Achievement/ Academic Tests	Nutrition/ Health Status
Center on Hunger, Poverty, and Nutrition Policy 1993, 1994, 1998*									X	X	X	X
Chandler et al. 1995		X	X				X	X		X		
Connors and Blouin 1982/83	X		X		X		X			X	X	X
Cook et al. 1996		X	X		X	X			X	X		
Craig 1986*	X				X		X		X	X	X	
Dairy Council 1993*	X	X							X	X	X	X

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*=Review or Summary Article

**= National Study

***= Longitudinal Study

TABLE I.1 (continued)

Citation (Author and Year)	Dietary Focus		Design		Data Collection				Outcomes			
	Break- fast	SBP/USBP Breakfast	Experi- mental	Non- Experi- mental	Dietary Intake	Admin- istrative Records	Cognitive Tests	Surveys of Children, Teachers, or Parents	Dietary Intake/ Status	Behavior/ Cognition	Achievement/ Academic Tests	Nutrition/ Health Status
Devaney and Fraker 1989		X		N	X	X		X	X			X
Devaney and Stuart 1998		X		N	X			X	X			
Dickie and Bender 1982a*	X		X		X		X	X		X	X	X
Dickie and Bender 1982b	X		X				X				X	
Dwyer et al. 1996***		X		X	X	X			X			
Dwyer et al. 1998***		X		X	X				X			
Food Research and Action Center 1989*									X			X

*=Review or Summary Article

**= National Study

***= Longitudinal Study

TABLE I.1 (continued)

Citation (Author and Year)	Dietary Focus		Design		Data Collection				Outcomes			
	Break- fast	SBP/USBP Breakfast	Experi- mental	Non- Experi- mental	Dietary Intake	Admin- istrative Records	Cognitive Tests	Surveys of Children, Teachers, or Parents	Dietary Intake/ Status	Behavior/ Cognition	Achievement/ Academic Tests	Nutrition/ Health Status
Gibson and O'Sullivan 1995**	X			X	X			X	X			X
Gietzen and Vermeersch 1980***				X		X					X	X
Hunt et al. 1979		X		X	X				X			
Kleinman et al. 1998				X				X		X		
Levine et al. 1989	X		X		X				X	X		X
Levitsky and Strupp 1995*										X		X
Lindeman and Clancy 1990	X			X	X			X		X		
Looker et al. 1997**				X				X				X

*=Review or Summary Article

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***= Longitudinal Study

TABLE I.1 (continued)

Citation (Author and Year)	Dietary Focus		Design		Data Collection				Outcomes			
	Break- fast	SBP/USBP Breakfast	Experi- mental	Non- Experi- mental	Dietary Intake	Admin- istrative Records	Cognitive Tests	Surveys of Children, Teachers, or Parents	Dietary Intake/ Status	Behavior/ Cognition	Achievement/ Academic Tests	Nutrition/ Health Status
Lopez et al. 1993	X		X		X					X	X	X
McIntyre and Horbul 1995	X			X	X			X	X			
McNulty et al 1996	X			X					X			X
Meyers 1989*									X	X	X	X
Meyers et al. 1989		X		X		X	X			X	X	
Michaud et al. 1991	X		X		X		X			X		X
Miller and Korenman 1994** (***)				X				X		X		X
Morgan et al. 1981	X			X	X				X			

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*=Review or Summary Article

**= National Study

***= Longitudinal Study

TABLE I.1 (continued)

Citation (Author and Year)	Dietary Focus		Design		Data Collection				Outcomes			
	Break- fast	SBP/USBP Breakfast	Experi- mental	Non- Experi- mental	Dietary Intake	Admin- istrative Records	Cognitive Tests	Surveys of Children, Teachers, or Parents	Dietary Intake/ Status	Behavior/ Cognition	Achievement/ Academic Tests	Nutrition/ Health Status
Murphy et al. 1998a		X		X		X	X	X		X	X	
Murphy et al. 1998b						X	X	X		X		X
Navia et al. 1997				X	X			X	X			X
Nicklas, et al. 1993	X			X	X			X	X			
Nicklas et al. 1994	X			X	X			X	X			
Nicklas et al. 1998	X	X		X	X			X	X			
Norstrand 1971		X	X				X	X		X	X	
Novello 1992*												X
Pollitt 1988*									X	X	X	X

*=Review or Summary Article

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TABLE I.1 (continued)

Citation (Author and Year)	Dietary Focus		Design		Data Collection				Outcomes			
	Break- fast	SBP/USBP Breakfast	Experi- mental	Non- Experi- mental	Dietary Intake	Admin- istrative Records	Cognitive Tests	Surveys of Children, Teachers, or Parents	Dietary Intake/ Status	Behavior/ Cognition	Achievement/ Academic Tests	Nutrition/ Health Status
Pollitt 1995*	X	X							X	X	X	
Pollitt, Cueto, and Jacoby 1998*			X							X	X	X
Pollitt, Gersovitz, and Gargiulo 1978*		X								X	X	X
Pollitt, Leibel, and Greenfield 1981	X		X				X			X	X	X
Pollitt and Matthews 1998*	X	X							X	X	X	X
Pollitt and Read 1985*									X	X		X

*=Review or Summary Article

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TABLE I.1 (continued)

Citation (Author and Year)	Dietary Focus		Design		Data Collection				Outcomes			
	Break- fast	SBP/USBP Breakfast	Experi- mental	Non- Experi- mental	Dietary Intake	Admin- istrative Records	Cognitive Tests	Surveys of Children, Teachers, or Parents	Dietary Intake/ Status	Behavior/ Cognition	Achievement/ Academic Tests	Nutrition/ Health Status
Powell et al. 1998		X	X			X	X	X		X	X	X
Rogers and Lloyd 1994*	X								X	X		
Sampson et al. 1995	X			X	X				X			X
Shaw 1998***	X			X				X		X		X
Siege-Riz 1998**	X	X		X	X				X			
Simeon and Grantham- McGregor 1989	X		X					X		X	X	X
Simeon 1998***		X		X				X		X	X	X
Smith et al. 1994	X		X		X			X		X	X	X

*=Review or Summary Article

**= National Study

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TABLE I.1 (continued)

Citation (Author and Year)	Dietary Focus		Design		Data Collection				Outcomes			
	Break- fast	SBP/USBP Breakfast	Experi- mental	Non- Experi- mental	Dietary Intake	Admin- istrative Records	Cognitive Tests	Surveys of Children, Teachers, or Parents	Dietary Intake/ Status	Behavior/ Cognition	Achievement/ Academic Tests	Nutrition/ Health Status
Strupp and Levitsky 1995*										X		X
Subar et al. 1998**				X	X				X			
Vaisman, et al. 1996	X		X		X		X			X	X	
Wyon et al. 1987	X		X		X		X	X		X	X	X

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*=Review or Summary Article

**= National Study

***= Longitudinal Study

on the likelihood of eating breakfast, the effects of SBP participation on nutrient intake, the effects of school breakfasts on school outcomes, and the implications of school breakfast findings for the design of the USBP evaluation.

A final chapter, Chapter V, draws implications from the literature for the evaluation design. Appendix A includes the abstract summaries of selected bibliographic citations, including the objective of the article, the sample and data used, outcomes, methodology, main findings, and comments pertinent to the design of a school breakfast evaluation study.

II. NUTRITION AND COGNITIVE DEVELOPMENT

Nutrition plays an important role in children's development, from before birth through infancy, early childhood, and adulthood. However, other environmental factors, such as poverty, family structure and support, and access to care, also affect children's nutritional and health status. Diet has been shown to have both short-term and long-term effects on behavior. Early work in the area of diet and behavior concentrated on malnutrition and cognitive development, especially in young children in developing countries, where the prevalence of hunger and undernutrition is highest. Later work in developed countries focused on the role of malnutrition in determining nutritional status, and on behavioral and cognitive effects.

A. THEORETICAL MODELS

Diet (that is, ingested foods and their nutrients and constituents) provides the energy needed for internal organs and affects metabolic pathways. The brain regulates food intake through complex processes related to thermogenesis, appetite control, and feedback mechanisms that indicate a state of hunger or satiety. The absorption of food causes further signals to the brain via physical, biochemical, osmotic, and hormonal responses (Anderson 1996). The specific content of the food affects certain biochemical and hormonal functions in the body and brain, thus linking diet to behavior and cognition.

Put simply, the most common explanatory model of nutrition and cognition is:

nutrition Æ brain development Æ cognition

Poor nutrition during times of critical brain development affects future cognitive outcomes. Numerous clinical and experimental studies have been conducted on the cognitive effects of early malnutrition (Levitsky and Strupp 1995). Experimental studies have used animals to study the short-term and the long-term, or enduring, effects of early malnutrition. Experimental and clinical findings suggest that attentional

processes, response inhibition, and planning are most vulnerable to early malnutrition. While these studies present a theoretical framework for understanding the complex relationships between nutrition and cognitive development, most cognitive tests used in the animal and human studies are not sensitive to subtle deficits in these functions, and many studies have been confounded by design flaws (Morley and Lucas 1997).

The literature for humans, based primarily on data from developing countries, provides little information about which brain structures or brain functions are affected (Gorman 1995). An alternative model to the one shown above is that the effects of malnutrition are a result of complex interactions between behavior and socioenvironmental factors (Gorman 1995; Pollitt and Mathews 1998; and Connolly and Grantham-McGregor 1993). People may also respond differently, depending upon need and available resources, which makes it difficult to separate the effects of malnutrition from those of other factors.

Other research explores the hypothesis of “functional isolation.” Levitsky (1979) suggests that undernourishment leads to poor motor development and lower activity levels and responsiveness. The lower activity levels, in turn, reduce young children’s exploration of their environment and the stimulation they receive from caretakers; as a result, they experience developmental delays. The evidence for the hypothesis that reduced activity levels are a mediating factor in cognitive development is mixed (Meeks et al. 1995). Regardless of the cause, there is evidence that stunting has effects on motor and cognitive development (Wachs 1995; Simeon and Grantham-McGregor 1990; and Pollitt et al. 1994).

Views about how malnutrition affects long-term nutrition and health have changed since the 1960s. It used to be thought that early malnutrition during critical periods of brain development endured and would result in brain damage or impaired brain function (Strupp and Levitsky 1995). Recent studies suggest, however, that important aspects of cognitive development occur both before and after periods of rapid brain growth, which means that neurological damage from undernutrition may occur at other times as well

(Center on Hunger, Poverty, and Nutrition Policy 1998). On the positive side, though, other study findings indicate that brain structure may recover in the environment of improved nutrition (Levitsky and Strupp 1995). Finally, it also is hypothesized that the types of behaviors and cognitive functions impaired by malnutrition may be more related to emotional responses to stressful events than to cognitive deficits per se.

B. EVIDENCE OF THE RELATIONSHIP BETWEEN NUTRITION AND COGNITIVE DEVELOPMENT

The relationship between nutrition and cognitive development begins as early as pregnancy, if not before. The development of the fetal brain is vulnerable to the mother's nutritional state. Protein-energy malnutrition during fetal development does not typically cause permanent brain damage, but nutrient deficiencies can have major effects (DeLong 1993; and Burger et al. 1993). Worldwide, maternal iodine deficiency contributes to mental retardation and cerebral palsy, as well as reduced cognitive function and school performance in offspring (Morley and Lucas 1997). Deficiencies of a number specific nutrients, most notably folic acid and zinc, have been shown to relate to neural tube defects and impaired brain development in the fetus (DeLong 1993). Animal studies suggest that undernutrition during gestation has the greatest impact on brain growth and long-term neurotransmitter metabolism, but extrapolation of the mechanisms to humans has been difficult. Finally, among other factors, inadequate weight gain and smoking during pregnancy can lead to low birthweight, a risk factor for poor growth and development in infancy and early childhood.

Nutrition during early infancy can further affect the growth and development potential of infants and young children. A healthy infant has nutritional requirements for periods of rapid growth and development. Malnutrition in early life may be directly linked to poor outcomes in cognition or nutritional status in childhood.

During infancy and early childhood, inadequate energy and nutrient intakes have been related to performance on behavioral tests, although causal links in humans have been difficult to establish. The role of protein-energy undernutrition and iron deficiency on later learning and behavior have been extensively studied. Observational studies have shown that children with undernutrition or stunting perform less well on cognitive tests and academic measures than well-nourished children (Morley and Lucas 1997). Low-birthweight children are at particular risk of poor early nutrition.

Breastfeeding patterns may also relate to later cognition and test performance. Studies have shown that breastfed children perform better than non-breastfed children (Morley and Lucas 1997). In these studies, however, it is difficult to disentangle the nutritional effects of breastfeeding from the confounding effects of such factors as the positive stimulation and intimacy of breastfeeding. In addition, mothers who breastfeed are often different from mothers who choose not to breastfeed in terms of education level and attitudes toward nutrition.

Although declining, iron deficiency is still quite common in the United States, particularly for young children, poor children, and adolescent females (Looker et al. 1997; and Centers for Disease Control and Prevention 1998). Iron deficiency anemia is associated with impaired cognitive and behavioral development (Center on Hunger, Poverty, and Nutrition Policy 1998; and Centers for Disease Control and Prevention 1998); iron deficiency is associated with fatigue, weakness, problems concentrating, reduced physical endurance, and lower activity levels (Pollitt and Leibel 1976). Iron deficiency anemia has a negative impact on a child's ability to learn, through poorer attention span and memory, and also increases the risk of lead poisoning (Centers for Disease Control and Prevention 1998). A follow-up study of Costa Rican children with known iron status in infancy found that those with iron deficiency anemia during infancy

had lower scores on mental and motor functioning at school even though they had normal hematological scores at age five (Lozoff et al. 1991).

Until the late 1980s, research focused on testing the validity of the hypothesized relationship between nutrition and behavior or cognitive function (Gorman 1995). More recently, research has examined the impacts of nutritional intervention or supplementation on the overcoming the deficits caused by early undernutrition. Intervention studies in developing countries (Guatemala, Indonesia, Colombia, Taiwan, and Jamaica) and in New York City were conducted during a critical period of brain development (prenatal or infancy) and followed children over time. In general, improvements in achievement tests were observed for those receiving nutritional supplementation, but the effects and study results vary by the length of duration of the supplementation, the length of followup, and socioeconomic and environmental influences.

A follow-up study of Guatemalan children was conducted to determine the influence of early diet and poverty on later intellectual development. Brown and Pollitt (1996) found that nutritional supplements provided early in life can combat the negative effects of poverty, but only somewhat. Children who regularly consumed a highly nutritious supplement before age two performed better on literacy, reading, and other academic tests, regardless of income, compared with children who consumed a less nutritious supplement. Poor nutrition in early childhood was shown to continue to hinder intellectual performance in adulthood, which indicates that deficits persist beyond childhood.

In the United States, mild to moderate undernutrition is most often seen among infants and young children, in the form of low birthweight, intrauterine growth retardation (small size for gestational age), or “failure to thrive” in the period after birth. Although these problems are not confined to poor families, they are strongly associated with poverty. In addition, low height for age (stunting) and low weight for height (wasting) are more prevalent in the United States among poor children than among children who are not

poor; moreover, they are particularly prevalent among those who are persistently poor (Miller and Korenman 1994).

Recent research indicates that undernutrition during any period of childhood, even for relatively short-term episodes, can have negative effects on cognitive development (Center on Hunger, Poverty, and Nutrition Policy 1998). Studies of the effects of nutritional supplementation programs, however, suggest that these programs may ameliorate the effects of nutritional deficits, even if the interventions occur after the early periods of rapid brain growth (Pollitt et al. 1996).

Other studies highlight the relationship between hunger and psychosocial functioning of children. The Community Childhood Hunger Identification Project (CCHIP) found that hungry children were more likely than nonhungry children to be irritable, anxious, and aggressive (Wehler et al. 1992). They also were more likely to be absent from or late to school. Using the CCHIP measure, investigators also found that children who were either hungry or at risk of being hungry were twice as likely as children who were not hungry to be classified as having impaired psychosocial functioning on a variety of standardized symptom checklists, to have repeated a grade in school, and to be receiving special-education services or mental-health counseling (Kleinman et al. 1998a; and Murphy et al. 1998a).

III. CONTRIBUTION OF BREAKFAST

Studies that focus on the role of breakfast typically examine its contribution to daily nutrient intakes and its effects on cognitive functioning. This chapter reviews these studies and their findings.

A. BREAKFAST CONSUMPTION OF CHILDREN

Most children eat something in the morning before school. The School Nutrition Dietary Assessment Study (SNDA-1) found that 88 percent of children consumed at least one food or beverage in the morning (Devaney and Stuart 1998). Elementary school children are even more likely than older students to eat something for breakfast: 93 percent of all elementary school students ate something in the morning before school.

Although most students eat some breakfast, several issues are important to consider in interpreting the prevalence estimates of breakfast consumption of children:

- C What defines breakfast? Is breakfast any food consumed in the morning, or must breakfast provide a minimum amount of food energy and other nutrients that are key to learning and behavior?
- C What are the trends over time in breakfast consumption?
- C Are there differences by demographic and socioeconomic characteristics in breakfast consumption?

Definition of Breakfast. An important issue associated with studies of the contribution of breakfast is how exactly to define it. Should breakfast be defined as consumption of any food item in the morning? Any food item after waking up? Should breakfast have a minimum number of calories, and, if so, what is that minimum?

In general, studies of breakfast consumption fall into two groups: (1) those that focus on whether breakfast is eaten, and (2) those that examine the effects of eating breakfast on various performance measures (Devaney and Stuart 1998). Studies that examine whether or not breakfast is consumed typically use the broader definition of any food or beverage consumed between waking up and the late morning hours. Studies that examine the impact of breakfast on behavior or performance measures typically use a more rigorous definition based on some minimum calorie content or the number of foods and/or food groups consumed. As discussed below, the definition of breakfast has important implications when assessing the prevalence of “skipping breakfast.”

Trends in Breakfast Consumption. Recent studies indicate a decline in breakfast consumption for children and adolescents over the past 25 years. National survey data from 1965 through 1991 indicate that the percentage of elementary school children eating breakfast declined from over 95 percent in 1965 to about 86 percent in 1989-1991 (Siega-Riz et al. 1998). For adolescents, the decline is even greater: in 1965, the percentage of adolescents who ate breakfast was about 87 percent, compared with slightly under 70 percent in 1989-1991.

An interpretation of trends in breakfast consumption must also consider how breakfast is defined. As discussed above, various definitions of eating breakfast exist, ranging from a very broad description of whether any food or beverage is consumed after waking to a more rigorous definition based on a minimum number of calories consumed. Of course, as the definition of breakfast becomes more robust, the percentage of students who eat breakfast declines. Specifically, in SNDA-1, almost 9 of 10 students consumed some food or beverage in the morning, but only 6 of 10 students consumed food from at least two of the main food groups and had breakfast intake of food energy greater than 10 percent of the RDA (Devaney and Stuart 1998).

Demographics and Breakfast Consumption. Several studies find that breakfast skipping varies by demographic and socioeconomic characteristics. In a study of low-income elementary students in Newark, New Jersey, Sampson et al. (1995) estimated that up to one-fourth of low-income children went to school without having had breakfast. The Child and Adolescent Trial for Cardiovascular Health (CATCH) data revealed that 11 percent of Hispanic students and 8 percent of African American students skipped breakfast, compared with none of the Asian American students and 4 percent of Caucasian students (Dwyer et al. 1998). Data from the Bogalusa Heart Study also showed that more blacks (24 percent) than whites (13 percent) skipped breakfast (Nicklas et al. 1998).

The longitudinal study by Siega-Riz et al. (1998) examined in detail the demographic and socioeconomic characteristics associated with skipping breakfast. This study found no differences in breakfast consumption by race or urbanicity. However, children in single-parent households, in households with incomes greater than 350 percent of the poverty index, and in families with fewer than three members were less likely to consume breakfast than children from dual-parent households, with lower-income and larger family size. In addition, eating breakfast was associated with living in a southern state or living with a female head of household with at least a college education. If the female head of household was employed outside the home, the likelihood of eating breakfast decreased.

Some observers conjecture that the downward trend in breakfast consumption may be attributable to the change in demographics. For instance:

- C An increasingly large number of women are in the labor force. In 1960, 28 percent of mothers with children under the age of 18 were in the labor force, compared with 68 percent in 1992.
- C There was a 150 percent increase in the divorce rate from 1960 to 1979.
- C The proportion of out-of-wedlock births increased from five percent in 1960 to over 25 percent in 1990.

These changes have led to a larger number of single-parent households with female heads and to a larger proportion of children living in poverty. Moreover, they have been associated with a growing number of children who are responsible for preparing their own meals.

The decline in breakfast consumption is of interest to the public, policymakers, and researchers because a growing body of research (reviewed in Chapter IV) links breakfast consumption with school performance. An additional consideration is that children's diets may lack the vitamins, minerals, and energy necessary for optimal physical and cognitive development and the prevention of chronic diseases in later life (American Dietetic Association 1999). Another public health concern is the relationship between children's eating habits and physical activity levels and the increase in the number of overweight school-aged children (Office of Disease Prevention and Health Promotion 1999; U.S. Department of Health and Human Services 1996; and Life Sciences Research Office 1995).

B. THE CONTRIBUTION OF BREAKFAST TO NUTRIENT INTAKE OF CHILDREN

Although studies of the nutrient effects of eating breakfast vary considerably in the study populations and data sets used, a consistent finding of these studies is 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 showed that eating breakfast was significantly and positively related to the daily intake of all nutrients examined (Devaney and Fraker 1989). Later studies of breakfast consumption patterns of children also found that total daily intakes of food energy and other nutrients were significantly lower for children who did not consume breakfast compared with children who did consume breakfast, and that children who skipped breakfast did not make up the difference in nutrient intakes at other meals (Nicklas et al. 1993; and Sampson et al. 1995).

Data from the Bogalusa Heart Study show that a large percentage of children who skipped breakfast did not meet two-thirds of the RDA for calcium, thiamin, iron, folacin, zinc, and vitamins A, E, D, and B₆. The largest differences in nutrient intake between breakfast skippers and breakfast eaters were for calcium, phosphorus, magnesium, riboflavin, vitamins B₁₂ and A, and folate (Nicklas et al. 1998 and 1993).

A look at other dietary components shows the effects of eating breakfast to be mixed. Several studies found that the mean daily intakes of sugar, cholesterol, and sodium were significantly higher for those who ate breakfast than for those who did not (Nicklas et al. 1998 and 1993; and Dwyer et al. 1998). Some studies found that the percentage of calories from fat over 24 hours is lower for breakfast eaters than breakfast skippers (Dwyer et al. 1998), while other studies found the opposite (Sampson et al. 1995).

The relationship between breakfast eating and fat intake depends on the foods consumed at breakfast. Some traditional breakfast foods such as eggs and pancakes are often higher in fat than breakfasts made up of lower-fat alternatives, such as ready-to-eat cereal, low-fat milk, and fruit. Given concerns about excess intake of fat, studies on the impact of ready-to-eat cereals on children's dietary intakes are of interest. Studies have examined the extent to which ready-to-eat cereal consumption is related to intakes of fat, vitamins, and minerals. National data from 1989-1991 indicate that ready-to-eat cereals, which are generally fortified with nutrients, are a significant contributor to daily total nutrient intake because of both their nutrient content and the relative frequency of cereal consumption by children (Subar et al. 1998). Ready-to-eat cereals are primary contributors to children's energy, carbohydrate, and fiber intakes, as well as intakes of most vitamins and minerals. For example, data from the 1989-1991 CSFII showed that ready-to-eat cereals provided 27 percent of dietary iron intake in children ages 6 to 11. In addition, cereals are often consumed with milk which, in turn, increases the intake of energy, calcium, and other nutrients such as vitamins A and D.

Seven-day food diaries collected for the Bogalusa Heart Study revealed that children who ate ready-to-eat cereals at breakfast at least three times over a period of one week consumed significantly less fat and cholesterol and significantly more fiber, thiamin, niacin, riboflavin, iron, folacin, pyridoxine, and vitamins A, B₁₂, and D than those who did not eat cereal at breakfast (Nicklas et al. 1994). In fact, breakfasts that include ready-to-eat cereals had higher contents of all essential vitamins and minerals, with the exception of phosphorus and sodium, than those that did not. On the other hand, breakfasts containing no ready-to-eat cereal have higher average contents of calories, protein, fat, cholesterol, and sodium (Morgan et al. 1981).

In summary, breakfast is a significant contributor to the daily intake of essential vitamins and minerals. 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. Mean daily intakes of sodium and cholesterol, however, are higher for breakfast eaters than for breakfast skippers. Evidence on the daily percentage of calories from fat is mixed, depending on the foods eaten at breakfast.

C. EVIDENCE OF THE EFFECTS OF EATING BREAKFAST ON COGNITIVE AND BEHAVIORAL OUTCOMES

The notion that breakfast can affect cognition and behavior dates back at least to the turn of the century. Empirical research aimed at elucidating and testing these effects has continued since the 1930s. Beginning in the late 1970s, and continuing to the present, there has been a succession of increasingly well-controlled studies on the effects of breakfast consumption on mental performance, mood, and scholastic achievement in school-age children. Much of what is currently known regarding the effects of breakfast on cognition can be attributed to the work of Pollitt and his colleagues. A recent review by Pollitt and

Mathews (1998) of 30 studies from the past two decades has provided a useful framework for considering the effects of breakfast on cognition.

A review of breakfast studies indicates that definitive conclusions about the effects of breakfast on cognitive functions are not possible at the present time. The preponderance of evidence suggests that skipping breakfast interferes with cognition and learning, and that this effect is more pronounced in poorly nourished children. However, the effects are subtle and have been difficult to document on a consistent basis. Pollitt and Mathews (1998) summarize the findings as follows:

No definitive conclusions can be drawn from the existing data on either the long- and short-term benefits of breakfast on cognition or the mechanisms that mediate this relation. The data strongly suggest that omitting breakfast interferes with cognition and learning, an effect that is more pronounced in nutritionally at-risk children.

The bulk of the studies to date have approached the question of the contribution of breakfast by studying what happens when children do not eat breakfast. Pollitt and Mathews (1998) group these studies under the heading of the acute effects of breakfast omission on cognitive performance. In addition, a growing body of studies has looked at the effects of glucose administration on cognitive performance.

Cognitive Outcomes. Beginning in the late 1970s, Pollitt published a series of reviews and studies that focused on the effects of breakfast eating and breakfast skipping on tests of attention, visual matching, memory processes, and other cognitive functions of children. Most studies were experiments, carried out in research centers, using a crossover design with random assignment of children to either a breakfast or a fasting condition. In the classic study, Pollitt et al. (1981) reported that children in the breakfast condition were found to perform significantly better than fasting children on a visual discrimination task (Matching Familiar Figures Test [MFFT]) used to measure attention processes, and on the Hagen Central Incidental

Test (HCIT), a test that measures attention processes similar to those assessed by the MFFT, but with an added memory component.

Over the next two decades, variants of this design by the same and other groups of investigators have provided some replication of findings, although some investigators have failed to detect any difference between the fasting and breakfast conditions. As Pollitt and Mathews (1998) note, the most widely studied tasks used in determining the effects of breakfast on memory are those relating to short-term memory. In these studies, diminished speed and accuracy on tests of visual and auditory short-term memory, immediate recall, delayed recall, recognition memory, and spatial memory were observed in child and adult subjects who omitted breakfast (Pollitt et al. 1998; Simeon 1998; Vaisman et al. 1996; Benton and 1998; and Smith et al. 1994 and 1992).

According to Pollitt and Mathews, the pooled findings suggest that attentional processes are also vulnerable to a prolonged fast, with studies showing lowered performance on visual discrimination of competing stimuli (Pollitt et al. 1998; and Simeon 1998), verbal fluency (Simeon 1998; and Grantham-McGregor et al. 1998), arithmetic (Conners and Blouin 1983), and stimulus discrimination (Pollitt et al. 1998).

On the other hand, tasks requiring *sustained* attention (Smith et al. 1992 and 1994) have been shown to be unaffected by skipping breakfast, as have tasks requiring general knowledge retrieval (Simeon 1998; and Smith et al. 1992). An overall absence of any relationship between breakfast omission and cognitive measures of memory, computation, or attentiveness has been reported by a number of investigators (Cromer et al. 1990; Dickie and Bender 1982; Lopez et al. 1993; and Lloyd et al. 1996), although Pollitt and Mathews criticize these studies by stating that, for the most part, they failed to control for potential confounding factors.

In general, the more recent studies of blood glucose as a more controllable marker or proxy for breakfast have shown effects similar to those found for breakfast alone. The cognitive processes of both memory and attention have been found to be affected, although most studies have focused on and found significant associations with memory alone. A group of nine studies reviewed by Pollitt and Mathews (1998) involving the association between cognitive functions and blood glucose usually given in the morning in conjunction with breakfast, or instead of it, have tended to show a significant connection between higher levels of blood glucose and improved memory, particularly on verbal and declarative memory tests (Benton and Parker 1998; and Crafts et al. 1994) and attention (Korol and Gould 1998). Here, too, the results have not been fully consistent, with some studies failing to find the hypothesized connections (Cromer et al. 1990; and Pollitt et al. 1997).

Mood and Behavior. Reports of improved mood and behavior resulting from breakfast go back to the Iowa Breakfast Studies and some of the other early studies of breakfast (Dickie and Bender 1982). In a review five years ago, Pollitt (1995) noted the continuing importance of this area but also a continuing lack of studies. To some extent, this has changed in the past five years.

In a study of 197 Swedish 10-year-old children, Wyon et al. (1997) found that significantly fewer children reported feeling bad and hungry during the morning at school following a high-energy breakfast. Smith and colleagues (1994) reported improved mood following breakfast in a group of university students. Murphy et al. (1998a and 1998b) and Kleinman et al. (1998a) have consistently reported significant associations mood and behavior problems and school breakfast omission and child hunger. However, Michaud et al. (1990), in a study of French schoolchildren, failed to find any effect of breakfast participation on mood.

Health. One of the most important effects of breakfast on cognition and learning may be its indirect link to these outcomes through its broader impact on health. Public health researchers (McGinnis and Forge 1993) and the Surgeon General (U.S. Department of Health and Human Services 1996) link poor diet and lack of exercise as the second leading cause of death and illness in the United States. Since the national educational goals proposed by the U.S. Department of Education now specify a direct link between health and children's ability to learn (Novello et al. 1992), habits that increase student health may thereby also enhance learning.

One of the most important public health studies ever conducted supports the hypothesis that regular breakfast eating is related to health. Beginning in 1965, the Alameda County Study (ACS) followed for 30 years a sample of about 7,000 subjects representative of the adult population of Alameda County, California. Over the past three decades, researchers have mailed surveys every nine years or so and published dozens of articles on the results.

The ACS study was based on the rather simple notion that the greater the number of health practices, the healthier that individuals and the total population would be. The seven primary health habits were (1) never smoked, (2) is physically active, (3) is of moderate weight, (4) is a moderate drinker, (5) sleeps seven to eight hours per night, (6) eats breakfast regularly, and (7) does not snack between meals. Over the past 20 years, most of the individual habits, as well as the total score, have been shown to be related to mortality and disability as well as morbidity (Kaplan 1986). All the individual habits have been validated in other studies, and most, including eating breakfast regularly, have been found to be predictive of health even 20 years after the original surveys.

Summary. While the results are not definite, existing research suggests that breakfast omission does affect the performance of specific cognitive tasks, particularly those involving memory. To this list it is

possible to add mood, behavior, health status, and at least certain types of attention (but not others). There are, however, significant gaps in the understanding of how physiological mechanisms work, and how age, sex, nutritional status, and the timing, size, and composition of the morning meal modify these effects.

IV. CONTRIBUTION OF SCHOOL BREAKFAST

Another critical body of literature for designing the planned USBP evaluation has examined the impacts of breakfasts eaten at schools on such outcome variables as nutrient intake, school attendance, short-term cognitive ability, and longer-term achievement. We review this literature in this chapter.

One important issue is the degree to which eating a school breakfast actually increases the probability of eating a breakfast at all (as compared to substituting for a breakfast at home). Evidence on this issue is considered in Section A below. Relatedly, it is important to consider whether consumption of a school breakfast increases the nutrient intake of students. Section B examines the literature pertaining to this question. Section C then describes in detail the growing literature that has focused directly on whether school breakfasts in general, and USBP programs in particular, have measurable effects on the key outcome variables that will be of interest in the USBP demonstration.

A. EVIDENCE OF THE ROLE OF THE SBP ON EATING BREAKFAST

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 (Dwyer 1996). There is also evidence that SBP participation rates are slightly higher in rural areas (Nicklas 1998). In fiscal year 1998, over seven million children and 68,426 schools participated (Food Research and Action Center 1999).

Data from 1991 showed that, among a sample of third-graders from Texas, Louisiana, California, and Minnesota, about 84 percent of the children who ate breakfast did so at home, compared to 13 percent at school and 3 percent at both home and school (Dwyer 1998). Many of the students eating two breakfasts came from sites with a greater number of low-income schools; thus, it may be that these students

relied on the SBP to supplement their intakes, since they are likely to have come from families with limited access to food at other meals and for snacks (Dwyer 1998).

A study, based on data from the Bogalusa, Louisiana schools, found that the introduction of the SBP dramatically reversed a trend of breakfast skipping among elementary school-aged children (Nicklas 1998). Using data from the Bogalusa Heart Study, the authors of the study projected that 3 million children in the United States would skip breakfast if no SBP were available, but that at least 600,000 of these children would eat breakfast if it were available at school (Nicklas 1998).

Devaney and Stuart (1998a), however, find that whether or not the SBP increases the likelihood of eating breakfast depends on how breakfast is defined. If breakfast is simply defined as any food or beverage consumed in the morning, then it is not associated with an increased likelihood of eating breakfast. When more robust definitions of breakfast are used, such as the intake of food energy greater than 10 percent of the RDA or consumption of foods from at least two of the five major food groups and intake of food energy greater than 10 percent of the RDA, then the SBP is associated with an increased likelihood of eating breakfast for low-income students.

B. EVIDENCE OF THE EFFECTS OF SBP ON NUTRIENT INTAKE

SBP regulations require that school breakfasts provide one-quarter of the RDA for calories, but the breakfasts offered in many schools fall short of that (Dwyer 1996). Hunt (1979) examined the effect of an SBP on African American children and found that, while participation rates were low, the program was successful in increasing the mean morning nutrient intake of children before 10 A.M. Among children consuming less than two-thirds of the RDA for one or more major nutrients, 16 percent from the control school versus 5 percent from the breakfast school had nothing to eat before 10 A.M. In addition, findings

from SNDA-1 showed that SBP participants had significantly higher intakes of energy, protein, thiamin, riboflavin, phosphorus, magnesium, and calcium than nonparticipants (Devaney et al. 1993).

1. No Breakfast Versus School Breakfasts Versus Home Breakfasts

Nicklas et al. (1998) observed a number of differences between the breakfasts served at home and those served at school. Breakfasts served at school contain more calories, protein, carbohydrates (specifically, lactose), and sodium than those served at home. Breakfasts served at home, on the other hand, contain more sucrose, total fat (especially saturated fatty acids), and dietary cholesterol than those served at school. A larger percentage of subjects eating breakfast at home did not meet two-thirds of the RDA for vitamins A and D, calcium, magnesium, thiamin, riboflavin, and zinc than those eating breakfast at school. When subjects consuming school breakfasts were compared to those consuming no breakfast, the school breakfast group had significantly higher mean daily intakes of saturated fatty acids, sodium, carbohydrates, and total fat than did the no-breakfast group. Dwyer et al. (1998), however, did not observe any major differences in nutrient intake between breakfasts eaten at home, at school, or in both of these places, with the exception of iron intake. School breakfasts contributed, on average, significantly less iron than did home breakfasts.

2. Nutrient Content of School Breakfasts

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 (Nicklas 1998). The increase in carbohydrate intake may be attributable to a greater consumption of cereal and fruit. Children are also more likely to drink reduced-fat or low-fat milk rather than whole milk at school (Nicklas 1998; and American Dietetic Association 1999).

Schools have also tried to improve the quality of the food items they serve. The “Eat Smart” program is designed to reduce the amount of total fat, saturated fat, and sodium in school food while increasing the amount of essential nutrients (Dwyer 1996). However, it did not appear to have any substantial impacts on dietary intake at breakfast. Still, downward trends in total and saturated fat were observed, and the authors believe that it may have been partly due to the Eat Smart intervention rather than to secular trends alone.

3. SBP and 24-Hour Dietary Intakes

In examining 24-hour dietary intake data, Devaney (1989a) found that children eating a school breakfast tended to have higher intakes over a 24-hour period than those not eating a school breakfast. While there was some tendency for the effects of the school breakfast to be attenuated when examined over the entire day, estimated effects on nutrient intake were still positive from the full-day perspective.

C. EVIDENCE OF THE EFFECTS OF SCHOOL BREAKFASTS ON SCHOOL OUTCOMES

Chapter III discussed the effects of eating breakfast on behavioral and cognitive outcomes and focused for the most part on individual subject outcomes in experimental situations. The focus now shifts to schoolwide interventions. These interventions involve schoolwide implementations of both Universal-Free School Breakfast Programs (USBPs) and traditional school breakfast programs (SBPs).

In the remainder of this chapter, we first provide an overview of the programs studied, discuss findings for specific outcomes, and then discuss methodological shortcomings of the studies.

1. Overview of Programs and Outcome Studies

The programs that have been examined in the literature are from both the United States and other countries (see Table IV.1). They involve both the traditional school breakfast approach (SBP) and USBP approaches. In most of the reports, the programs were implemented on a schoolwide basis (or on a larger scale, such as a partial-district), but in some programs only certain students (sometimes just one or more classrooms) were provided with the programs. In some of the reports, the outcomes assessed were schoolwide, such as school breakfast participation or attendance rates, and in some the outcomes studied were at the individual level (for example, individual students' scores on psychological tests in schools that did and did not implement the USBP). Types of data vary from existing school records, to whole-school or districtwide administrations of new measures, to large- or small-sample survey questionnaires, to individual interviews and tests.

Lawrence, Massachusetts. The first study of a schoolwide breakfast program was the 1989 report by Meyers and his colleagues (Meyers et al. 1989b) of the free breakfast program that was established in 1986 in Lawrence, Massachusetts. Their findings helped influence government officials in Jamaica and Peru to establish USBPs in a number of pilot schools. These programs were useful in providing academic researchers with subjects with which to test the impact of breakfast on various cognitive outcomes (see Pollitt et al. 1996 and Simeon 1996 for summaries). They also provided data on schoolwide outcomes (Jacoby et al. 1998; and Powell et al. 1998) that are just now becoming available.

Philadelphia. In the United States, the impact of the Meyers et al. (1989) study was at least partially responsible for a pilot program the USDA started in the early 1990s that made it possible for schools with a high percentage of low-income students to provide breakfast and/or lunch free to

TABLE IV.1
STUDIES OF SCHOOL BREAKFAST PROGRAM OUTCOMES

Authors/Date	Location	Number of Schools	Number of Subjects
1. Meyers et al. 1989	Lawrence, MA	3	305 SBP/688 comparison
2. Jacoby et al. 1996	Peru	10	201 SBP/151 comparison
3. Powell et al. 1998	Jamaica	10	408 SBP/408 comparison
4. Murphy et al. 1998	Philadelphia, PA Baltimore, MD	151 10	50 SBP/83 comparison
5. Wahlstrom et al. 1995, 1996, 1997	Minnesota	6	832 SBP/628 comparison
6. Cook et al. 1996	Rhode Island	2	225 SBP/225 comparison
7. Murphy et al. 1999a interviewees	Maryland	6	46 SBP/46 comparison
8. Abell Foundation 1998, student records Murphy et al. 1999b, student data	Baltimore Baltimore	3 31	1,500 SBP/1,500 comparison 15,000 SBP/7,500 comparison
9. Murphy et al. 1999c	Boston	14	In progress, 459 SBP student survey respondents
10. Worobey and Worobey 1997	New Jersey	1	21 SBP/15 comparison

NOTE: First four entries in table are published in peer-reviewed publications; others are unpublished reports.

all students. This approach to administering the school meals program was pilot-tested in Philadelphia, Newark, and a number of smaller school districts beginning in 1991.

Studies in schools with USBPs in Philadelphia have continued until the present. In the most recent and as yet unpublished study, nearly 200 elementary school students from a single school that started a USBP have been studied over the past two years using detailed nutritional assessments obtained through 24-hour recalls based on student interviews. These interviews also assessed child hunger and self-reports of psychosocial symptoms using standardized questionnaires. Students' height, weight, and skinfold thickness were assessed by the school nurse, and the relationships among these measures is being assessed.

Minnesota. In 1994, the Minnesota state legislature authorized funding for a pilot study of a USBP that was eventually implemented in six schools around the state. Although this program was much smaller than the USBPs in Philadelphia and Newark, funding for an evaluation was provided, and researchers from the University of Minnesota collected a wide range of data from the six schools, including official school data on breakfast participation and test scores; surveys of staff, parents, and students; and interviews and focus groups with staff.

These findings were written up in three yearly reports by Wahlstrom and her associates (1995, 1996, and 1997) and summarized by officials from the state department of education in an eight-page full-color brochure that has been widely distributed over the past four years (Minnesota Department of Children, Families, and Learning, various editions from 1994 to 1998).

Rhode Island. In 1994, a coalition of community groups decided to provide a USBP in Central Falls, Rhode Island. Researchers from the Tufts University Center on Hunger, Poverty, and Nutrition Policy were asked to provide a basic evaluation. The findings of this evaluation are summarized in a brief

report (Cook et al. 1996) and contain treatment-versus-control-group differences in a number of important areas.

The investigators document statistically significant increases in school breakfast participation, a significantly larger decline in tardiness in the USBP as opposed to the control schools, and significantly larger decreases in tardiness and absence rates for USBP-versus-non-USBP students.

Baltimore. Also beginning in 1994, an anti-hunger group in Baltimore received funding to pilot test a USBP in several Baltimore city public schools. Although there was no intended evaluation of this project, advocacy group staff and officials from the Baltimore Public Schools joined forces with the same team of academic researchers who were working with the Philadelphia public schools in the project described above, to study the effects.

The initial gains in school breakfast participation in the Baltimore schools appeared to be small. However, the school food service became interested in a new approach that not only made breakfast free but also provided it in each student's homeroom. This classroom breakfast approach led to much larger gains in participation, and the research team was able to detect changes in schoolwide outcomes like attendance, tardiness, and disciplinary-incident rates. These findings were summarized in the Abell Foundation's newsletter (1998).

Both the large increase in participation and the possibility of improved outcomes led to the expansion of the program, and funding from the Kellogg Corporation allowed the research team to continue to track outcomes. In fall 1998, the Baltimore City School district added 31 new schools to its in-classroom USBP. Although the study is still in progress, results to date have been summarized in a report by Murphy et al. (1999c).

Maryland, Beyond Baltimore. The interest generated by the Baltimore study fueled a long-standing interest by Maryland state officials in such programs, and in fall 1998 they were able to fund a USBP program in six school districts around the state. State officials contracted with the academic researchers who had been conducting the Baltimore evaluation to evaluate this Maryland “Meals for Achievement” program. Preliminary results of this program, which is also still in progress, have been summarized by Murphy et al. (1999b).

The Maryland evaluation, though significantly smaller than Minnesota’s, was able to build on the methods and results of the Minnesota study. In particular, instruments from the Minnesota study were adapted for student, parent, and staff survey questionnaires asking for assessments of the program’s impacts on student learning, attention, behavior, hunger, complaints of aches and pains, and satisfaction with the program. An innovation of the Maryland study was the addition of a matching “control” school in each of the six districts, which made possible a number of comparisons on these measures that had not been done before.

Interviews with students and their parents assessed psychosocial functioning and child hunger. Also, individual school record data collection included students’ absences and tardiness, as well as grades in all subjects for the first year of USBP and the year before. Schoolwide rates of absence, tardiness, disciplinary incidents, and standardized test scores (both commercial and state tests) have been collected and are being analyzed, as are changes in all these indicators based on follow-up interviews and further school record reviews at the end of the first year of the USBP. The MMFA program and its evaluation have been continued for 1999-2000, and schoolwide data and surveys will be collected through a second year in both old and new schools.

Massachusetts. When the Massachusetts state legislature authorized a pilot USBP program for 50 schools from around the state, officials from the Boston public schools collaborated with an anti-hunger organization to set up a program in 14 schools (5 elementary and 9 middle schools) beginning in December 1998. It was decided to track outcomes before and after the start of the USBP program.

The evaluation design is very similar to the one being used in Maryland, including the use of student, parent, and staff surveys to assess changes in behavior and attention, as well as comparisons with matched control schools for the analysis of changes in schoolwide outcomes like attendance rates and test scores. Also as in the Maryland evaluation, individual interviews with students and parents will assess changes in nutritional status and in psychosocial functioning associated with breakfast participation.

2. Effects of School Breakfast on Attendance and Tardiness

USBP participation is associated with higher rates of attendance (Abell Foundation 1998; Cook et al. 1996; Jacoby et al. 1996; Meyers et al. 1989; Murphy et al. 1998a, 1999; and Powell et al. 1998). Several studies also found that participation is associated with declines in tardiness (Abell Foundation 1998; Cook et al. 1996; Meyers et al. 1989; Murphy et al. 1998b, and Murphy et al. 1999). The size of these effects is moderate, and some of the studies either did not conduct significance tests or had relatively small samples and did not find the effects to be statistically significant. However, since the findings are shared by many studies, based on different samples and using different methodologies, the overall finding that breakfast program participation leads to higher attendance and less tardiness is credible. This conclusion is shared by the most recent major review of this literature prior to the current project (Pollitt and Mathews 1998).

3. Effects of School Breakfast on Cognition and Academic Achievement

The estimated effects of participation in school breakfast programs on academic achievement have been mixed in previous studies. Meyers et al. (1989) found the largest effects, with participation in the regular SBP estimated to lead to a significant increase of 10 percent of a standard deviation in a child's battery score on the Comprehensive Test of Basic Skills (CTBS). Even this study, however, failed to find statistically significant effects of participation on the subtests that make up the CTBS: participation was estimated to have positive, but not significant, effects on language and math subtest scores, and essentially no effect on the reading subtest score.

Two other studies of USBP programs in the United States are relevant. Murphy et al. (1998a) did not examine test scores but found that USBP participation in two large eastern cities was positively and significantly related to students' math grades. In addition, Wahlstrom et al. (1997) presented data on mean test scores before and after USBP implementation in several USBP and comparison schools in Minnesota. However, this study conducted no significance tests and made no claims about the implications of these data with respect to the effects of the USBP on academic achievement.

Other studies of the effects of breakfast program participation on academic achievement were based on foreign programs. Powell et al. (1983) found that participation in the Jamaican school breakfast program was positively and significantly related to arithmetic test scores, but this study failed to find significant effects on spelling and reading test scores. A later study by Powell et al. (1998) found that participation in the Jamaican program was not significantly related to test scores overall, although it was positively and significantly related to test scores among younger children. Finally, Jacoby et al. (1996) found that participation in the Peruvian breakfast program was not significantly related to achievement

overall, although they did find positive effects on vocabulary scores among a subset of heavier children they hypothesized to be undernourished.

Two studies focused on the effects of breakfast program participation on short-term cognitive outcomes. Like the studies on academic achievement, the findings of these studies have been mixed. Jacoby et al. (1996) found that participation in the Peruvian breakfast program was insignificantly related to student performance on a coding test (the only short-term cognitive outcome they examine). Chandler et al. (1995) found that participation in the Jamaican breakfast program had positive and significant effects on a verbal fluency test, but was insignificantly related to performance on three other short-term cognitive tests. The authors of this study noted that their finding of a positive effect on verbal fluency was consistent with another Jamaican study (Simeon and Grantham-McGregor 1989) that examined the effects of eating breakfast versus no breakfast on cognitive outcomes. The authors also hypothesized that the effects of participation were limited to only verbal fluency because it was the only one of the four cognitive outcomes examined that did not rely on students' reactions to external stimuli but instead involved "initiating and maintaining a mental process in the absence of any externally based organization." No U.S. studies of SBP participation have examined how participation affects cognitive functioning.

Finally, a few studies have also examined the effects of breakfast program participation on other, related outcomes. Murphy et al. (1999) and Wahlstrom et al. (1997) found that being in a USBP school was associated with decreases in nurse visits and improvements in teacher and parent perceptions of the learning environment in school (although these relationships were not statistically significant). Murphy et al. (1998b) and Murphy et al. (1999) found that USBP participation was significantly associated with children's psychosocial outcomes, arguing that the program led to lower levels of such symptoms as anxiety, hyperactivity, childhood depression, and psychosocial dysfunction.

4. Methodological Issues

Several design and methodological issues are important for understanding the existing evidence on the effects of school breakfasts on school outcomes and planning for a rigorous, definitive evaluation of the USBP. These issues are:

- C ***Limited Attention Devoted to Any One Outcome.*** Only a relatively small number of studies have examined the effects of school breakfasts on any given outcome (except for attendance/tardiness).
- C ***Differences in the Breakfast Program Interventions.*** Previous studies have examined different types of breakfast programs serving specific populations. Their applicability to implementing a USBP is uncertain.
- C ***Nonexperimental Designs.*** Most of the studies used nonexperimental designs that were potentially subject to selection bias.
- C ***Small Sample Sizes and Inappropriate Statistical Tests of Significance.*** Existing studies often analyzed small samples of both students and schools, and most did not adequately account for their clustered samples in their significance testing.

Each of these issues is discussed below.

Relatively Small Number of Studies Have Been Conducted on School Outcomes. Compared with the number of studies examining the effects of eating breakfast on behavioral and cognitive development or the general link between nutrition and cognitive development, a relatively small number of studies examined the effects of *school breakfasts* on these outcomes. For example, only two studies of the SBP examined how participation influenced achievement test scores, and no studies of the SBP focused on short-term cognitive outcomes. Similarly, two studies examined students' psychosocial outcomes, and another two focused on students' visits to the school nurse. Given some of the methodological limitations of these studies, the fact that they are also few in number makes drawing definitive conclusions from them difficult.

Differences in the Program Interventions. An important consideration is that breakfast feeding programs (and their evaluations) vary considerably in the populations served and the intervention provided. Many of the existing studies focus on breakfasts provided to children in developing countries (Chandler et al. 1995; Jacoby et al. 1996; and Powell et al. 1998). Although these studies provide useful information, one cannot necessarily infer the effects of participation in the SBP on the basis of the estimated effects of the Jamaican or Peruvian school breakfast programs.

Even those studies of the SBP vary from what might be expected from a USBP. One of the strongest studies--the study of the impacts of introducing a SBP in Lawrence, Massachusetts (Meyers et al. 1989)--compared outcomes among low-income students after the SBP program was implemented with outcomes before the SBP. It is not clear whether the effects of participating in a USBP, which is most likely to be implemented in a school already operating the SBP, would be the same as the effects of participating in the regular SBP.

Nonexperimental Design. Existing studies of the SBP have used nonexperimental designs: individual students (or schools) chose on their own whether or not to participate in the program. Thus, there was no guarantee that program participants were similar to nonparticipants, and this design necessitated controlling for relevant preexisting differences between the two groups when measuring differences between the groups in the outcome measures. The studies controlled for the preexisting differences in a variety of ways, although most used some sort of pre-post design among both treatment group and control group members. However, each of these studies is subject to the potential criticism that its findings are driven more by the preexisting differences between participants and nonparticipants than by the effects of the breakfast program. The internal validity of these studies is not as great as the internal validity of the experimental studies.

Small Sample Sizes. Even if the studies properly controlled for all relevant pre-existing differences between participants and non-participants (or used an experimental design), it was necessary to statistically test for whether the resulting differences between the two groups in outcome measures were due to the effects of the program rather than being due to chance. In general, the larger the samples used by the studies, the smaller the likelihood that an estimated effect of a given size was due to chance. If the results of these studies were to be generalized beyond the specific sites (and the specific points in time) in which the programs were being examined, the size of both the sample of schools being studied and the sample of students being studied are relevant. However, most of the studies used relatively small samples. For example, Murphy et al. (1998) analyzed a sample of 133 students in 3 schools, Powell et al. (1983) analyzed a sample of 115 students in a single school, and the Abell Foundation (1998) analyzed school-wide data from just 3 USBP and 3 non-USBP schools. Even in studies that used large samples of students, these students came from relatively few schools. For example, Meyers et al. (1989) analyzed a sample of over 1000 students, but these students came from just 6 schools within a single school district.

Inappropriate Significance Tests. In principle, tests of statistical significance allow researchers to determine the extent to which they can be confident that their estimates reflect the true effects of participation rather than random chance, and these significance tests take into account the sample sizes of students. In practice, however, the significance tests used in these studies appeared to take advantage of the assumption that their observations on students' outcomes and characteristics were statistically independent of one another.¹ For a sample of students drawn from within a single school, this might be a

¹The studies did not present sufficiently detailed descriptions of their methodologies to determine whether this assumption was maintained throughout their analysis. However, this assumption is commonly made in significance testing and most of the studies made no mention of relaxing it. Furthermore, the studies achieved levels of statistical significance that would have been unlikely had they dropped this assumption of independence.

reasonable assumption (although the results of the analysis of such a sample would not be generalizable beyond that school). However, most of the studies drew their samples from more than one school. In this case, one would expect the outcomes among students attending the same school to be related to one another, due to school-wide characteristics that affected all students within the school. For example, the curriculum in a one school may have been particularly strong, so that sample members drawn from that school may have all had relatively positive outcome values. Given the relatively small samples of schools in these studies, properly taking into account this correlation across different sample members within the same school would likely have led to dramatically lower significance levels.

V. IMPLICATIONS FOR USBP EVALUATION DESIGN

The studies reviewed in previous chapters, particularly those discussed in Chapter IV, have important implications for the design of the USBP evaluation. In this concluding chapter, we highlight some of the most important implications, particularly as they relate to data collection issues. Section A discusses implications for what administrative variables should be examined in the planned evaluation. Section B examines implications for measuring cognition and achievement. Finally, Section C examines implications for collecting data on survey-related variables.

A. ADMINISTRATIVE DATA

A wide range of school administrative data have been used effectively in earlier evaluations related to the school breakfast program. These are discussed below.

1. School Breakfast Participation

Previous studies (Wahlstrom et al. 1997; and Murphy et al. 1999a and 1999b) have shown that participation can increase by as much as 400 percent (for example, from 20 percent to 80 percent of all students eating breakfast at school each day) when a free breakfast is made a part of the school day, or as little as 35 percent (McGlinchy 1986; and Murphy et al. 1999c [Boston]) when it is simply provided free to all without additional interventions.

School breakfast participation will probably increase in the planned USBP demonstration. However, whatever the outcome, the evaluation must document what happens to school breakfast participation rates using readily understandable figures. The past studies suggest that the district food service directors can

be asked to supply average daily breakfast participation and general enrollment for each school for the year prior to the implementation of USBP, as well as for every year of the program.

2. Attendance

One of the most consistent findings of earlier breakfast program studies has been its positive impact on student attendance (Pollitt 1998; Abell Foundation 1998; Meyers et al. 1986; and Murphy et al. 1998 and 1999b [Maryland]). Attendance improvement is likely to play an important role in descriptions of the benefits of the program. Past studies have examined both absences and tardiness as attendance indicators. This information is routinely collected for almost all schools and is well accepted by educators as important in and of itself and as an enhancer of other positive educational outcomes. In addition, attendance information is relatively easy and inexpensive to collect. Besides aggregate, schoolwide data, obtaining releases of data on individual students should also be considered, although this requires more work.

3. Administrative, or Aggregate, Data on Standardized Tests of Academic Functioning (Commercially Distributed)

Previous studies have reported significant differences between SBP and non-SBP participants on the Comprehensive Test of Basic Skills (CTBS; Meyers et al. 1989), and increases in standardized test score percentiles over time for math and reading on other tests used by participating districts, including the Iowa, California, Stanford, and Metropolitan tests (Wahlstrom et al. 1997). However, Murphy et al. (1999c) in Baltimore found no greater increases in CTBS reading or math scores in the 31 schools that adopted a USBP program than in 15 similar comparison schools that did not adopt the USBP program. The absence of positive findings in that study replicates the absence of positive findings on the Wide Range Achievement Test of Reading, Math, and Spelling in the Jamaican study by Powell et al. (1998).

Despite this ambiguity in past results, the attention given to these test scores in past work highlights the importance of obtaining them from the participating school districts that already administer them. This was the approach of Wahlstrom et al. (1997) in the Minnesota study.

4. Administrative, or Aggregate, Data on Standardized Tests (State Provided/State Specific)

Most of the discussion in the previous section applies to another type of standardized test--that is, state competency, or achievement, test. Many states currently test the students in some grades (such as 4th, 8th, or 12th) or all grades every year in basic areas like reading and math on a competency test developed for the specific states. A number of the studies in progress in Maryland, Baltimore, and Boston (Murphy et al. 1999a, 1996b, and 1999c) are planning to compare pre-post changes in state competency test scores for the USBP and comparison schools, although Murphy et al. 1999c (Baltimore), the only study that has looked at this kind of data, did not find any greater improvement in the USBP sample.

This previous work suggests that it is relatively inexpensive to collect the schoolwide data from these tests from the school districts in the states that use them. Since many observers will ask about them, they should be collected.

5. Grades

Murphy et al. (1998) reported that school breakfast participation and increases in participation were associated with increases in math grades (but not with grades in other subjects) from the semester before the USBP started to the end of the first semester of the program. The experiences of this and other past studies suggest that, while data on grades can be successfully obtained, the cost of data entry and analysis of grade data for each student can be considerable, given the large number of subjects, terms, and years covered by the study.

6. Tardiness

Tardiness, an important variable widely recognized as an indicator of student and school functioning, has been used in a number of past studies (Abell Foundation 1998; Meyers et al. 1986; and Murphy et al. 1998). However, many school districts do not collect data on tardiness, which suggests that new data collection procedures will be needed if this information is needed for all schools involved in the USBP evaluation.

7. Nurse Visits

Two studies have shown that USBP participation is associated with a decrease in the number of visits to the school nurse (Wahlstrom et al. 1997; and Murphy et al. 1999 [Maryland]). Attention had to be paid to controlling for routine administration of medications such as Ritalin and insulin (which should not decrease with improved student health) versus complaints of hunger or aches and pains (which should decrease if students feel better). Wahlstrom mailed a questionnaire to school nurses at the end of the year asking them to specify the reason for each student visit to the school nurse (contagious disease, injury, minor illness, acute illness, or other), broken down if possible by morning versus afternoon, and excluding children who were seen for health screens, medication administration, and so forth. Considerable work was involved in collecting this information.

8. Height/Weight and Other Anthropometric Measures

Murphy et al. (1991), in their study of a USBP program in a Philadelphia school, collected information on height, weight, and skinfold thickness. Although the data have not been fully analyzed, they document the prevalence of obesity in the Philadelphia sample and will provide an opportunity for investigators to

control for under- and overweight in their analyses of individual student data on nutrition, breakfast participation, and so forth.

Height and weight could potentially be obtained in much the same way as the data on nurse visits. Since many schools routinely weigh and measure their students at least once each year, anonymous data can be requested for all students in each school. The release of individual-level data would require parental consent.

9. Disciplinary Incidents

Disciplinary incidents are another indicator that can be obtained from principals, based on existing or new administrative data. Three studies (Minnesota (Wahlstrom et al. 1997), Maryland [Murphy et al. 1999a]; and Baltimore [Abell Foundation 1998]) have reported decreases in the number of disciplinary incidents at school. This kind of data provides a useful yardstick of student behavior. These past studies suggest that information on most incidents is routinely recorded by most schools, so obtaining it should be straightforward and inexpensive. However, there is little standardization across schools or districts.

B. OBTAINING DATA THROUGH TESTS ADMINISTERED SPECIFICALLY FOR THE EVALUATION

As noted above, several studies have found it useful to draw upon aggregate data from standardized commercial tests that were already being used within the school districts being studied. However, it is very unlikely that all school districts in the USBP demonstration will be using the same test, and thus reliance on these tests will involve using different test indicators for different schools, which, while possibly feasible, is clearly less than ideal. This raises issues of the feasibility and desirability of administering a common set of tests in all the USBP and comparison schools.

The experience of the past studies discussed earlier suggests that this is feasible. Among the tests that can be used are the Comprehensive Test of Basic Skills, the Iowa Tests, and the Metropolitan Achievement Test.

However, administering these tests can be very expensive and time-consuming. The experience of one of the studies that we reviewed suggests the benefits of using a briefer alternative. An alternative to the classic, full assessment batteries like the CTBS, which require considerable student time to complete, is several briefer ones. As noted above, the Jamaican study cited by Powell and her associates used the Wide Range Achievement Test (WRAT) of reading, spelling, and math to assess pre/post-USBP changes to assess academic progress. The advantage of the WRAT is that it is much shorter, with an administration time of about 30 minutes. For at least the arithmetic and reading subtests, group administration is possible. The WRAT and other tests like it provide a less time-intensive alternative to full-scale tests like the CTBS.

C. SURVEYS OF SCHOOL STAFF

The studies reviewed above also suggest that survey methods can be used effectively to obtain data to support the planned USBP evaluation. Classroom teachers have extensive information about students' classroom participation and behavior.

The earlier studies in Minnesota (Wahlstrom et al. 1997), Maryland (Murphy et al. 1999a, Baltimore (Murphy et al. 1999b) and Boston (Murphy et al. 1999c) have used questionnaire surveys to obtain ratings of student learning, attention, and behavior. In all these studies, teachers filled out brief survey forms that asked them to rate whether students' learning, behavior, attitudes, discipline, or attention had improved since the start of the SBP.

The Baltimore USBP study surveyed school principals. Those in the control schools reported lower levels of positive change than principals in the USBP schools, although none of these differences attained

statistical significance in this very small sample. The SBP study of 59 teachers and administrators by Norstrand (1971) also reported more positive ratings of improvements in student learning and adjustment, although statistical significance tests were not performed.

D. OBTAINING DATA ON STUDENT MOOD, STUDENT BEHAVIOR, AND SHORT-TERM COGNITIVE OUTCOMES

Several studies have found that school breakfast participation is related to better psychosocial functioning. Implications for the planned evaluation are considered here.

1. Parent Reports on Measures of Mood

During the early and mid-1990s, at least two different studies reported statistically significant associations between breakfast consumption or eating larger breakfasts and better mood. These studies involved items providing bipolar line ratings of 18 feelings, such as tense-calm (Smith et al. 1994) and items asking students whether they had felt good/bad or hungry the previous day in the late morning (Wyon et al. 1997).

Kleinman and Murphy have built on this work and found significant relationships between school breakfast participation and well-validated parent- and student-completed questionnaires in several different studies. Scores on the Pediatric Symptom Checklist (PSC; Jellinek and Murphy 1988), a one-page list of a broad range of emotional and behavioral problems, were found to be related both to staff reported rates of pre-USBP school breakfast consumption in one published study (Murphy et al. 1998) and one unpublished study (Murphy et al. 1999a) of USBP and to staff-reported increases in school breakfast consumption after the USBP started (Murphy et al. 1998a). Kleinman and Murphy used other parent-completed measures in their studies, including the Child Behavior Checklist (CBCL; Achenbach 1991).

This past work suggests the potential usefulness of including questions about the student's mood, if a parent survey is conducted in the USBP evaluation.

2. Student Reports on Measures of Mood

The Revised Children's Manifest Anxiety Scale (RCMAS; Reynolds 1985) and the Children's Depression Inventory (CDI; Kovacs 1985) are student self-report measures that have both been shown to be related to school breakfast participation (Murphy et al. 1998b). A different student self-report measure (the youth self-report version of the PSC) has been used in more recent USBP evaluations, and this measure has not been found to have statistically significant associations with school breakfast participation.

3. Teacher Reports on Behavior

The Connors Teachers Rating Scale (CTRS-39) is a measure that has been widely used over the past 20 years in a variety of studies to assess classroom attention and hyperactivity in students. Two published studies (Murphy et al. 1998b; and Lindeman and Clancy 1990) found improvements in classroom behavior associated with school breakfast on the CTRS, although on differing subscales, but these differences failed to reach statistical significance in the latter study.

4. Cognitive Tests

Cognitive tests like the MFFT, used successfully by Pollitt and others to obtain the effects of breakfasts, could be added to the USBP evaluation interviews that are conducted with individual students. This suggests that these tests be considered for the USBP evaluation, although none have been used in studies of school breakfast programs.

E. PARENT, STUDENT, AND STAFF RATINGS OF SATISFACTION WITH USBP

Most of the recent studies (Wahlstrom et al. 1997; and Murphy et al. 1999a, 1999b, and 1999c) have also used brief questionnaires to assess the satisfaction of various groups like parents, teachers, and students with the USBP. Although satisfaction is not an educational outcome per se, it may be useful for local and national planners to consider.

REFERENCES

- Abell Foundation. "Data from Abell Foundation Project Concludes: Changes in Student Breakfast Program Will Increase Participation and Improve Student Performance." *The Abell Report*, February/March 1998, 11, pp. 1-7.
- Achenback 1998. Reference forthcoming in next version of report.
- American Dietetic Association. "Position of the American Dietetic Association: Dietary Guidance for Healthy Children Aged 2 to 11." *Journal of the American Dietetic Association*, vol. 99, 1999, pp. 93-101.
- Anderson, G.H. "Hunger, Appetite, and Food Intake." In *Present Knowledge of Nutrition*, edited by E.E. Ziegler, and L.J. Filer. Washington, DC: ILSI Press, 1996.
- Benton, D., and P.Y. Parker. "Breakfast, Blood Glucose, and Cognition." *American Journal of Clinical Nutrition*, vol. 67, April 1998, pp. 772S-778S.
- Brown, J.L., and E. Pollitt. "Malnutrition, Poverty and Intellectual Development." *Scientific American*, vol. 274, February 1996, pp. 38-43.
- Brown, J.L., and L.P. Sherman. "Policy Implications of New Scientific Knowledge." *Journal of Nutrition*, vol. 125, August 1995, pp. 2281S-2284S.
- Burger, S.E., J.D. Haas, and J.P. Habicht. "Testing the Effects of Nutrient Deficiencies on Behavioral Performance." *American Journal of Clinical Nutrition*, vol. 57, 1993, pp. 295S-302S.
- Center on Hunger, Poverty and Nutrition Policy, Tufts University. "The Link Between Nutrition and Cognitive Development in Children." Tufts University, 1993.
- Center on Hunger, Poverty and Nutrition Policy, Tufts University. "The Link Between Nutrition and Cognitive Development in Children." Tufts University, 1994.
- Center on Hunger, Poverty and Nutrition Policy, Tufts University. "The Link Between Nutrition and Cognitive Development in Children." Tufts University, 1998.
- Centers for Disease Control and Prevention. "Recommendations to Prevent and Control Iron Deficiency in the United States." *Morbidity and Mortality Weekly Report*, vol. 47, no. RR-3, pp. 1-29, 1988.
- Centers for Disease Control and Prevention. "Guidelines for School Health Programs to Promote Lifelong Healthy Eating." *Morbidity and Mortality Weekly Report*, vol. 45, no. RR-9, June 14, 1996.

- Centers for Disease Control and Prevention. "Recommendations to Prevent and Control Iron Deficiency in the United States." *Morbidity and Mortality Weekly Report*, vol. 47, no. RR-5, pp. 1-30, April 3, 1998.
- Center for Nutrition Policy and Promotion. "Breakfast and Learning in Children, Symposium Proceedings, April 22, 1999." U.S. Department of Agriculture, September 1999.
- Chandler, A.K., S.P. Walker, K. Connolly, and K. Grantham-McGregor. "School Breakfast Improves Verbal Fluency in Undernourished Jamaican Children." *Journal of Nutrition*, vol. 125, April 1995, pp. 894-900.
- Connolly, K.J., and S.M. Grantham-McGregor. "Key Issues in Generating a Psychological-Testing Protocol." *American Journal of Clinical Nutrition*, vol. 57, 1993, pp. 317S-318S.
- Connors, C.K., and A.G. Blouin. "Nutritional Effects on Behavior of Children." *Journal of Psychiatric Research*, vol. 17, 1982/1983, pp. 193-201.
- Cook, J.T., O. Punam, and G.L. Kelly. "Evaluation of a Universally-Free School Breakfast Program: Central Falls, Rhode Island." Center on Hunger, Poverty and Nutrition Policy, Tufts University School of Nutrition Science and Policy, January, 1996.
- Crafts, T. "Breastfeeding: Food for Thought." *Midwifery Today and Childbirth Education*, vol. 29, no. 38, spring 1994.
- Craig, A. "Acute Effects of Meals on Perceptual and Cognitive Efficiency." *Nutrition Reviews*, vol. 44 (supplement), May 1986, pp. 163-171.
- Cromer, B.A., K.J. Tarnowski, A.M. Stein, P. Harton, and D.J. Thornton. "The School Breakfast Program and Cognition in Adolescents." *Journal of Developmental and Behavioral Pediatrics*, vol. 11, no. 6, December 1990, pp. 295-300.
- Dairy Council. "Breakfast: Its Effects on Health and Behavior." *Dairy Council Digest*, vol. 64, 1993, pp. 7-12.
- DeLong, G.R. "Effects of Nutrition on Brain Development in Humans." *American Journal of Clinical Nutrition*, vol. 57, no. 2 (supplement), February 1993, pp. 286S-290S.
- Devaney, Barbara, and Thomas Fraker. "The Dietary Impacts of the School Breakfast Program." Report submitted to the U.S. Department of Agriculture, Food and Nutrition Service. Princeton, NJ: Mathematica Policy Research, Inc., October 1986.
- Devaney, Barbara, and Thomas Fraker. "The Dietary Impacts of the School Breakfast Program." *American Journal of Agricultural Economics*, vol. 71, no. 4, November 1989, pp. 932-948.

- Devaney, Barbara, Anne Gordon, and John Burghardt. *The School Nutrition Dietary Assessment Study: Dietary Intakes of Program Participants and Nonparticipants*. Alexandria, VA: U.S. Department of Agriculture, Food and Nutrition Service, Office of Analysis and Evaluation, October 1993.
- Devaney, Barbara. "Recommendations for Defining Breakfast." Memorandum from Barbara Devaney to Patricia McKinney, April 17, 1998a.
- Devaney, Barbara, and Elizabeth Stuart. "Eating Breakfast: Effects of the School Breakfast Program." Report submitted to the U.S. Department of Agriculture, Food and Nutrition Service. Princeton, NJ: Mathematica Policy Research, Inc., July 13, 1998.
- Dickie, N.H., and A.E. Bender. "Breakfast and Performance." *Human Nutrition: Applied Nutrition*, vol. 36A, 1982a, pp. 46-56.
- Dickie, N.H., and A.E. Bender. "Breakfast and Performance in Schoolchildren." *British Journal of Nutrition*, vol. 48, November 1982b, pp. 483-496.
- Dwyer, Johanna T., Lynn Hewes, Paul Mitchell, et al. "Improving School Breakfasts: Effects of the CATCH Eat Smart Program on the Nutrient Content of School Breakfasts." *Preventive Medicine*, vol. 25, 1996, pp. 413-422.
- Dwyer, Johanna T., Mary Kay Ebzery, Theresa Nicklas, et al. "Do Third Graders Eat Healthful Breakfasts?" *Family Economics and Nutrition Review*, vol. 11, no. 4, 1998, pp. 3-18.
- Food Research and Action Center (FRAC). "The Relationship Between Nutrition & Learning: A School Employee's Guide to Information and Action." Prepared for the National Education Association, 1989.
- Food Research and Action Center. "Federal Food Programs: School Breakfast Program." In [http://www.frac.org/html/federal_food_programs/programs/sbp.html]. 1999.
- Gibson, S.A., and K.R. O'Sullivan. "Breakfast Cereal Consumption Patterns and Nutrient Intakes of British Schoolchildren." *Journal of the Royal Society of Health*, December 1995.
- Gietzen, D., and J.A. Vermeersch. "Health Status and School Achievement of Children from Head Start and Free School Lunch Programs." *Public Health Reports*, vol. 95, no. 4, July-August 1980, pp. 362-368.
- Gorman, K. "Malnutrition and Cognitive Development: Evidence from Experimental/Quasi-Experimental Studies Among the Mild-to-Moderately Malnourished." *Journal of Nutrition*, vol. 125, 1995, pp. 2239S-2244S.

- Grantham-McGregor, S.M. "Evaluation of School Feeding Programs: Some Jamaican Examples." *The American Journal of Clinical Nutrition*, vol. 67, no. 4, 1998, pp. 785S-789S.
- Hunt, Isabelle, Harry Lieberman, Anne Coulson, Norma Murphy, and Virginia Clark. "Effect of a Breakfast Program on the Nutrient Intake of Black Children." *Ecology of Food and Nutrition*, vol. 8, 1979, pp. 21-28.
- Jacoby, E., S. Cueto, and E. Pollitt. "Benefits of a School Breakfast Program Among Andean Children in Huaraz, Peru." *Food Nutrition Bulletin*, 1996, vol. 17 pp. 54-64.
- Jellinek, M.S., and J.M. Murphy. "Screening for Psychosocial Disorders in Pediatric Practice." *American Journal of Dis. Child.*, November 1998, pp. 1153-1157.
- Kaplan, G.A., and T.C. Camacho. "Perceived Health and Mortality: A Nine Year Follow-Up of the Human Population Laboratory Cohort." *American Journal of Epidemiology*, vol. 117, 1983, pp. 292-304.
- Kennedy, Eileen, and Carole Davis. "U.S. Department of Agriculture School Breakfast Program." *American Journal of Clinical Nutrition*, vol. 67(suppl), 1998, pp. 798S-803S.
- Kleinman, R.E. "Persistent Hunger Among Children in the U.S.: Does It Exist and So What?" Presentation to the United States Department of Agriculture, 1998a.
- Kleinman, R.E., J.M. Murphy, M. Little, P. Pagano, C.S. Wehler., K. Regal, and M.S. Jellinek. "Hunger in Children in the United States: Potential Behavioral and Emotional Correlates." *Pediatrics*, vol. 101, January 1998b, pp. 1-6.
- Kovacs (1985). Reference forthcoming in next version of report.
- Korol, D.L., and Gould. "Glucose, Memory, and Aging." *American Journal of Clinical Nutrition*, vol. 67, suppl., 1998, pp. 764S-771S.
- Levine, Allen S., JoAnn Tallman, Martha Grace, Shirley Parker, Charles Billington, and Michael Levitt. "Effect of Breakfast Cereals on Short-Term Food Intake." *American Journal of Clinical Nutrition*, vol. 50, 1989, pp. 1303-1307.
- Levitsky, D.A., and B.J. Strupp. "Malnutrition and Tests of Brain Function." *Nutrition and Behavior*, 1979, pp. 89-93.
- Levitsky, D.A., and B.J. Strupp. "Malnutrition and the Brain: Changing Concepts, Changing Concerns." *Journal of Nutrition*, vol. 125, 1995, pp 2212S-2220S.
- Life Sciences Research Office. "Third Report on Nutrition Monitoring in the United States." Bethesda, MD: Life Sciences Research Office, 1995.

- Lindeman, A.K., and K.L. Clancy. "Assessment of Breakfast Habits and Social/Emotional Behavior of Elementary Schoolchildren." *Journal of Nutrition Education*, vol. 2, October 1990, pp. 226-231.
- Lloyd, H.M., P.J. Rogers, D.I. Hedderley, and A.F. Walker. "Acute Effects on Mood and Cognitive Performance of Breakfasts Differing in Fat and Carbohydrate Content." *Appetite*, vol. 27, no. 2, October 1996, pp. 151-164.
- Looker, Anne C., Peter R. Dallman, Margaret D. Carroll, Elaine W. Gunter, and Clifford L. Johnson. "Prevalence of Iron Deficiency in the United States." *Journal of the American Medical Association*, vol. 277, no.12, March 26, 1997, pp. 973-976.
- Lopez, I., I. Andraca, C.G. Perales, E. Heresi, M. Castillo, and M. Colombo. "Breakfast Omission and Cognitive Performance of Normal, Wasted and Stunted Schoolchildren." *European Journal of Clinical Nutrition*, vol. 47, February 1993, pp. 533-542.
- Lozoff, B., E. Jimenez, and A.W. Wolf. "Long-Term Developmental Outcome of Infants with Iron Deficiency." *New England Journal of Medicine*, vol. 325, no. 10, September 5, 1991, pp. 687-694.
- Marcotte Breakfast Programs. "A Guide to Universal Free School Breakfast Programs." Center on Hunger and Poverty, Tufts University MA. March 1999.
- Maryland Meals for Achievement "Project Overview." 9/23/98.
- McGinnis, J.M., and W.H. Foege. "Actual Causes of Death in the United States." *Journal of the American Medical Association*, vol. 270, no. 18, November 10, 1993, pp. 2207-2212.
- McGlinchy. "Everyone Eats for Free: Can Universal Feeding Work?" *School Business Affairs*, vol. 58, 1992, pp. 3-7.
- McIntyre, Lynn, and Betty Ann Horbul. "A Survey of Breakfast-Eating Among Young Schoolchildren in Northeastern Ontario." *Canadian Journal of Public Health*, vol.86, no. 5, September to October 1995, pp. 305-308.
- McNulty, Helene, et al. "Nutrient Intakes and Impact of Fortified Breakfast Cereals in Schoolchildren." *Archives of Disease in Childhood*, vol. 75, 1996, pp. 474-481.
- Meeks, Gardner, et al., 1995.
- Meyers, A.F. "Undernutrition, Hunger, and Learning in Children." *Nutrition News*, vol. 52, fall 1989a, pp. 5-8.

- Meyers, A.F., A.E. Sampson, M. Weitzman, B.L. Rogers, and H. Kayne. "School Breakfast Program and School Performance." *The American Journal of Diseases of Children*, vol. 143, October 1989b, pp. 1234-1239.
- Michaud, C., N. Musse, J. Nicolas, and L. Mejean. "Effects of Breakfast-Size on Short-Term Memory, Concentration, Mood and Blood Glucose." *Journal of Adolescent Health*, vol. 12, January 1991, pp. 53-57.
- Miller, J., and S. Korenman. "Poverty and Children's Nutritional Status in the United States." *American Journal of Epidemiology*, 1994, vol. 140, no. 3, pp.233-43.
- Minnesota Department of Children, Families, and Learning, various editions from 1994-98 (see Wahlstrom, 1997).
- Morley, R., and Lucas. "Nutrition and Cognitive Development." *British Medical Bulletin*, vol. 53, no. 1, January 1997, p. 123-34.
- Morgan, Karen J., Mary E. Zabik, and Gilbert A. Leveille. "The Role of Breakfast in Nutrient Intake of 5- to 12-Year-Old Children." *American Journal of Clinical Nutrition*, vol. 34, 1981, pp. 1418-1427.
- Murphy, J.M., and R. Kleinman. "The Harvard/Kellogg Hunger/Breakfast Project: Findings and Recommendations." *Harvard Medical School and The Food Service Departments of the Baltimore and Philadelphia Public Schools*. Prepared for Shirley Watkins and the U.S. Department of Agriculture, November 6, 1997.
- Murphy, J.M. "Student Gains Associated with Classroom Feeding Are Confirmed for a Second Year." Memo to Shirley Watkins from J.M. Murphy, July 27, 1998a.
- Murphy, J.M., I.L.Kopits, R.C. Hicks, J. Marinaccio, and R. Kleinman. "Effects of a Universally Free, In-Classroom School Breakfast Program; Results from the Maryland Meals for Achievement Study." Massachusetts General Hospital, Harvard Medical School. Draft, May 3, 1999. See earlier citation, Maryland Meals for Achievement, "Project Overview," September 23, 1998b.
- Murphy, J.M., M.E. Pagano, J. Nachmani, P. Sperling, S. Kane, and R. Kleinman. "The Relationship of School Breakfast to Psychosocial and Academic Functioning: Cross Sectional and Longitudinal Observations in an Inner City School Sample." *Archives of Pediatric Adolescent Medicine*, vol. 152, September 1998c.
- Murphy, J.M., C.A. Wehler, M.E. Pagano, M. Little, R. Kleinman, and M.S. Jellinek. "Relationship Between Hunger and Psychosocial Functioning in Low-Income American Children." *Journal of the American Academy of Child & Adolescent Psychiatry*, vol. 37, February 1998d, pp. 163-170.

- Murphy, J.M., I.M. Kopits, and R. Kleinman. "Impact of a Universally Free, In-Classroom School Breakfast Program on Achievement; Results from the Abell Foundation's Baltimore Breakfast Challenge Program Evaluation." Massachusetts General Hospital, Harvard Medical School, May 25, 1999.
- Murphy, J.M. Dieticians of Canada Talk, June 1999, Vancouver. Murphy 1999 a, b, c. Studies of School Breakfast Outcomes in Maryland, Baltimore, and Boston.
- Navia, B., A.M. Requejo, R.M. Ortega, A.M. Lopez Sobaler, M.E. Quintas, P. Andres, M.R. Redondo, and T. Rivas. "The Relationship Between Breakfast and Whole Diet Energy Profiles in a Group of Preschool Children." *Annals of Nutrition & Metabolism*, vol. 41, 1997, pp. 299-306.
- Nicklas, Theresa A., Weihang Bao, Larry S. Webber, and Gerald S. Berenson. "Breakfast Consumption Affects Adequacy of Total Daily Intake in Children." *Journal of the American Dietetic Association*, vol. 93, no. 8, August 1993, pp. 886-891.
- Nicklas, Theresa A., Leann Myers, and Gerald S. Berenson. "Impact of Ready-to-Eat Cereal Consumption on Total Dietary Intake of Children: The Bogalusa Heart Study." *Journal of the American Dietetic Association*, vol. 94, no. 3, March 1994, pp. 316-318.
- Nicklas, Theresa, Carol E. O'Neil, and Gerald S. Berenson. "Nutrient Contribution of Breakfast, Secular Trends, and the Role of Ready-to-Eat Cereals: A Review of Data from the Bogalusa Heart Study." *American Journal of Clinical Nutrition*, vol. 67, 1998, pp. 757S-763S.
- Norstrand, G. "A Study of the Effects of School Breakfast on Reading Achievement, Attendance, and School Adjustment of Pupils." Dissertation, Brigham Young University, 1971, pp. 1-81.
- Novello, A.C., C. Degraw, and D.V. Kleinman. "Healthy Children Ready to Learn: An Essential Collaboration Between Health and Education." *Public Health Reports*, vol. 107, January/February 1992, pp. 3-10.
- Office of Disease Prevention and Health Promotion. "Physical Activity and Health." A Report of the Surgeon General, U.S. Department of Health and Human Services, Centers for Disease Control, 1996.
- Parker, L. "Appendix D: Executive Summary of Nutrition and Learning: A School Employee's Guide to Information and Action." *School Food Service Research Review*. Prepared for the National Education Association, 1989.
- Peck, H.I. "The Breakfast-Performance Link: A Status Report on the Study by the School Food Service Foundation." *School Food Service Journal*, November 1991, p. 37.
- Pollitt, E., and R.L. Liebel. "Iron Deficiency and Behavior." *Journal of Pediatrics*, vol. 88, no. 3, March 1976, pp. 372-381.

- Pollitt, E., M. Gersovitz, and M. Gargiulo. "Educational Benefits of the United States School Feeding Program: A Critical Review of the Literature." *American Journal of Public Health*, vol. 68, May 1978, pp. 477-481.
- Pollitt, E., R.L. Liebel, and D. Greenfield. "Brief Fasting, Stress, and Cognition in Children." *The American Journal of Clinical Nutrition*, vol. 34, August 1981, pp. 1526-1533.
- Pollitt, E., and M.S. Read. "Bridges Between Nutrition, Neuroscience, and Behavior." *The American Journal of Clinical Nutrition*, vol. 42, August 1985, pp. 348-351.
- Pollitt, E. "Developmental Impact of Nutrition on Pregnancy, Infancy, and Childhood: Public Health Issues in the United States." *International Review of Research in Mental Retardation*, vol. 15, 1988, pp. 33-80.
- Pollitt, E. "Poverty and Child Development: Relevance of Research in Developing Countries to the United States." *Child Development*, vol. 65, no. 2, April 1994, spec. no., pp. 283-295
- Pollitt, E. "Does Breakfast Make a Difference in School." *Journal of the American Dietetic Association*, vol. 95, October 1995, pp. 1134-1139.
- Pollitt, E. et al. "Iron Deficiency and Educational Deficiency." *Nutrition Reviews*, vol. 55, no. 4, April 1997, pp. 133-141.
- Pollitt, E., S. Cueto, and E.R. Jacoby. "Fasting and Cognition in Well- and Undernourished Schoolchildren: A Review of Three Experimental Studies." *American Journal of Clinical Nutrition*, vol. 67, 1998, pp. 779S-784S.
- Pollitt, E., and R. Matthews. "Breakfast and Cognition: An Integrative Summary." *American Journal of Clinical Nutrition*, vol. 67, 1998, pp. 804S-813S.
- Ponza, Michael, Dexter Chu, Mary Kay Fox, and William Rhodes. "Analysis of Nutrition Outcomes of Students." Final report to the Food and Nutrition Service. Princeton, NJ: Mathematica Policy Research, Inc., February 28, 1997.
- Powell, C.A., S.P. Walker, S.M. Chang, and S.M. Grantham-McGregor. "Nutrition and Education: A Randomized Trial of the Effects of Breakfast in Rural Primary School Children." *American Journal of Clinical Nutrition*, vol. 68, 1998, pp. 873-879.
- Reynolds (1985). Reference forthcoming in later version of report.
- Rogers, P.J., and H.M. Lloyd. "Nutrition and Mental Performance." *Proceedings of the Nutrition Society*, vol. 53, 1994, pp. 443-456.

- Sampson, Amy E., Sujata, Dixit, Alan F. Meyers, and Robert Houser, Jr. "The Nutritional Impact of Breakfast Consumption on the Diets of Inner-City African-American Elementary School Children." *Journal of the National Medical Association*, vol. 87, no. 3, 1995, pp. 195-202.
- Shaw, M.E. "Adolescent Breakfast Skipping: An Australian Study." *Adolescence*, vol. 33, winter 1998, pp. 851-861.
- Siega-Riz, Anna M., Barry M. Popkin, and Terri Carson. "Trends in Breakfast Consumption for Children in the United States from 1965 to 1991." *American Journal of Clinical Nutrition*, vol. 67, no. 4, April 1998, pp. 748S-756S.
- Simeon, D.T. "School Feeding in Jamaica: A Review of Its Evaluation." *American Journal of Clinical Nutrition*, 67 (suppl), 1998, pp. 790S-4S.
- Simeon, D.T., and S. Grantham-McGregor. "Effects of Missing Breakfast on the Cognitive Functions of School Children of Differing Nutritional Status." *American Journal of Clinical Nutrition*, vol. 49, 1989, pp. 646-653.
- Smith, A.P., A.M. Kendrick, and A.L. Maben. "Effects of Breakfast and Caffeine on Performance and Mood in the Late Morning and After Lunch." *Neuropsychobiology*, vol. 26, no. 4, 1992, pp. 198-204.
- Smith, A., A. Kendrick, and A. Maben. "Effects of Breakfast and Caffeine on Cognitive Performance, Mood and Cardiovascular Functioning." *Appetite*, vol. 22, 1994, pp. 39-55.
- Strupp, B.J., and D.A. Levitsky. "Enduring Cognitive Effects of Early Malnutrition: A Theoretical Reappraisal." *Journal of Nutrition*, vol. 125, 1995, pp. 2221S-2232S.
- Subar, A.F., S.M. Krebs-Smith, A. Cook, and L. Kahle. "Dietary Sources of Nutrients Among U.S. Children, 1989-91." *Pediatrics*, vol. 102, no. 4, October 1998, pp.913-923.
- U.S. Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, Fourth Edition*. Washington, DC: U.S. Government Printing Office, 1995.
- Vaisman, N., H. Voct, A. Akivis, and E. Vakil. "Effect of Breakfast Timing on the Cognitive Functions of Elementary School Students." *Archives of Pediatric & Adolescent Medicine*, 150, 1996, pp. 1089-1092.
- Wachs, T.D. "Relation of Mild-to-Moderate Malnutrition to Human Development: Correlational Studies." *Journal of Nutrition*, vol. 125, no. 8, suppl. August 1995, pp. 2245S-2254S.
- Wahlstrom, K.L., A. Bemis, and J. Shneider. Center for Applied Research and Educational Improvement "Minnesota Universal Breakfast Pilot Study: Final Report, Year Three, 1996-97." December 1997.

Wehler, C.A. "The Community Childhood Hunger Identification Project: A Model of Domestic Hunger-- Demonstration Project in Seattle, Washington." *Journal of Nutrition Education*, January/February Supplement 1992, vol. 24, no. 1, pp. 29S-35S.

Worobey, J. and H.S. Worobey. "The Impact of a Two-Year Breakfast Program for Preschool-Aged Children on Their Nutrient Intake and Pre-Academic Performance." Department of Nutritional Sciences, Cook College/NJAES, Rutgers University, 1997.

Wyon, D.P., L. Abrahamson, M. Jartelius, and R.J. Fletcher. "An Experimental Study of the Effects of Energy Intake at Breakfast on the Test Performance of 10-Year-Old Children in School." *International Journal of Food Sciences and Nutrition*, vol. 48, 1997, pp. 5-12.

APPENDIX A
SELECTED ABSTRACTS

CITATION

Abell Foundation. *The Abell Report*, 11, February/March 1998, pp 1-7. "Data From Abell Foundation Project Concludes: Changes in Student Breakfast Program Will Increase Participation and Improve Student Performance."

Objective of the Article

To provide a report of the academic effects of a universally free, in-classroom breakfast program that was pilot tested in the Baltimore City schools.

Sample and Data Used

The study compared schoolwide outcomes in three pilot Baltimore City Public Schools which adopted a free in-classroom breakfast program with three similar schools which did not adopt the new program. These latter schools served as control schools.

Outcomes Examined

Rates of student participation in breakfast programs were compared between the schools that adopted the universally free, in-classroom breakfast and schools that continued the already established regular breakfast programs. School attendance, discipline, tardiness, and academic achievement were also compared as outcome measures.

Methodology

Because this article appeared in the newsletter put out by the foundation that funded part of the free breakfast program, it offers an overview of the project without including specific statistical or methodological information. The report describes findings from an unpublished study in progress.

Main Findings

The study found differences in outcomes between the breakfast schools and the control schools:

- C After the program began in February of 1997, the rate of breakfast participation climbed immediately, to nearly 75 percent of the student population and 85 percent within two months. In the three control schools, there was virtually no change in the breakfast participation rate.

- C From February through June 1997, attendance in the three schools offering free breakfast rose to 89 percent from 86 percent, in contrast to the three control schools, where the average daily attendance dropped from 85 percent to 84 percent during the same period.
- C In the three pilot schools, the number of disciplinary incidents dropped by half in the semester after classroom feeding began. In the one control school that sent data, the number of disciplinary incidents was virtually the same over the course of the two semesters.

Comments

This unpublished, poorly controlled study makes several unique contributions to the designers of the USBP evaluation. First of all, it is the first study to document the dramatic increases in participation that accompany a classroom feeding approach to universally free school breakfast. Second, this is the first study to use official school records to document improvements in student behavior. Third, this study confirms the report by Meyers et al. in 1989 that improvements in attendance and punctuality accompany the implementation of a universally free school breakfast program. If such findings can be confirmed, they suggest that it might be possible to use these indicators as measures in the USBP.

CITATION

American Dietetic Association. "Position of The American Dietetic Association: Dietary Guidance for Healthy Children Aged 2 to 11." *Journal of the American Dietetic Association*, vol. 99, 1999, pp. 93-101.

Objective of the Article

To review what U.S. children are eating and to explore trends in dietary, food, and nutrient intakes as well as the impact of school meals on children's diets.

Sample and Data Used

Position statement: Not Applicable.

Outcomes Examined

Position statement: Not Applicable.

Methodology

Position statement: Not Applicable.

Main Findings

- C Evidence from existing studies show that there is a significant positive relationship between eating breakfast and school performance as well as overall nutritional well-being of children.
- C Approximately 14% of all children skip breakfast; these children have total nutrient intakes that are lower than their breakfast-eating counterparts.
- C The total energy intake of American children has either increased or remained stable while the energy intake per kilogram body weight has decreased. The percentage of energy intake from saturated and unsaturated fat has decreased from 38% to 33% and the percentage of energy from saturated fat has decreased from 16% to 11% over the past 30 years.
- C The percentage of total fat from milk, fats/oils, pork, mixed meats, eggs, and desserts has decreased while the percentage of fat from poultry, cheese, and snacks has increased.

- C In the last couple of decades, milk consumption has declined by 24% among boys and 32% among girls between the ages of 6 and 11. Milk-drinkers consume more reduced-fat or fat-free milk than they do whole milk.
- C On average, reported mean energy, vitamin, and mineral intakes of children aged 2 to 11 meet or exceed the Recommended Daily Allowance (RDA). After age 11, there is an increase in the percentage of youth who do not meet the RDAs, especially for iron (in girls) and zinc, and the Dietary Reference Intakes (DRIs) for calcium.
- C Ninety-one percent of children ages 6 to 11 are consuming about 2.5 servings of fruits and vegetables per day--just half the recommended minimum.

CITATION

Benton, D., and P.Y. Parker. "Breakfast, Blood Glucose, and Cognition." *American Journal of Clinical Nutrition*, vol. 67, April 1998, pp. 772S-778S.

Objective of the Article

To compare the findings of three studies that explored the role of blood glucose in breakfast-induced improvement of different forms of memory function.

Experiment 1: Breakfast, Blood Glucose and Memory

Sample and Data Used

Thirty-three university students, 16 women and 17 men, with a mean age of 21.3 years, made up the total sample.

Subjects fasted from the time of their evening meal (no later than 7 p.m.) the previous day until they arrived at the research laboratory the following day at 9 a.m. At this time subjects had their blood glucose measured; then they either ate breakfast or consumed a nutritional milk-based beverage (group assignment was based on randomization). After reading quietly for two hours, the subjects took two memory tests and had their blood glucose concentrations measured.

In addition, researchers quizzed subjects about their normal breakfast habits.

Outcomes Examined

The outcome variables included performance on a spatial memory test and a word recall exercise. For the spatial memory test, two measurements were taken: the time taken to finish the task and the number of errors made. Performance on the immediate recall exercise was evaluated by the number of words recalled and by the time elapsed before subjects gave up.

Blood glucose concentrations were measured using reagent strips and a glucometer, which produced quantitative results comparable with accepted laboratory methods.

Methodology

The spatial memory scores were analyzed using a three-way ANOVA (sex, whether the subject ate breakfast for the experiment, and whether the subject habitually ate breakfast). Recall of the word list was examined by using a four-way ANOVA (sex, whether the subject ate breakfast for the experiment, whether

the subject usually ate breakfast, and word list score. The word list score was used as a repeated-measures factor). Blood glucose concentrations were related to memory scores by using Pearson's product-moment correlation coefficient.

Main Findings

- C The time taken for both the spatial memory tasks and the word list recall was significantly greater when the subjects fasted than when they ate breakfast. Eating breakfast did not influence the number of errors on either task.
- C For the spatial memory test, there were significant negative coefficients of correlation between the blood glucose concentration, length of time, and number of errors; that is, the higher the concentration of blood glucose, the better the performance.
- C The coefficients of correlation between word recall performance and blood glucose concentration were not significant.

Comments

It is unclear from the data presented whether changes in glucose concentrations causally influenced memory, or, alternatively, whether test performance and glucose concentration reflected a third variable, perhaps hormonal, that modulated both blood glucose concentrations and memory.

Experiment 2: Influence of Breakfast and Blood Glucose Manipulation on Brown-Peterson Task

Sample and Data Used

Eighty undergraduate women, with a mean age of 22.6 years, made up the sample. The choice of women only was made based on their availability for the study and on previous reports that sex differences were unimportant.

Four groups were compared, subjects either (1) ate breakfast and consumed a drink containing 50 g of glucose, (2) ate breakfast and consumed a placebo drink, (3) fasted and consumed a drink containing glucose, or (4) fasted and consumed a placebo drink.

The subjects followed their normal routine of eating or not eating breakfast before arriving at the laboratory at 9 a.m. On the basis of the subjects' meal records, the energy content of their breakfast was calculated. In a double-blind procedure, the subjects randomly consumed either a glucose or placebo drink and sat quietly for 20 minutes before testing began on the Brown-Peterson task.

Outcomes Examined

The outcome variable consisted of performance on 40 consonant-syllable trigrams (Brown-Peterson task) that were constructed for this study. Performance in the first four trials was compared with that in the last four.

Methodology

The effects of the drink and breakfast were analyzed using a four-way ANOVA (whether the subjects drank a placebo or glucose drink, whether the subject ate breakfast, trials 1-4 or trials 5-8, and distractor interval, with the last two factors used as repeated measures).

Main Findings

Those in the placebo group who did not consume breakfast did not significantly improve from trials 1-4 to trials 5-8. In contrast, in subjects who drank the glucose drink, but did not eat breakfast before testing, performance significantly improved from trials 1-4 to trials 5-8. Similarly, those who ate breakfast showed practice effects whether they drank the glucose drink or not.

Those who did eat breakfast but consumed a placebo recalled the trigrams with lower accuracy than the other three groups did. Thus, consuming a glucose drink nullified the negative consequences of missing breakfast.

For the breakfast groups, breakfast consumption alone raised blood glucose concentrations, and an additional glucose drink was of no further benefit.

Comments

Because subjects in this experiment were allowed to follow their normal breakfast routine before the beginning of the experiment, there is a risk of self-selection. The question of whether investigators were simply measuring diurnal rhythms must be asked, (i.e., Do people who eat breakfast simply remember more easily because they are more alert in the morning?).

Experiment 3: Influence of Breakfast and Glucose Manipulation on Memory

Sample and Data Used

One hundred thirty-seven women and 47 men, with a mean age of 22 years, made up the sample. Subjects either ate or did not eat breakfast as they normally would. The four groups compared (1) ate breakfast and consumed a glucose drink (n=55), (2) ate breakfast and consumed a placebo drink (n=51);

(3) fasted and consumed a glucose drink (n=38), or (4) fasted and consumed a placebo drink (n=40). Following breakfast, in a manner similar to Experiment 2, subjects were assessed for cognitive functioning on a battery of tests.

Outcomes Examined

The outcome variables included performance on a word list and the Graduate and Managerial Assessment Test of Abstract Reasoning. Subjects were also read a story from the Wechsler Memory Scale and asked to write down as much as they could recall from the story in two minutes.

Methodology

A two-way ANOVA was used to analyze word recall and abstract reasoning (whether the subject had a placebo or glucose drink and whether the subject ate or did not eat breakfast).

Main Findings

On examination of the number of words recalled, researchers found a significant interaction between type of drink consumed and whether the subject ate breakfast. Of the subjects who fasted, those who consumed the glucose drink recalled more words than those who consumed the placebo drink. Of those who had taken the placebo, those who ate breakfast recalled more words than those who fasted. However, for those who ate breakfast, the type of drink did not influence the number of words recalled.

Those who ate breakfast recalled more of the Wechsler story than those who fasted. In this instance, the glucose drink did not influence recall of the story, regardless whether the subjects had fasted, and there was no interaction between these variables.

The abstract reasoning scores indicated no effect from the drink, breakfast consumption, or an interaction between these variables.

Comments

The authors conclude that taken together their three studies show that the consumption of breakfast benefits memory. One of the mechanisms for this interaction is the raising of blood glucose, although this is not the only mechanism. It also appears that psychological function is not uniformly affected by missing breakfast.

Memory, and in particular declarative memory, may be the area of cognitive functioning that is most affected by breakfast consumption. Declarative memory refers to information that can be consciously recalled and declared verbally as opposed to procedural memory, which involves conditioning, habituation, and skills like bicycle riding. Since procedural memory plays such an important role in academic settings, it may have special relevance to evaluating the effects of school breakfast programs.

CITATION

Brown, J.L., and E. Pollitt. "Malnutrition, Poverty and Intellectual Development." *Scientific American*, vol. 274, February 1996, pp. 38-43.

Objective of the Article

To review recent findings from a follow-up study in Guatemala regarding the interaction of malnutrition, poverty, and intellectual development.

Sample and Data Used

This project was an extensive follow-up study of Guatemalan children who were studied by other scientists many years earlier in 1969. The follow-up study was carried out from 1988 to 1989. Children and young adults in Guatemala who had received nutritional supplements in infancy were studied to assess the influence of early diet and poverty on later intellectual development. Children had either received Atole, a highly nutritious supplement, or Fresco, a less nutritious supplement. Seventy percent of participants in the original study participated in the follow-up. Subjects, in 1988, ranged in age from 11 to 27 years old.

Subjects were given a battery of cognitive tests to assess for current intellectual functioning. The researchers then determined how economic status, measured by house quality, father's occupation, and mother's education, correlated with test scores.

Outcomes Examined

Adolescents and young adults took tests of literacy, vocabulary, reading comprehension, general knowledge, and arithmetic. Subjects were also given a standard nonverbal intelligence test.

Methodology

Study methodology was not covered in this article.

Main Findings

Individuals who regularly consumed Atole (the highly more nutritious supplement) before the age of 2 performed at about the same level on most tests, such as tests of vocabulary skills, regardless of economic status. The performance of those given a less nutritious supplement called Fresco varied with poverty level.

Among individuals who had more than two years of formal education, those who consumed Atole scored significantly higher than those who received Fresco, an indication that poor nutrition in infancy can subsequently undermine the benefits of schooling. In addition, Atole appeared to have increased the advantage of education. With every additional year of schooling, the differences in achievement between the adolescents who received Atole and those who consumed Fresco increased.

Subjects who received Atole in early life performed significantly better on most tests of cognition than those who received Fresco. The strongest effects of Atole were observed among those at the low end of the social and economic ladder. These children performed as well as the more privileged children in their villages. However, the children in this study all lived in extreme poverty and did not perform at the same level as a child from a middle-income household in a more prosperous area of Guatemala. Hence adequate nutrition alone could not fully compensate for the negative effects of poverty on intellectual growth.

The authors conclude that the better long-term effects in the Atole group can probably be explained by the differences in the children's motor skills, physical growth, and social emotional development. The children who received Fresco in their early life suffered from numerous physical disadvantages. Furthermore, because undernourished children remain small for their age, adults tend to treat them as if they were younger. Such a response would likely slow cognitive development.

The results in Guatemala are consistent with the prevailing understanding of the interactions between poor nutrition, poverty, and education. Nutritional supplements combat the effects of poverty, but only somewhat. Early malnutrition can undermine the overall value of education.

Most importantly, this study demonstrates that poor nutrition in early childhood can continue to hinder intellectual performance in adulthood. Studies such as the one in Guatemala have prompted Brown and others to suggest that when the social and economic aspects of a child's environment cannot be easily changed, providing adequate nutrition during childhood can lessen the cognitive deficits engendered by poverty.

Other conclusions are that deficits, once introduced, tend to persist and exacerbate and that poor diet can have negative effects throughout childhood, not just infancy.

Comments

This is a summary piece with no details of the tests or economic differences of the groups. Presumably these are listed in the primary sources cited in text. The relevance for U.S. studies may be limited due to the far greater poverty and malnutrition in low-income individuals in Central America compared with the United States.

CITATION

Brown, J.L., and L.P. Sherman. "Policy Implications of New Scientific Knowledge." *Journal of Nutrition*, vol. 125, August 1995, pp. 2281S-2284S.

Objective of the Article

This article highlights the relevance of recent research findings on nutrition to health programs and social policies by synthesizing findings from previous studies rather than presenting new data.

Main Findings

- C Chronic mild under-nutrition directly influences child development (cognition and behavior) by impeding social and environmental interactions, including the important child-caregiver relationship.
- C Cognitive and behavioral impairments associated with even mild under-nutrition may last a lifetime.
- C Developmental plasticity indicates that children and adults may be affected by under-nutrition at times other than the earliest years of life, but that with appropriate interventions some of the damage may be offset. Under-nutrition seldom occurs in isolation but is usually accompanied by other risk factors, such as low family income and poverty status, which have implications for intervention strategies.
- C Intervention strategies are most effective when they are multidimensional, for example, involving not only nutritional supplementation but developmental, caregiver and educational components.
- C Nutritional supplementation cannot ensure that impairment will be corrected, but when accompanied by psychosocial intervention, it can be highly beneficial.
- C Interventions targeting malnourished children and their families are likely to affect not only the individual but societal development as well, thanks to improvements in educational quality, workforce skills and productivity, economic competitiveness and quality of life.

Comments

The argument is made that from a human capital perspective, investing in better nutrition and children's cognitive development for all children can lead to better productivity.

CITATION

Center on Hunger, Poverty, and Nutrition Policy. "Link between Nutrition & Cognitive Development." Tufts University: 1993.

Center on Hunger, Poverty, and Nutrition Policy. "Link between Nutrition & Cognitive Development." Tufts statement: revised 1994.

Center on Hunger, Poverty, and Nutrition Policy. "Link between Nutrition & Cognitive Development." Tufts statement: revised 1998.

Objective of the Articles

These three documents--which are essentially the same document revised every few years to encompass new findings--present the latest research on the relationship between nutrition and children's cognitive development, prepared by an anti-hunger advocacy group. They were developed to broaden public awareness and influence public policies related to nutrition.

Sample and Data Used

These reports provide an overview of research on the causal pathways between nutrition and cognitive development in children and summarize international and U.S. studies.

Outcomes Examined

Childhood development (social skills), developmental delays, iron deficiency, anemia, cognitive impairment, poor nutritional status.

Methodology

These are descriptive reports with a list of appropriate scientific references and a discussion of the potential impact of child nutrition programs on improving nutritional status and cognition of children.

Main Findings

Current scientific research has shown that:

- C Under-nutrition along with environmental factors associated with poverty can permanently retard physical growth, brain development, and cognitive functioning.

- C The longer a child’s nutritional, emotional and education needs go unmet, the greater the likelihood of cognitive impairments.
- C Iron deficiency anemia is associated with impaired cognitive development in children and increases problems with lead exposure.
- C Iron repletion therapy can reduce some of the effects of anemia on learning, attention, and memory.
- C Poor children who attend school hungry perform significantly below non-hungry low-income peers on standardized test scores.
- C There exists a strong association between family income and the growth and cognitive development of children.
- C Improved nutrition and environmental conditions can modify the effects of early under-nutrition.
- C Supplemental feeding programs can help offset threats posed to the child’s capacity to learn and perform in school, threats that result from inadequate nutrient intake.
- C Once under-nutrition occurs, its long-term effects may be reduced or eliminated by a combination of adequate food intake and environmental (home, school) support.

Comments

These advocacy pieces are widely distributed and are meant to provide a focal point and documentation for efforts to enhance the nutritional well being of children, particularly those in the United States. “Recent research provides compelling evidence that under-nutrition—even in its milder forms—during any period of childhood can have detrimental effects on cognitive development and adult productivity.”

These articles discuss the complex, interactive nature of malnutrition, poverty, education, and health and include a bibliography of selected literature on the link between poverty, nutrition, and cognition in children.

CITATION

Chandler, A.K., S.P. Walker, K. Connolly, and S.M. Grantham-McGregor. "School Breakfast Improves Verbal Fluency in Undernourished Jamaican Children." *Journal of Nutrition*, vol. 125, April 1995, pp. 894-900.

Objective of the Article

The short-term cognitive effects of breakfast in mildly undernourished primary school children were compared with those of adequately nourished children of the same age.

Sample and Data Used

The subjects were 97 undernourished and 100 adequately nourished children. The undernourished children consisted of those that were only mildly undernourished because more severe undernourishment in Jamaica is rare. Four primary schools in rural Jamaica were selected. Each school had at least 25% of children with weight-for-age < 1 SD of the National Center for Health Statistics growth references and at least 30 children enrolled in each of grades 3 and 4. Adequately nourished children and undernourished children were matched for sex and grade level. Only children who had attended school on at least 50% of the days in the previous term were included in the study. Children whom the teachers considered to be mentally retarded were also excluded.

A questionnaire to assess socioeconomic status was given to each child. The questions concerned details of housing, the type of water supply and sanitation, and household possessions. The validity of the questionnaire was determined by visiting the homes of 10% of the children and interviewing the mothers. Qualities of uniforms and school supplies were also examined. Note: all children walked to school between one and five miles per day.

A breakfast program began in the schools one week before testing began and continued until the last test was completed. Children received either breakfast or a "placebo" (quarter of an orange) in the first test period, and the treatment order was reversed for the second test period. There was an interval of at least three weeks between the test sessions. The children were fed at 8:30 a.m., and testing was conducted from 9 a.m. to noon. Each child was tested twice, once having received breakfast and once having received a placebo. Each child was therefore compared with himself or herself after receiving or not receiving breakfast.

Outcomes Examined

Outcome variables included performance on a fluency and digit span test, the results of which had been detrimentally affected when children missed breakfast in a previous Jamaican study. Visual search and speed-of-information processing tests were added to this study as outcome variables.

Methodology

The effects of breakfast on children's test scores were examined with repeated-measures ANOVA. The test and retest scores were the within-subjects factor. The between-subjects factors were nutritional status and treatment order.

Main Findings

Undernourished children's performance improved significantly on a test of verbal fluency when they received breakfast. The performance of adequately nourished children did not change.

No effects of breakfast were observed for the visual search test, digit span test, or speed of information processing tests between groups.

Comments

While the two tests that measured aspects of speed of visual processing were moderately correlated ($r = 0.69$), correlations with fluency and digit span were low, indicating that these tests measure different functions.

It should be noted that undernourished children may respond differently to breakfast because they have experienced hunger more often in the past and may thus be more responsive to receiving or being denied food.

The findings of this study extend those of a previous Jamaican study conducted under more controlled conditions, and support the targeting of school meals to undernourished children.

For the USB evaluation, several points are important. The fact that verbal fluency was impacted but that visual search, digit span, and information processing were not shows yet again that the effects of breakfast on performance are selective and that the choice of measures is important. According to the authors, the areas most affected may vary depending how malnourished the children are. This is important in the United States because children here will probably be less malnourished overall than Third World children who are stunted or wasted. For the USB evaluation, this is one of the more important studies suggesting that school breakfast may have measurable effects.

CITATION

Conners, C.K., and A.G. Blouin. "Nutritional Effects on Behavior of Children." *Journal of Psychiatric Research*, vol. 17, 1982/1983, pp. 193-201.

Objective of the Article

Following nutritional intervention, cognitive performance, along with central and autonomic responses, was measured in 10 children ages 9 to 11 years.

Sample and Data Used

Ten normal children, aged 9-11-years-old, were seen on four occasions about one week apart. Twice, the children received a standard breakfast, and twice they had no breakfast. On each test day their performance was assessed three times at 9:50 a.m., 11 a.m. and 12:10 p.m. At each 30-minute session they performed a continuous performance task (CPT).

Visual stimuli was presented which consisted of alphabetic characters displayed for 50 milliseconds on a computer-controlled electroluminiscent display panel with a one-second interstimulus interval. Subject pressed a response button whenever the letter "X" was presented. At the same time, electrodes attached to the scalp recorded the visual evoked potentials to each letter.

Phasic changes in the cardiac cycle were examined with an EKG during a warned reaction time task. During each session following the CPT, children were presented with an auditory warning for a visually presented dot to which the subjects pressed a response key.

Between sessions within a day, the child performed a computerized arithmetic test using a graded series of problems which pretesting determined was at the child's level.

Outcomes Examined

The outcome variables included autonomic (evoked cardiac response), central (event-related potentials), and behavioral (CPT and arithmetic test) measures.

Methodology

An analysis of variance was used to determine any significance between groups.

Main Findings

The results for the CPT showed that in both the breakfast and no-breakfast conditions children made more errors and became more variable as the morning progressed. But at each time point, the children with breakfast made fewer errors and were less variable. The difference in variability between breakfast and no-breakfast was statistically significant at all three measured times.

In the arithmetic task there was no difference between conditions early in the morning, but at the mid-morning session there was a clear improvement in the breakfast condition (possibly a practice effect).

Breakfast resulted in reduced cardiac acceleration in response to the tone, and the breakfast/no-breakfast differences in the latency of this response became more apparent later in the morning. Whereas no-breakfast increases the acceleratory phase, the declaratory phase appears to be enhanced in the breakfast condition. This suggests that no-breakfast may enhance sympathetically mediated arousal influences on the heart while diminishing vaguely mediated inhibitory influences.

There were highly significant breakfast effects on the amplitude and latency of visual evoked potentials recorded during the CPT.

Comments

This study, which was conducted about 20 years ago showed that tests of attention and of motor behavior were sensitive to breakfast skipping, with significantly more errors for subjects who skipped breakfast than for those who ate breakfast. The study also suggests that the number of errors increased for all subjects over each of three periods as the morning progressed. Other cardiac and central nervous system differences were detected, suggesting that skipping breakfast had a significant effect on several different cognitive functions.

As noted by Pollitt and Mathews, randomization of subjects and sex of the participants were not reported. The small sample size ($n=10$) of this experiment should also be considered when making interpretations. It is not clear whether this study has ever been replicated.

CITATION

Cook, J.T., O. Punam, and G.L. Kelly. "Evaluation of a Universally-Free School Breakfast Program: Central Falls, Rhode Island." Center on Hunger, Poverty and Nutrition Policy, Tufts University School of Nutrition Science and Policy: January, 1996.

Objective of the Article

To determine whether the change from the regular School Breakfast Program (SBP) to the Universally-Free School Breakfast Program (UF) had an effect on: (1) SBP participation, (2) overall breakfast participation, (3) morning nutrient intake, (4) absenteeism and tardiness.

Sample and Data Used

The sample comprised all 2,763 children in grades Pre-K through 6 registered in the Central Falls, RI, school district. A stratified random sample was selected from these students based on their eligibility for the free SBP (1/3 eligible, 2/3 not eligible), resulting in a pretest subsample of 225 students. A control group subsample of comparable size was selected from two Providence, RI schools resembling Central Falls schools in terms of eligibility rates for free school breakfasts. Although separate samples were used for pre- and post-tests, no information is given on the number of students chosen for the post-test.

Pretest subsamples were interviewed in February and March of 1994, while post-test subsamples were interviewed in May 1994 regarding dietary intake. A modified dietary recall instrument was used to collect information about each subject's food consumption from the time they awoke until the time of the interview. All children interviewed were asked whether they had eaten anything since waking. If the subject responded negatively, three additional questions were asked about the reasons for not eating, and how frequently they do not eat breakfast. If subjects responded that they had eaten, they were then asked to describe what was eaten, how much, and where it was eaten.

School records were used to gather information on absences and tardiness.

Outcomes Examined

The outcome variables included information obtained from the dietary intake interviews and absenteeism/tardiness.

Methodology

Responses recorded on the interview protocols were coded and entered into computer software packages for nutrient and statistical analysis. Data from respondents in grades Pre-K to 2 were only

analyzed at a qualitative level, and for principal between-group differences for pre- and post-test periods. Data from respondents in grades 3-6 were subjected to more detailed analytic procedures.

Quantitative intake data from respondents in grades 3 to 6 were entered into Food Processor II diet analysis software for initial nutrient content analysis. Resulting nutrient content data were then entered into EpiInfo and SPSS for further statistical analysis. Some preliminary analyses were also accomplished using standard spreadsheet software.

In addition to data obtained from interviews, school-level data on attendance and tardiness were obtained from the Office of School Food Services for both Central Falls and Providence schools for the 30-day period just prior to survey implementation. This data was used to assess the effects of the change to a universally free breakfast program on attendance and tardiness in the Central Falls schools.

Main Findings

- C Based on single-day measures, participation in the SBP increased nearly 60% among Central Falls students than among the control group after implementation of the UF breakfast. Based on 30-day measures, after the program became universally free a significantly larger proportion of Central Falls students were categorized as “frequent” participants as opposed to “infrequent” participants.
- C The proportion of children in poor families (below 130% of poverty) participating in the SBP increased 71% more in Central Falls schools than in the control group schools after the SBP became universally free.
- C The increase in SBP participation rates was significantly greater among poor students in the Central Falls schools than among nonpoor children, while group differences by poverty status were not significant.
- C Using single-day measures, the proportion of very young children (grades K through 2) participating in the SBP increased by 110% more in universally-free schools than in control-group schools. Within UF schools, the increase in single-day SBP participation rates among children in grades K-2 was 144% greater than the increase among children in grades 3-6, while control group differences by age were not significant.
- C SBP participants have significantly higher average intakes of seven out of nine nutrients examined than nonparticipants.
- C The proportion of children not eating breakfast declined by 36% after the change to a UF-SBP.
- C Tardiness declined significantly more for intervention schools.

Comments

Overall, this study confirms previous reports of the increase in participation that accompanies a change to a universally free school breakfast program. The study is the first to note a decrease in schoolwide rates of tardiness. Although schoolwide attendance rates did not increase, absence rates were lower for frequent school breakfast participants.

This study is also the first to report that a USB program led to a decrease in the overall rate of students who skipped breakfast. This is also the first study to report that a significant percentage of the students who eat breakfast at home eat “junk food” most of the time and that another 17% eat foods high in fats and sugars. Both of these trends are arrested for students who eat breakfast at school.

The significantly greater increase in participation among poor children indicates that participation increased most in students with the greatest need for nutrition assistance.

CITATION

Craig, A., "Acute Effects of Meals on Perceptual and Cognitive Efficiency." *Nutrition Reviews*, vol. 44 supplement, May 1986, pp. 163-171.

Objective of the Article

To present a selective review of the literature regarding the timing of meals and performance tests, the nature of the meals and of the people who eat them, and the complexities of mental performance itself.

Main Findings

Several factors, singly or in combination, affect the outcome of any experimental study on short-term changes in mental performance:

- C Temporal factors: (1) the delay between food ingestion and measurements of performance; (2) the gap in time since the previous meal was eaten; and (3) the time of day at which the meal is consumed.
- C Performance factors: (1) the nature, complexity and duration of the task; (2) the amount of effort the person is willing to expend on performing the task; (3) bias in favor of certain response alternatives; and (4) preference for speed over accuracy in performance.

The Influence of Breakfast

Yensen in 1959 suggested, on the basis of his taste-threshold data, that the advantages of having breakfast only reveal themselves late in the morning (beyond 11 a.m.). In Yensen's study, the first test of the day was given at 9:00 a.m., an hour and a quarter after the start of breakfast. The results showed a consistently adverse effect of the meal similar to, but more extensive, than the dip known to occur after lunch (frequently referred to as the "post-lunch dip"). However, the advantages of fasting generally disappeared by 11:30 a.m.

The early part of the waking day is a period that is generally associated with the upward phase of the circadian rhythm, when there is a rapid increase in levels of alertness, arousal and activation. It seems reasonable to suppose that these endogenous time-of-day effects could mask any effects that are directly caused by eating breakfast.

Pollitt et al. found that in the late forenoon, school children are more likely to make errors on the Matching Familiar Figures Test when they have missed breakfast. On the other hand, breakfast did not affect mean efficiency on the Continuous Performance Test (CPT). These results may reflect the

insensitivity of the CPT to food ingestion or it may be that the advantages of having breakfast only reveal themselves in the late morning.

The Influence of Meal Size

Relevant studies in this area have been done mainly on the adverse effect of lunch. It should also be noted that relevant studies regarding meal size do not permit a distinction between meal volume and caloric value.

Hammer found that a doubling of the caloric value of lunch produced at most a marginal increase in the magnitude of the post-lunch dip. Yensen obtained a more pronounced effect through a mere 50% increase in kilocalories. Craig and Richardson found that accuracy on performance tests was significantly influenced not only by the size of the experimental lunch, but also by the size of the lunch that the subjects normally consumed.

The Influence of Meal Content

In assessing qualitative aspects of meals, investigators have compared meals that are relatively high in protein, carbohydrates or fat. Simonson et al. observed that accuracy on their high-paced letter-recognition task was significantly lower after a high-carbohydrate lunch than after either the standard lunch or a lunch with a high fat content. However, this result varies from the findings of King et al. whose data on scotoma (visual blind spot) and motor performance allowed them to conclude that a high-carbohydrate meal, whether at breakfast or at lunch, produced superior performance to that following either a standard meal or a high-protein meal. Recently, Spring et al. reported that on a sustained dichotic-shadowing task, omission errors were greater and overall accuracy lower after a high-carbohydrate meal than after a meal that was high in protein.

The Influence of Meal Time

Investigators who have focused attention on the post-lunch dip have concluded that, in general, it apparently matters little precisely when eating occurs (within a range of approximately three hours). For example, in a recent study by Smith and Miles it was found that detection of repeated digits in a sustained attention task declined just as much following a meal given at midnight, in the middle of an eight-hour night shift, as following the normal lunch at midday. However, the speed with which detections were made increased following the meal in the night, whereas it characteristically declined following the usual midday lunch, implying that the time at which the meal was consumed may have some influence after all.

The Influence of Personal Variables

Spring et al. found that in terms of efficiency on the dichotic shadowing task, the relative disadvantage of a carbohydrate compared to a protein meal only achieved significance in the case of older subjects (> 40 years old). Younger subjects were relatively impervious to differential effects of the meals. Craig and Richardson found that omission rates on the letter-cancellation task were noticeably influenced by a heavy lunch only for those people who normally ate a light snack.

Another characteristic, personality, was implicated as a determinant of the post-lunch dip in the study by Craig et al. who found that the more extraverted and less neurotic the individual, the greater the extent of the post-lunch dip in efficiency.

Comments

There appears to be sufficient evidence to warrant the conclusion that the initial effect of food ingestion is determined by what is eaten and when it is eaten, as well as by personal characteristics. Findings on the immediate effects of lunch and breakfast differ. For lunch, there is evidence of a “post-meal” decrease in performance. There is no such consensus regarding whether there is a post-breakfast dip. There does appear to be an interaction between the length of the preceding fast, the size of the meal, and the neuroticism of who eats it. Longer fasts, smaller meals, and more neurotic individuals are associated with less of a post-meal dip.

In terms of a study of the effects of major changes in the school breakfast program, the issue of timing becomes a potentially important one. If, in general, cognitive performance degrades somewhat for one to several hours after meals, it clearly bounces back at some point. If short-term effects of breakfast are to be evaluated, then the timing of both home and school meals may need to be taken into account.

CITATION

Dairy Council. "Breakfast: Its Effects on Health and Behavior." *Dairy Council Digest*, vol. 64, 1993, pp. 7-12.

Objective of the Article

This article presents a selective review of the literature regarding breakfast, the School Breakfast Program (SBP), and the Universal Breakfast Program.

Main Findings

Recent findings regarding breakfast consumption and specifically SBP participation include:

- C According to a Gallup survey involving 407 children in grades 4 through 8, nearly 60 percent of the children interviewed said that they skipped breakfast. Two-thirds of the children said that they decide for themselves what to eat for breakfast.
- C Other studies indicate that as many as 25 percent of elementary school children do not eat breakfast and that, in general, the percentage of breakfast skippers increases with age, at least until middle age.
- C In lower-income families, lack of food in the home may explain why both children and adults do not regularly eat breakfast. Surveys conducted throughout the last decade document a rising incidence of poverty-induced hunger, particularly among children, and an increase in the demand for emergency food. At school, children might not participate in SBP because the program might not be available because it might be offered too early, there might not be enough time before class once they arrive at school, or there might be a perceived social stigma associated with the program.

Children who eat breakfast have been shown to have improved total daily nutrient intake and nutritional status.

- C Eating breakfast helps control body weight by minimizing impulsive snacking, and possibly reduces risk of coronary heart disease by lowering blood cholesterol levels. Breakfast enhances the ability to learn. SBP participants have shown significantly greater improvements in standardized test scores and decreases in tardiness rates and absenteeism as compared with nonparticipants.

The benefits of a universal breakfast include:

- C A reduction in childhood hunger
- C Preparation for learning
- C Promoting program quality and increasing student participation
- C Providing children with an incentive to go to and stay in school
- C Removing the welfare stigma associated with the current SBP

Comments

These findings, summarized by the Dairy Industry, support the benefits of a universally free school breakfast program.

CITATION

Devaney, Barbara, and Thomas Fraker. "The Dietary Impacts of the School Breakfast Program." *American Journal of Agricultural Economics*, vol. 71, no. 4, November 1989, pp.932-948.

Objective of the Article

To examine the dietary impacts of the School Breakfast Program (SBP) based on 24-hour dietary recall data collected during the 1980-81 school year.

Sample and Data Used

Twenty-four-hour recall data were collected from students, along with background/demographic information, and information on participation in USDA school nutrition programs. Background data included information on family income, family size and composition, and family food expenditures. The analysis also made use of data from two surveys conducted during the 1980-81 school year as part of the National Evaluation of School Nutrition Programs (NESNP-1): (1) the Cross-Sectional Survey of Students (CSS), which used personal interviews and in-school assessments to obtain data on 6,566 students in grades 1 through 12, and (2) the Household Survey of Parents (HSP), which used household interviews to obtain data on the families of the 6,556 students interviewed.

Outcomes Examined

Three components were analyzed:

1. A systematic analysis of the relationship between the availability of the SBP and the likelihood of eating any breakfast;
2. The estimation of a model of nutrient intake and SBP participation, both at breakfast and over 24 hours
3. An analysis of the effect of the SBP on cholesterol intake.

Methodology

Descriptive data were generated by age and gender. Probit regressions, in which the likelihood of eating breakfast is a nonlinear function of SBP availability and socioeconomic characteristics of the child and the child's household, were run.

Main Findings

- C The availability of the SBP had virtually no relationship to whether students eat breakfast.
- C Both negative and positive SBP effects were found in the analysis of nutrient and cholesterol intakes.
- C Calcium and magnesium intakes were found to be positively associated with SBP participation.
- C SBP participation was related to lower intakes of cholesterol.
- C Iron intake at breakfast was negatively related to participation in the SBP.
- C Results for 5- to 10-year-old students show a reduction of the effects of the SBP on nutrient intake as the analysis expands from breakfast intake to intake over 24 hours.

Comments

Given the prevalence of iron-deficiency anemia in children from low-income families, this suggests that breakfasts served under the SBP do not address a significant nutritional problem of the program's target population.

This article describes the importance of considering the impact of breakfast on nutrient intake over the course of a 24-hour period.

CITATION

Devaney, Barbara and Elizabeth Stuart. "Eating Breakfast: Effects of the School Breakfast Program." U.S. Department of Agriculture, Food and Nutrition Service, 1998. Contract No. 53-3198-7-006.

Objective of the Article

To present findings from a re-analysis of the SNDA-1, using alternate definitions of breakfast.

Sample and Data Used

SNDA-1 is a nationally representative data set containing information from parent and student surveys as well as 24-hour dietary recalls on 3,350 students in grades 1 through 12 in 1992.

Outcomes Examined

The analysis noted whether the student ate breakfast, based on students' dietary recall data on foods and beverages consumed (using alternate definitions of breakfast).

Methodology

Literature on breakfast consumption patterns were reviewed to identify alternate definitions of eating breakfast. Based on the literature, three alternate definitions were used for the study:

- Ⓒ Consumption of any food or beverage
- Ⓒ Breakfast intake of food energy greater than 10 percent of the Recommended Dietary Allowance (RDA)
- Ⓒ Consumption of foods from at least two of five main food groups and intake of food energy greater than 10 percent of the RDA

Explanatory variables included the availability of the SBP (or another breakfast program) in school and student and family characteristics such as: age, gender, race, ethnicity, whether the child is eligible for free or reduced-price school meals, family size and composition, mother's employment status, and residential location. Probit analysis was used to examine the effect of eating breakfast, while controlling for student and family characteristics.

Main Findings

- C If breakfast is defined as any food or beverage consumed, then the SBP is not associated with an increased likelihood of eating breakfast.
- C As the definition of breakfast becomes more robust, the SBP is associated with an increased likelihood of eating breakfast for low-income students.
- C The estimated effects of SBP availability on the likelihood of eating breakfast are largest for low-income elementary students.

Comments

The choice of a particular definition for “breakfast” has an impact on the dietary outcomes findings.

CITATION

Dickie, N.H., A.E. Bender. "Breakfast and Performance." *Human Nutrition: Applied Nutrition*, vol. 36A, 1982a, pp. 46-56.

Objective of the Article

This article, published in the early 1980s presents a selective review of the literature regarding the effect of breakfast on mental and/or physical performance and questions the conclusion that "the omission of breakfast is detrimental in terms of measured performance."

Main Findings

After reviewing several studies from the 1930s and '40s, which purported to show beneficial effects of breakfast but which the authors criticize as being imprecise, the authors review the findings of the "Iowa Breakfast Studies", which were conducted by Tuttle and his team beginning in the late 1940s and continued through 25 publications. The objective was to measure the effects of a variety of breakfast regimens on a range of physiological parameters.

Tuttle, Wilson, Daum, 1949

In the first experiment, four breakfast classifications were used: (1) "heavy" breakfast [800 kcal]; (2) "light" breakfast [400 kcal]; (3) no breakfast, i.e., no food between 6:30 p.m. and noon the following day; (4) coffee breakfast (coffee with 28 g of cream and no sugar). The results showed no difference in work output between the heavy breakfast and no-breakfast groups. Reaction time showed a group tendency toward an increase when breakfast was omitted and tremor magnitude was significantly increased in every subject when no breakfast was eaten.

When the experiment was repeated with the same group of subjects, four of the six showed a significant decrease in maximum work output when breakfast was omitted, while the output of the other subjects remained virtually unchanged. Simple reaction time showed a significant increase in five of the six subjects during the no-breakfast period.

Three subjects showed a significant increase in choice reaction time and tremor magnitude while the other three showed no change during the no-breakfast period.

Daum et al. 1950

In a later experiment, the effect of various sizes of breakfast on the physiological responses of 10 women were studied. The breakfasts compared were (1) "heavy" vs. "light" breakfast; (2) "basic" vs. no breakfast; (3) no breakfast vs. black coffee only; (4) black coffee vs. "basic" breakfast with coffee.

Some significant differences in reaction time were observed in subjects who changed from a heavy to a light breakfast. However, these differences could not be attributed to the altered breakfast regimen as some significant changes in performance were noted among the control group who continued to eat the heavy breakfast.

Results from the other three comparisons show that in six subjects, choice reaction time was significantly shorter during the no-breakfast period. These findings contrast with the results from an earlier investigation by Tuttle et al. (1949) when reaction time for five out of six subjects was significantly increased during the no-breakfast period and demonstrate some of the inconsistencies of such studies.

Tuttle et al. 1954

This study examined the effects of skipping breakfast on the physiological response, mental attitudes and scholastic attainments of boys 12-14 years of age.

In the first study of seven boys, the majority had a better scholastic attitude when breakfast was included than when it was omitted. Maximum work rate and output were significantly less when breakfast was omitted but reaction time and grip strength were no different between groups.

Avedson, Sterky, and Tjernstrom 1969

This study examined whether there were any “negative” effects on the mental and physical capacity of 31 boys (aged 11-17 years) who ate a breakfast containing 6% protein compared with a breakfast containing 30% protein. The energy value of both breakfasts was the same. Sub-maximal work capacity was calculated from heart rate on bicycle ergometers. The boys also performed a “mental concentration test” as a measure of attentiveness, memory, concentration and persistence.

The authors found that there were no significant differences in physical or mental performance on the two breakfast diets. However, it was reported that eight boys omitted breakfast on one or more days during the experiment. Four of these boys achieved their highest scores on the “mental concentration test” when they omitted breakfast.

Matheson 1970; Norstrand 1971; Tavano 1971

A number of other studies have been carried out to estimate the benefits of school breakfast programs. Overall, the results have shown that the introduction of these programs did not lead to improvement in school performance or attendance.

Richardson 1972

This small-scale study was carried out on the effect of omitting breakfast on mental performance. The experiment involved a group of adult subjects. Half of the subjects habitually omitted breakfast and the other half customarily ate a moderate meal for breakfast.

Richardson reported that there was no indication among the subjects of any change in performance that could be attributed to the omission or consumption of breakfast.

However, the results did show that for three of the tests, the subjects tended to improve more in performance when they were tested following their normal breakfast routine. Improvements in performance were consistently less when they departed from their normal meal routine.

The author concluded that the occasional omission of breakfast was more deleterious than the constant omission of breakfast.

Belloc and Breslow 1972 and 1980

A survey of 7,000 adults was conducted to assess the relationship between physical health status and seven health practices. Those who ate breakfast almost every day reported slightly better physical health than those who omitted breakfast. In a follow up study nine years later (Breslow and Enstrom 1980) the authors observed a higher mortality rate for individuals with few health practices vs. those with more health practices, although the effects of individual habits such as breakfast eating could not be separated out.

Comments

This article claims “The statements regarding the importance of breakfast which are found in the standard textbooks and frequently quoted are apparently based not on the Iowa research papers but on the ‘complete summary’ of the Iowa breakfast studies’ which drew general conclusions which were somewhat at variance with the actual findings. The studies were carried out on small numbers of subjects without any clear cut findings. In fact most of the subjects showed no change in response to the various tests when breakfast was omitted. . . Thus, there does not appear to be any good evidence to support what has become the nutritionists’ dictum that ‘breakfast is the most important meal of the day.’”

This paper provides a valuable contribution by introducing skepticism and a demand for rigor in a field that, at the time, was based on many statistically inadequate studies. Based on the data presented by the authors for review, the early studies do indeed appear to be very imprecise, with very small sample sizes and contradictory conclusions. However, there are clear examples of statistically significant effects of breakfast skipping on attention, concentration, and attitudes.

CITATION

Dickie, N.H. and A.E. Bender. "Breakfast and Performance in Schoolchildren." *British Journal of Nutrition*, vol. 48, November 1982b, pp. 483-496.

Objective of the Article

The results from two studies that examined the effects of omitting breakfast on mental performance are reported.

Study 1 Objective: To compare the mental performance of schoolchildren who habitually ate or did not eat breakfast

Sample and Data Used

Two hundred twenty-seven first-year students from three London schools, average age 12.5 years, made up one sample. Another 260 fourth-year students with an average age of 15.3 made up a second sample.

By means of a short questionnaire, completed before each test period, children were placed into one of four groups: (1) breakfast and midmorning snack, (2) breakfast, no midmorning snack; (3) no breakfast but a midmorning snack, and (4) no breakfast and no midmorning snack. Breakfast was regarded as any solid food taken on the morning of the test before arriving at school, while the term mid-morning snack included any food or drink taken at break time.

All students were asked to complete a cancellation test before and after lunch, at noon and 2 p.m. respectively. From the first sample of 227 pupils, 118 were retested on the same day and time the next week. From the second sample of 260 pupils, 89 were retested the following week.

Outcomes Examined

The outcome variable for the first part of this study was performance on the cancellation test, an intellectually simple task intended to measure visual acuity, attentiveness, and vigilance. By comparing the percentage in speed and accuracy scores received before and after lunch each child served as his own control. If lack of breakfast reduced test performance, the difference would be expected to disappear after the mid-day meal. The ability to perform the test as such was unimportant.

Methodology

The Kruskal-Wallis one-way analysis of variance was used to determine whether there were any significant differences between the groups on the basis of each student's percentage change in score for pre- to post-lunch tests.

Main Findings

There were no significant differences between the breakfast eaters and non-breakfast eaters on cancellation test performance in either first-or fourth-year pupils.

Study 2 Objective: To compare the effects of omitting breakfast on mental performance in children accustomed to eating the morning meal

Sample and Data Used

The study was conducted in a series of four London boarding schools. In the first investigation, 55 students (experimental group n=35, control group n=20) with an average age 17 years made up the first sample. A second investigation involved 53 students (experimental group n=33, control group n=20) with an average age of 16.2 years.

In the first investigation the 55 students were tested with two versions of the Memory and Search Test (referred to as MAST 4 and MAST 6 for this study), and simple addition tests consecutively. In the second investigation, the students were tested with a sentence verification task. In each investigation the subjects were randomly assigned into two groups. For three consecutive days of the first week, following their normal breakfast routine, students were asked to perform the noted tests. This week was used to stabilize performance and mitigate the effects of practice. The following week the same subjects were again tested on three consecutive mornings. This time, however, the experimental group omitted breakfast, while the control group ate their usual breakfast. Subjects in the experimental group were instructed not to eat or drink anything from the time they awoke until after testing was completed.

Outcomes Examined

The outcome variables included performance on the two versions of the MAST (MAST 4 and MAST 6), a sentence verification task, and simple addition tests. The tests were scored on speed (the number of questions attempted), achievement (the number of questions correctly answered), and accuracy (the number of questions correctly answered, as a percentage of the speed score). The results were also assessed on the basis of the changes in scores between successive test sessions.

Methodology

The differences in the MAST 4, the MAST 6 and simple addition scores between the control and experimental groups were evaluated using Student's t-tests. The Mann-Whitney U test was used for the sentence verification test data.

Main Findings

The results did not show any performance change in subjects who omitted their accustomed breakfast on three consecutive days. The differences that were observed were of the order of 5% but they were not consistent and could not be ascribed to the omission of breakfast since differences also occurred during the non-experimental period.

The subjects in this study fasted for up to 16 hours and were apparently able to perform as well as control subjects who had eaten breakfast 3 hours before the test.

Comments

Study 1 had several potentially confounding factors that were not controlled for, that is, timing and composition of breakfast, effects of midmorning snack, effects of lunch, and the disproportionate sample size of each group.

While the findings from Study 2 suggest that the omission of breakfast is not detrimental, this does not rule out the possibility that there could be some deterioration of performance in normal daily activities because many subjects tend to be highly motivated during a test, thus performing better than normal.

While provocative and important, these studies raise as many questions as they answer. As the authors themselves state, the effects could have been because breakfast is truly unimportant or because the tests employed were not sufficiently discriminating to detect the effects of missing breakfast. The authors also raise the possibility that the subjects' knowledge of the fact that they were being tested could have supplied enough motivation to enhance their performance, thus overpowering any positive effects of eating breakfast. But there are many other potential confounding factors in this study as well. Breakfast participation or lack of it was, in all cases, based on student self report. In Study 2, the breakfast skipping condition was based on students voluntarily refraining from eating on the morning of the study. Subjects who skipped breakfast were 35 young men who were a mean age of 17 who were students at an English boarding school. As such, the degree to which they actually skipped breakfast can not be determined.

The results from the two studies failed to show that the omission of breakfast was detrimental to late morning performance on a test of visual acuity, attentiveness, and vigilance in one study and tests of simple addition, short term memory, and sentence verification in the other.

Still, the findings presented in this paper are clear and important. Whatever the effect of breakfast skipping, it appears to be neither large nor consistent. As pointed out by Rogers and Lloyd, these kinds of mixed findings suggest that even if they are there, the effects of breakfast eating are relatively small. For this reason alone, future studies need to be cognizant of sample sizes for statistical power and the need to be able to control for many potentially confounding influences.

CITATION

Dwyer, J.T., M.K. Ebzery, T.A. Nicklas, et al. "Improving School Breakfasts: Effects of the CATCH Eat Smart Program on the Nutrient Content of School Breakfasts." *Preventive Medicine*, vol. 25, 1996, pp. 413-422.

Objective of the Article

To examine the impact of the Eat Smart School Nutrition Program, the food service component of the Child and Adolescent Trial for Cardiovascular Health (CATCH), on the percentage of calories from total and saturated fat, as well as the sodium content of school breakfasts. It also assesses whether the Eat Smart intervention affected levels of calories, carbohydrate, total sugars, dietary fiber, and other essential nutrients, such as protein, calcium, iron, and vitamins A and C in school breakfasts. The study also examines levels of student participation in the program.

Sample and Data Used

School breakfast menus, recipes, and vendor product information were collected for five consecutive days in 59 (24 control and 35 intervention) CATCH schools offering breakfast. These data were collected in the fall of 1991 (baseline), the spring of 1993 (interim, or, 1.5 years after the intervention was in place), and the spring of 1994 (follow-up, or, 2.5 years after the intervention was in place).

Outcomes Examined

Seventeen outcomes were examined: calories, total fat, saturated fat, sodium, cholesterol, carbohydrate, protein, dietary fiber, total sugars, calcium, iron, vitamin C, vitamin A, and percentage of calories from total fat, saturated fat, carbohydrate, and protein.

Methodology

Average daily breakfast participation rates were calculated by summing the number of paid, reduced-price, and free breakfasts for the month, then dividing by the product of the total number of days on which breakfast was served and the average daily attendance for that month.

Seventeen models were constructed for each of the outcomes. Each model included as fixed effects: time, site, treatment group and all higher order interactions as independent variables to investigate the effect of treatment across all sites and over time. A random effect (school nested within site and treatment group), was included to reflect the correlation among five-day averages within a school across the three periods of data collection. A compound symmetric covariance structure was assumed in all models. Means and standard errors from the repeated-measures ANOVA models were adjusted by setting the variable of

interest at a particular level and averaging over all levels of all other fixed effects. A contrast of means reflecting the time by treatment group interaction was constructed to compare the change from baseline to follow-up in control schools with that in intervention schools.

Main Findings

- C The Eat Smart goal for #30% of calories from fat was essentially met by both the intervention (28.4%) and the control (30.3%) groups at baseline. At follow-up, these figures dropped to 23.3 percent in intervention schools and to 25.2 percent in control schools. Mean percentage of calories from fat was lower in intervention schools than in control schools at baseline, interim, and follow-up, but no significant differences were attributable to the intervention.
- C The Eat Smart goal for <10 percent of calories from saturated fat was not met by either the intervention or the control group at baseline and at interim. By follow-up, the intervention schools met the Eat Smart goal, while the control schools did not; however, this difference was not statistically significant.
- C The goal of reducing sodium by >25 percent was not met by either group. The goal of not exceeding 500 mg of sodium per breakfast was also not achieved by either group. Breakfast sodium levels in both groups did decline over time, though; by follow-up, both groups were within 30 mg of the 500 mg goal.
- C Dietary cholesterol reduction was not a stated goal; however, Eat Smart recommended substitutions that would lower cholesterol levels in food choices. The National Cholesterol Education Program guidelines specify that breakfast should contribute no more than 75 mg of cholesterol. These levels were met at baseline in all schools, with a large drop from interim to follow-up; no statistically significant values were found between intervention and control schools, though.
- C SBP regulations require that school breakfasts provide one-quarter of the RDA for calories, or 500 calories. The breakfasts offered in all schools fell short by about 14 to 49 calories.
- C The differences over time in percentage of calories from protein and total carbohydrates, and mean levels of total sugars, calcium, iron, vitamins A and C, and dietary fiber were not significant between intervention and control groups. The percentage of calories from carbohydrates rose slightly in both groups, but no statistically significant differences from baseline to follow-up were found. Total sugar and dietary fiber levels remained fairly stable, and no significant differences between groups over time were found.
- C The mean percentage of calories from total fat in breakfasts offered did not differ between groups over time.

- C The decrease in the percentage of calories from saturated fat was significant in Texas and approached significance in Louisiana.
- C The decrease in cholesterol over time between groups was significant only in Louisiana.
- C No significant differences in participation over time between groups were found.
- C No significant changes in the percentage of free and reduced-price breakfasts between groups were found.

Comments

Because data were collected on food choices offered, rather than foods selected and consumed, this may not be representative of students' actual breakfast consumption patterns.

A suggestion for further research was that factors that affect the participation of children who are at high risk of under-nutrition--such as males, those certified for free meals and urban minorities--should be addressed.

CITATION

Dwyer, J.T., M.K. Ebzery, and T.A. Nicklas, et al. "Do Third Graders Eat Healthful Breakfasts?" *Family Economics and Nutrition Review*, vol. 11, no. 4, 1998, pp.3-18.

Objective of the Article

To describe breakfast consumption patterns and the nutrient contribution of breakfast meals measured prior to school- and family-based interventions designed to reduce risk factors for cardiovascular disease, when the CATCH sample was in the third grade, and to compare findings with national goals and results from similar studies.

Sample and Data Used

The total CATCH sample consisted of 5,106 elementary school students from 96 public schools in California, Louisiana, Minnesota, and Texas. There were 24 schools in each state: 14 treatment and 10 control. Fifty-nine of these schools (61%) participated in a SBP. Before implementing the CATCH intervention, a subsample of 3,486 students from the four states were randomly selected to provide representative 24-hour dietary recalls. Of this subsample, students who consented and for whom a blood cholesterol level was available were interviewed for baseline measurement in the fall of 1991 when they were third graders (n=1,920). To evaluate CATCH intervention effects, 24-hour dietary recalls were conducted at follow-up in the spring of 1994 (when the study participants were in the fifth grade). Of the 1,920 cases in the sample, 237 were excluded from the primary analysis for quality assurance reasons. This resulted in a sample of 1,683.

Outcomes Examined

Data were analyzed to determine nutrient intakes at breakfast and the contribution of breakfast to the total daily intake of children.

Methodology

Students recorded all food and beverages consumed from the time they woke up until the time they went to bed. The following day, CATCH staff asked students to recall everything they had consumed the previous day. Students' food records were used as a memory prompt. The students were asked to estimate portion sizes using three-dimensional food models, two-dimensional shapes, and measuring utensils. They were then asked to provide the name (i.e., breakfast, lunch, snack, dinner), time, and source of each meal.

CATCH staff also collected school breakfast menus, information on recipes, prepared food products, and preparation methods to coincide with the 24-hour dietary recall in order to determine nutrient intakes from school breakfasts. (No information was collected on the use of vitamin and mineral supplements or salt added at the table.) The Minnesota Nutrition Data System, version 2.2, was used to calculate breakfast and total daily nutrient intakes.

A mixed linear model was used for the analysis. The dependent variables were analyzed both in absolute units and relative to the total energy content of breakfast. Site, gender, race/ethnicity, and source of meal were included as fixed independent effects. Interaction terms for gender with race/ethnicity and source of meal with gender, race/ethnicity, and site were included. A random effect accounted for between-school variation among sites. Means were adjusted for all factors in the model. Means and standard errors were transformed back to the original units for presentation when log or square root transformations were used to reduce skewness.

Main Findings

- C Ninety-four percent of all students in the sample reported eating breakfast: No Asian-American students and 4 percent of Caucasian students reported skipping breakfast, compared with 11 percent of Hispanic students and 8 percent of African-American students ($p < 0.001$).
- C Skipping breakfast is more prevalent among children from low-income than higher-income families. However, low-income children are more likely to participate in a SBP when it is available than are higher income children.
- C Fourteen percent of the CATCH schools in Minnesota and 13 percent of the CATCH schools in California provided a SBP, while all of the CATCH schools in Louisiana and Texas provided a SBP.
- C Two percent of the students in Minnesota skipped breakfast, compared with 5 percent in California, 6 percent in Louisiana, and 10 percent in Texas ($p < 0.001$).
- C One percent of the students in Minnesota and 2 percent of the students in California ate breakfast at school, compared with 22 percent of the students in Louisiana and 29 percent of the students in Texas.
- C Students who ate breakfast consumed significantly more calories than those who did not. Breakfast eaters also had higher intakes of carbohydrates, sodium, cholesterol, and most vitamins and minerals.
- C Eating breakfast, whether at home or at school, increased children's daily intakes of vitamins and minerals and decreased the percentage of calories from fat.

Comments

Because household income data were unavailable for individual CATCH children, the authors surmised that Texas and Louisiana schools had more children from poor and minority families (based on the ethnic distribution and the number of children eligible for free or reduced-price meals at each site). The lack of information on individual socioeconomic status makes it difficult to accurately and reliably conclude differences between groups. Another study limitation is that it only made use of a single 24-hour recall, which is not representative of usual nutrient intake for an individual. Also, there is evidence to suggest that 24-hour recalls systematically underestimate food intakes by 10 to 20 percent. Thus, actual intakes may have been higher than those reported. It is also possible that some students reported foods eaten at breakfast as snacks, which would also introduce error into the analysis. Moreover, quantitative data on discretionary salt use was not obtained, so estimates of total dietary sodium are underestimated for those who add salt at the table or in cooking. Finally, the study did not take vitamin and mineral supplements into account.

CITATION

Food Research and Action Center (FRAC). *The Relationship Between Nutrition & Learning: A School Employee's Guide to Information and Action*. Prepared for the National Education Association, 1989.

Parker, L. "Appendix D: Executive Summary of Nutrition and Learning: A School Employee's Guide to Information and Action." *School Food Service Research Review*. Prepared for the National Education Association, 1989.

Objective of the Article

This 41-page monograph and five-page executive summary provide basic information about the relationship between nutrition and learning to ensure that students benefit from nutrition programs. The article was prepared by FRAC, an anti hunger advocacy organization, for the National Education Association in order to enable its members to advocate for school breakfast and lunch programs and nutrition education.

The monograph has six chapters. The first concerns the relationship between nutrition and learning, the second is on nutrition programs that help children learn, the third focuses on obesity, the fourth is on what schools can do to ensure student access to food programs, the fifth is on what schools can do to ensure healthful foods in the child nutrition programs, and the sixth addresses a model school nutrition policy.

Main Findings

Hunger and under-nutrition among America's children:

- C A 1985 study by the Public Health Department in Utah showed that almost one-third of all children surveyed among the low-income population were below the fifth percentile for height for their age. This is six times the level expected in a normal population. Also, one-fifth were below the fifth percentile for weight for their age, four times what is expected in the normal population.
- C A 1983 study carried out by the Public Health Department in Massachusetts showed that chronic malnutrition is a significant problem in low-income, preschool children in Massachusetts, with 9.8 percent of the children identified as having low height-for-age. In addition, anemia was present in 12.2 percent of the children.
- C A 1983 study of children under age five admitted to Boston City Hospital's emergency room found that the prevalence of growth retardation was nearly three times the expected rate for a normal population.

- C A 1983 assessment of the nutrient intake of low-income children at the children's clinic of Cook County Hospital in Chicago revealed that 48 percent of the children under two years of age had nutritionally deficient diets.
- C A 1986 study of hunger among low-income children in New Haven, Conn., found that 18 percent of families with children between the ages of 1 and 11 had a chronic hunger problem. In addition, the study found that 65.3 percent of the households had experienced at least one indicator of a hunger problem.
- C A 1986 hunger survey in Milwaukee found that 16 percent of the children served by food pantries in the city were forced to skip one or more meals per day due to lack of food and money.
- C A 1986 survey of emergency food shelf users in the state of Minnesota revealed that 21 percent of all households with children reported that their children missed meals on a regular basis because there was not enough money to buy food.
- C In 1987, the U.S. Conference of Mayors documented an 18 percent increase in the number of families with children who were seeking emergency food in major cities across the nation.

Comments

This article summarizes previous research emphasizing the prevalence of hunger and poor nutrition among students and points to steps that school personnel can take in advocating for more attention to nutrition programs.

CITATION

Gibson, S.A. and K.R. O'Sullivan. "Breakfast Cereal Consumption Patterns and Nutrient Intakes of British Schoolchildren." *Journal of the Royal Society of Health*, December 1995.

Objective of the Article

To examine the relationship between breakfast cereal consumption and total daily nutrient intakes.

Sample and Data Used

Individual weighed records of the consumption of all food and drink consumed over seven days by 2,705 British schoolchildren were analyzed. The children were grouped according to amount of cereal consumed per day (none; less than 20g; 20-40g; over 40g), and results were examined for each age group (10-11 and 14-15 years) in boys and girls separately.

Outcomes Examined

The study looked at intakes of energy, fat energy, fat, carbohydrate, calcium, iron, thiamin, riboflavin, niacin, and vitamin B₆.

Methodology

Total energy and nutrient intakes of children in each of these four categories were calculated, and the differences between the groups were assessed by one-way analysis of variance (ANOVA) and the Duncan multiple range test. Intake data were compared to Reference Nutrient Intake (RNI) standards.

Main Findings

- C Eighty-one percent of children reported eating cereal during the week.
- C The proportional energy from fat intake was inversely related to the level of breakfast cereal consumption.
- C Body Mass Index (BMI) was lower in girls and boys who consumed breakfast cereal.
- C Those eating the most breakfast cereal had the highest intakes of iron.
- C Non-consumers of cereal had average riboflavin intakes at or below the RNI.
- C For boys, those who consumed cereal every day had mean intakes of calcium above the RNI.

Comments

Findings for British children are likely to be applicable to U.S. children based on similar patterns and trends in nutrient intake and weight status in children in the two developed countries.

CITATION

Gietzen, D. and J.A. Vermeersch. "Health Status and School Achievement of Children from Head Start and Free School Lunch Programs." *Public Health Reports*, vol. 95, no. 4, July-August 1980, pp.362-368.

Objective of the Article

To determine whether the nutritional input of the Head Start and Free Lunch Programs could affect physical and educational outcomes for disadvantaged children.

Sample and Data Used

The school health records (from pre-K to grade 8) of approximately 1,100 students in a small, predominantly white, semi-rural school district in northern California were screened to select children for the study. The study sample included four groups of children: (1) 113 Free Lunch participants; (2) 100 Head Start participants; (3) 55 Title I students; and (4) 64 preschool children. The treatment group made up of the Free Lunch and the Head Start participants; the comparison group consisted of the Title I and preschool participants.

Outcomes Examined

The educational outcome variables included: (1) scores on the Comprehensive Test of Basic Skills; (2) assignment to low, medium or high track; (3) birth dates to determine whether or not the individual is overage for grade; and (4) placement in a special education program.

The physical education variables studied included: (1) number of absences from school for medical reasons; (2) performance on the 6-minute jog-walk; and (3) height for age, weight for age, and weight for height.

Methodology

The study used cross-sectional, longitudinal, and mixed longitudinal approaches to analyze data from school health records. The chi-square statistic was used to test the significance of differences in the distribution of children from the four cohorts for tracking, special education, and poor growth. Differences in means were tested for significance using Student's t-test and analysis of variance.

Main Findings

The results suggest that receiving free lunches is not sufficient for the educational and physical disadvantages suffered by children from low-income families.

- C No significant differences in test scores were found between the three disadvantaged groups (Head Start, Free Lunch, and Title I).
- C There were no significant differences in tracking and grade retention status between the groups of disadvantaged children that could be attributed to participation in any of the three intervention programs.
- C Results of the cross-sectional analysis of the growth indices did not reveal significant differences among the cohorts in the weight for age or weight for height measures. The Head Start boys, however, were significantly taller than the Free Lunch boys on measures of height over the total age range. Differences among Head Start, Title I, and preschool boys and among all groups of girls were not significant.
- C Other physical status variables also showed better performance among Head Start children than children receiving school lunches. There were no significant differences among the girls, but Free Lunch boys had a lower mean score on the six-minute jog-walk than boys from Title I and Head Start.
- C Children from Head Start had significantly fewer absences due to illness than children from either the Title I or Free Lunch group.

Comments

The study is useful for suggesting outcomes that are important to consider; however, it utilized a small, nonrandom sample and lacked adequate controls. Moreover, it is not clear that the Title I and preschool students adequately served as a comparison group. Although the two programs did not include a nutritional component, it is possible that some Title I or, even, preschool students may have participated in some form of a school lunch program. As for the preschool children (who all came from middle- to upper-income families), it is of little or no surprise that they had a tendency to outperform their disadvantaged counterparts on many outcome measures.

CITATION

Hunt, Isabelle, Harry Lieberman, Anne Coulson, Norma Murphy, and Virginia Clark . “Effect of a Breakfast Program on the Nutrient Intake of Black Children.” *Ecology of Food and Nutrition*, vol. 8, 1979, pp.21-28.

Objective of the Article

To evaluate the effect of a free school breakfast on the nutrient intake of a sample of black children in a metropolitan area in Los Angeles County, CA.

Sample and Data Used

Twenty-four-hour dietary recalls were obtained from 555 children enrolled in grades three through six in two schools in Compton, CA. The children ranged in age from 7 to 13, with a mean age of 10.5 years. Two hundred and fifty-two black children attending a school with a breakfast program were compared with 303 black children in a school in which breakfast was not served.

Outcomes Examined

Mean dietary intake and mean percentage of RDA consumed in one day.

Methodology

Interviews were conducted by community workers trained by nutritionists. The interviewing began after the breakfast program was implemented. Workers interviewed children and their guardians in their homes on Tuesdays, Wednesdays, or Thursdays (to obtain information that reflected what is typically eaten on weekdays). Respondents were asked to recall everything the child ate or drank in the previous 24 hours, using food models as a guide. Nutrient intake data were evaluated by comparing the reported dietary intakes with the appropriate RDA. T-tests and the chi-square test were used to determine statistical significance.

Main Findings

- C Children in the breakfast school consumed significantly more of their total daily nutrient intake before 10 a.m. than those in the control school for all nutrients.

- C Of the children with poor diets, 16 percent from the control school vs. 5 percent from the breakfast school had nothing to eat before 10 a.m. This difference was significant at the .005 level.
- C No statistically significant differences were found in the mean total daily nutrient intakes of children in the breakfast and control schools.
- C Participation rates in the breakfast program were low; however, the program did increase the mean morning nutrient intake of children (before 10 a.m.) in the breakfast school.

Comments

Twenty-four-hour dietary recalls performed on one day may not be representative of the child's daily eating patterns to categorize a child as having a "poor diet".

CITATION

Kleinman, R.E., J.M. Murphy, M. Little, P. Pagano, C.S. Wehler, K. Regal, and M.S. Jellinek. "Hunger in Children in the United States: Potential Behavioral and Emotional Correlates." *Pediatrics*, vol. 101, January 1998, pp. 1-6.

Objective of the Article

The objective of the article was to determine the relationship between hunger as defined by the Community Childhood Hunger Identification Project (CCHIP) measure and variables reflecting the psychosocial functioning of low-income, school-aged children.

Sample and Data Used

The study group included 328 parents and children from a CCHIP study of families with at least one child under the age of 12 years and with incomes at or below 185% of the poverty level (\$25,812 for a family of four at the time the households were screened in 1993) living in the city of Pittsburgh and surrounding Allegheny County.

Hunger status was determined by parent responses to the standard eight food-insufficiency questions from the CCHIP survey that classify households and children as "hungry," "at-risk for hunger," or "not hungry".

All parents whose child was between the ages of 6 and 12 years at the time of interview were asked to complete the Pediatric Symptom Checklist (PSC).

Outcomes Examined

The outcome variable used for this study was the PSC, a brief parent-report questionnaire that assesses children's emotional and behavioral symptoms.

Methodology

To test the hypothesis that hungry children have a higher rate of psychosocial dysfunction than non-hungry children, Pearson P^2 analysis of case rates and one-way analysis of variance of differences in mean PSC total symptom scores were used for the three CCHIP hunger groups. To explore the relationship between hunger status and more specific behavioral symptoms, the differences between the three hunger groups on individual PSC symptoms were examined. Finally, a factor analysis assessed differences between the hunger groups in terms of clusters of PSC symptoms.

Main Findings

- C Those children defined as hungry on the CCHIP measure were significantly more likely to have clinical levels of psychosocial dysfunction on the PSC than children defined as at-risk for hunger or not hungry.
- C Analysis of individual items and factor scores on the PSC showed that virtually all behavioral, emotional, and academic problems were more prevalent in hungry children, but that aggression and anxiety had the strongest degree of association with hunger.
- C Children who were coded as hungry on the CCHIP measure were from two to four times more likely to have repeated a grade, received special education services, or received mental health counseling than other low-income children whose parents did not report hunger.
- C The authors concluded that children from families that report multiple experiences of food insufficiency and hunger were more likely to show behavioral, emotional, and academic problems on a standardized measure of psychosocial dysfunction than children from the same low-income communities whose families do not report hunger.

Comments

A correlational study design like the current one cannot prove a causal relationship between hunger and behavioral problems. Although it is possible that hunger causes the types of behavior problems documented in the current study, it is also possible that hunger is less of a cause than a correlate of still another variable.

Furthermore, since the CCHIP data is based on parent reports, several issues are raised. First, a parent report of multiple family experiences of food insufficiency does not necessarily mean that each child in the family has had the same experience, and even if the children have experienced food insufficiency, it does not follow that they have suffered from a clinically significant state of under-nutrition. Reliance on parent's reports of child psychosocial symptoms and of child hunger also introduces the possibility of confounding because both reports might be unduly biased by factors such as parental dysfunction or distress.

In addition, because this current study, like other CCHIP studies, made use of lay interviewers working under the auspices of a community-based antihunger group, the possibility of bias may exist.

Once these caveats have been noted, however, it is important to restate the central finding that children for whom a parent reported child hunger were two to seven times more likely to report psychosocial problems on the PSC and on measures of academic functioning.

CITATION

Levine, Allen S. et al. "Effect of Breakfast Cereals on Short-Term Food Intake." *American Journal of Clinical Nutrition*, vol., 50, 1989, pp.1303-1307.

Objective of the Article

To evaluate the effect of high-fiber cereals on short-term food intake.

Sample and Data Used

Two studies were conducted. There were 14 participants in the first and 19 participants in the second study. The subjects were all healthy adults ages 24 to 59 in the first study and 24 to 55 in the second study. None of the subjects in the first study were obese (defined as having a body mass index, or, BMI>25 kg/m²); five of the subjects in the second study were obese with BMI>27 kg/m². Subjects arrived in the Special Diagnostic and Treatment Unit (SDTU) at the Minneapolis VA Medical Center at 7:30 a.m. having been instructed to fast from 10 p.m. the previous night. Two baseline breath H₂ samples were taken, follow-up samples were collected every hour for the next six hours. On the day of the first study, 14 healthy subjects were randomly assigned to eat one of five breakfasts: 57g of Kellogg's All-Bran, Ralston Purina's Bran Chex, General Mills's Fiber One, General Foods's Post Toasties, or Nabisco's Shredded Wheat along with 240 ml of 2 percent milk and 120 ml of orange juice.

At 11 a.m., they returned to the SDTU for an ad libitum buffet luncheon. The buffet consisted of yogurt, hamburgers on buns, bread, jelly, margarine, peanut butter, cheese, peaches, carrots, radishes, celery, pickles, condiments, corn chips, milk, orange juice, and coffee, with or without cream. Food intake was measured during the 30-minute meal and values for kilocalories were calculated according to the Agricultural Handbook 8.

In the second study, 19 healthy subjects followed the same protocol as above, except that they were randomly assigned to receive either a very-low-fiber cereal (Post Toasties) or a very-high-fiber cereal (Fiber One). The subjects were not told which cereal they were receiving, nor were they told the fiber content of the cereals.

A questionnaire was administered to all subjects before the buffet lunch on each day of the study. Questions were included to help mask the major purpose of the study. Most of the questions were irrelevant to the study; however, three were pertinent. These questions asked subjects to rank their hunger before the buffet lunch on a Likert scale from 1 (much more hungry than usual) to 5 (much less hungry than usual).

Outcomes Examined

Feelings of hunger ranked on a Likert scale from 1 (much more hungry than usual) to 5 (much less hungry than usual) as well as individual food intake measured while at the buffet lunch.

Methodology

Data were analyzed by a repeated-measures ANOVA. Specific contrasts were conducted by the use of the least-significant difference test, and statistical significance was defined as $p < 0.05$.

Main Findings

- C Having a high-fiber cereal for breakfast results in a decrease in the calories consumed during breakfast and at lunch.

Comments

The exact amount of energy available in dietary fiber is not known. This complicates the calculation of energy ingested. For the purpose of the study, the caloric content printed on the packaging was used.

CITATION

Levitsky, D.A. and B.J. Strupp. "Malnutrition and the Brain: Changing Concepts, Changing Concerns." *Journal of Nutrition*, vol. 125, 1995, pp. 2212S-2220S.

Objective of the Article

To review the literature on the cognitive effects of early malnutrition and to present a theoretical framework for determining whether the cognitive processes that are most vulnerable to poor nutrition were adequately assessed.

Sample and Data Used

Clinical and experimental studies that assessed behavior following a period of nutritional rehabilitation were reviewed to draw conclusions about enduring, as opposed to concurrent, effects of nutritional health.

Outcomes Examined

Cognitive processes (emotionality, motivation, anxiety, cognitive inflexibility) were examined.

Methodology

Rather than a literature review, this study reviewed the types of cognitive changes that were consistently observed in studies of cognition and nutrition to guide decisions about cognitive tests in future studies.

Main Findings

Experimental and clinical behavioral data suggest that attentional processes, response inhibition, and planning are most vulnerable to early malnutrition. Cognitive test most often used in animal and human studies are not sensitive to subtle deficits in these functions. For example, children with attention deficit hyperactivity disorder may perform normally on IQ tests despite problems with attention. Nutritional problems do not exist in isolation, but are often found with iron deficiency anemia or elevated blood lead levels.

Comments

This review provides insight into the choice of cognitive tests that may be affected by either short-term or long-term poor nutrition.

CITATION

Lindeman, A.K., and K.L. Clancy. "Assessment of Breakfast Habits and Social/Emotional Behavior of Elementary Schoolchildren." *Journal of Nutrition Education*, vol. 2, October 1990, pp. 226-231.

Objective of the Article

This article reports on a study intended to examine the effects of breakfast habits on the social and emotional behavior of schoolchildren, using a carefully selected study design.

Sample and Data Used

Three hundred eighty-two third- and fourth-grade students and their 16 teachers from two upstate New York school districts participated in this study. All were Caucasian; 48% were male and 52% were female.

Data were collected from late October through November, in concurrence with the observation by Evertson and Veldman that behavior ratings made very early or very late in the school year may not be as reliable as those obtained at midyear. This allowed adequate rater (teacher) exposure to the children for a reliable assessment of their normal behavior.

Teachers received copies of the revised Conners Teachers Rating Scale (TRS), along with written and verbal instructions for their use. On designated days, teachers randomly chose five pupils in the class for whom morning behaviors would be observed and rated. Those students noted by the teacher as displaying easily observed symptoms of hyperactivity or a learning handicap were excluded in advance.

All students completed the self-administered student survey of demographic information, evening and morning activities, and food intake. Children were also asked about hours of sleep the night before, length of the morning bus ride, and expression of hunger for lunch. Children were asked to circle or check foods eaten for breakfast that morning. This procedure was repeated on two subsequent dates, each one week apart, on the same day and time.

Breakfasts were classified by carbohydrate content: low, medium, and high, and by protein content: low, medium, and high. Breakfasts were also described qualitatively by the foods consumed.

Outcomes Examined

The outcome variable used for this study was the TRS.

Methodology

The student's t-test for independent samples, and a one-way ANOVA were used to determine the significance of results obtained from quantitative data. The significance of any relationships between breakfast habits and behaviors was determined with Pearson's product moment and point biserial correlations.

Main Findings

Because less than 10% of the students omitted breakfast there was inadequate information to detect any statistical differences in classroom behavior between those students who ate vs. those who omitted breakfast.

Cereal and milk were by far the most popular (77.8 percent) breakfast foods overall. Almost half of the sample ate moderate levels of carbohydrate or protein breakfasts, at 48.2 percent and 56.2 percent, respectively.

There was no observed increase in problem morning behaviors associated with skipping breakfast, undoubtedly affected by the small number of students who omitted the meal. Students who ate breakfast tended to score slightly lower on the conduct problem, inattentive/passivity and hyperkinesis syndromes, but the differences were not statistically significant.

- Ⓒ There was no observed effect of types of breakfast consumed on morning behavior.
- Ⓒ Other activities such as hours of sleep and time on the morning bus had no observable effect on late-morning behavior. None of these activities were found to have any observable effect on morning behavior.

Comments

According to the authors, a future study with a larger ($n > 400$) sample could possibly identify an adequate number of children who omitted breakfast and could provide enough statistical power to detect differences between groups of breakfast eaters and omitters.

Another important factor, given Pollitt's often-stated conclusion that the effects of breakfast are more pronounced in nutritionally at-risk children, is that these students appeared to be of higher than average socioeconomic status (no students were from minority groups and there was a lower than average percentage of students from single-parent families. Also, less than 10 percent of these students reported skipping breakfast, which is lower than the national percentage of students who skip breakfast. Given the fact that this sample had a smaller-than-expected percentage of nutritionally at-risk students, the fact that there was an apparent trend in the right direction was potentially quite important.

CITATION

Looker, Anne C., Peter R. Dallman, Margaret D. Carroll, Elaine W. Gunter, and Clifford L. Johnson. "Prevalence of Iron Deficiency in the United States." *Journal of the American Medical Association*, vol. 277, no.12, March 26, 1997, pp. 973-976.

Objective of the Article

To determine the prevalence of iron deficiency and iron deficiency anemia in the U.S. population.

Sample and Data Used

Nationally representative, cross-sectional data were used from the third National Health and Nutrition Examination Survey (NHANES III). The survey collects data via household interviews and direct standardized physical examinations including phlebotomy in mobile examination centers. The NHANES III is a six-year study (1988-1994) that used a stratified, multistage probability design to select the sample. The sample used in the study was restricted to 24,894 males and nonpregnant females ages 1 and older.

Outcomes Examined

Results from three laboratory tests of iron status (free erythrocyte protoporphyrin, transferrin saturation, and serum ferritin) were analyzed. Iron deficiency was defined as having an abnormal value for two or more of these non-indicators. Iron deficiency anemia was defined as having iron deficiency and a low hemoglobin value.

Methodology

Sample weights were used to calculate prevalence estimates and to account for oversampling and nonresponse to the household interview and physical examination but not for nonresponse to the phlebotomy. The sampling weights for phases 1 and 2 were based on the March 1990 and March 1993 Current Population Surveys for the civilian non-institutionalized population. Descriptives (mean, frequencies, cutoff values) and other statistics were generated.

Main Findings

- C Iron deficiency is very common among toddlers. This national study finds that iron deficiency anemia among toddlers occurs much less frequently than smaller, non-nationally representative studies from the 1960s have reported. Approximately 9 percent of toddlers ages 1 to 2 years,

or, 700,000 toddlers have iron deficiencies; approximately 3 percent, or, 240,000 toddlers have iron deficiency anemia.

- C Iron deficiency and iron deficiency anemia are relatively common in the United States among women of childbearing age (especially those who are black, Mexican American, poor, have >12 years of education, or have four or more children). Approximately 9 percent to 11 percent, or, 7.8 million women and adolescent girls were iron deficient; approximately 2 percent to 5 percent, or, 3.3 million women and adolescent girls have iron deficiency anemia.

Comments

The study provides the most recent national data on iron deficiency for U.S. children by age and income level. The data indicate that despite dietary changes or improvements that may have taken place, iron deficiency remains a problem for a large proportion of children ages 1-4 years and adolescent females.

CITATION

Lopez, I., Andraca, I., C.G. Perales, E. Heresi, M. Castillo, and M. Colombo. "Breakfast Omission and Cognitive Performance of Normal, Wasted and Stunted Schoolchildren." *European Journal of Clinical Nutrition*, vol. 47, February 1993, pp. 533-542.

Objective of the Article

To study the effect of breakfast omission on the cognitive functions of low-income children determined to have either normal nutritional status, a unique deficit in height-for-age (stunting), or a unique deficit in weight-for-height (wasting).

Sample and Data Used

Two hundred and seventy-nine children, 145 girls and 134 boys, from a low socioeconomic background in Chile comprised the total sample. Children ranged in age from 8 years, 7 months to 10 years, 11 months (mean age = 9 years, 3 months). Children were categorized nutritionally as normal, wasted or stunted. The sample was selected from the fourth- fifth- and sixth-grade classes of 12 public state schools located in the outskirts of Santiago, Chile.

After anthropometric assessment, children who fulfilled one of the following criteria were included: (a) Nutritionally normal group (n=106), with height/age (H/A) and weight/height (W/H) between 95 percent and 115 percent of the 50th percentile of the National Center for Health Statistics (NCHS) standards (1978). (b) Wasted group (n=73), with W/H below 91 percent of the 50th percentile of NCHS standards, and normal H/A. (c) Stunted group (n=100), with H/A below 92 percent and W/H above 95 percent of the 50th percentile of NCHS standards. Additional selection criteria were normal health status, normal neurological examination, absence of pubertal development as stated by Tanner's (1978) standards and an IQ higher than 80 (Wechsler Intelligence Scale for Children –WISC).

Once participants were selected, their homes were visited in order to assess their socioeconomic background through administration of the Specific Socioeconomic Scale. Parents were instructed during a personal interview, and later reminded by letter, to send their children to school without breakfast on the morning when cognitive evaluation was to take place. In order to minimize the effects of a novel environment on mental function, all the assessments and the examination performed following the selection procedure were carried out entirely at the schools.

A 24-hour diet recall was conducted in order to estimate quality, quantity, and timing of food and drink consumed the previous day, as well as the duration of fasting. Children were also asked, in private, if they had had anything to eat that morning. Twenty-three percent confirmed they had eaten, and were assigned to the breakfast condition.

Subjects were assigned to either a breakfast or fasting group. In the first group the children received a standard meal consisting of 394 kcal and 6 grams of protein, 1 hour before cognitive assessment took place. In contrast, the fasting group was first assessed and then received breakfast.

Cognitive test administration took place between 9:00 a.m. and 11:00 a.m. each morning (four subjects were studied each morning). Capillary blood and urine samples were then obtained from the subjects to test for glycaemia and ketonuria determinations.

Outcomes Examined

The outcome variables included three specific cognitive tests that were developed specifically for this study to evaluate short-term visual memory, problem-solving capacity, and attention. These were designed and implemented through a computational system devised and applied with a microcomputer equipped with a floating keyboard and joystick. This method allowed standard administration and accurate measurements of performance and time employed on each task.

Methodology

The study design consisted of six groups according to nutritional status and study condition. A two-factor ANOVA was used to determine significant differences between groups. Where significant differences were found, Tukey's test for multiple comparisons was applied. In order to examine the effects of some variables that differed significantly between nutritional groups or study condition, the socioeconomic index, IQ, food intake of the previous day and glycaemia levels were added as covariates in an analysis of covariance (ANCOVA).

Main Findings

- C No statistical differences were noted between study conditions or nutritional groups for either memory score or problem-solving capacity. While no effect attributable to breakfast was observed, a significant nutritional status effect over attention test performance was found. Tukey's test showed that stunted children made significantly more errors than normal and wasted children in the breakfast condition. This difference was also significant between fasting stunted and normal subjects. The normal and wasted groups accomplished this task with similar results in both conditions. There was no significant difference in mean reaction time between groups.
- C In all groups the estimated energy intake of the previous day fell below the recommended daily allowance (RDA) established for this age group. Protein intake attained levels above RDA standards.
- C Undernourished groups obtained 25 percent of their nutrients from school breakfast programs, compared to 18 percent obtained by normal children. Stunted children came from the poorest environment and showed the lowest IQ scores.

Comments

While the naturalistic model used in this study has advantages, such as limited interference in the child's daily routine and allows one to assess his or her customary behavior more fully, there are inherent disadvantages to this approach especially the impossibility of fully controlling the experimental conditions within groups.

The authors present a very lengthy and thorough review of most of the other studies involving nutritionally at risk samples. They go to some lengths to explain the absence of findings showing a connection between the fasting condition and poorer cognitive performance. About the only confounder that appears to have undercut the predicted effect was the fact that the cognitive tests were administered via personal computer which was a great novelty and thus potentially highly motivating for the students.

That said, the fact that there were no significant differences between the fasting and breakfasted groups in this nutritionally at-risk group calls to mind the negative findings reported by Dickey and Bender and others and underscores the difficulty of selecting measures that can reliably detect differences between children who fast and children who eat breakfast.

CITATION

McIntyre, Lynn, and Betty Ann Horbul. "A Survey of Breakfast-Eating Among Young Schoolchildren in Northeastern Ontario." *Canadian Journal of Public Health*, vol.86, no. 5, September to October 1995, pp. 305-308.

Objective of the Article

To determine if children were hungry in the classroom.

Sample and Data Used

Directors of the district's school boards were asked in an informal telephone survey if they identified a problem with children arriving at school hungry and also if the school had a food policy that incorporated access to food.

A breakfast survey (the Halifax Breakfast Survey Instrument) was administered in the classroom to children in grades 1, 2 and 3 (n=1100) within the Cochrane District of Northeastern Ontario. The survey asks if the child had anything to eat or drink before arriving at school that morning, and, if so, what (respondents had to pick from a list of food choices). It also asks who prepared the food. Schools were classified as either low or average income based on the advice of the school's public health nurse in consultation with the principal. This rating informally took housing, employment and family composition factors into account. Grade was not recorded for each respondent, thus, children in a combined grade 1 and 2 class could not be distinguished by grade.

Outcomes Examined

The main outcome variables were breakfast consumption (0,1); content of breakfast (checklist of possible food items); adequacy (not adequate, liberally adequate, vigorously adequate); and who made breakfast (child, someone else).

Methodology

The chi-square test, student's t-test, and one-way ANOVA were used to compare children's breakfast consumption patterns by sociodemographic variables. A logistic regression was run to determine predictors of breakfast consumption, foods eaten for breakfast, and who prepared breakfast.

Main Findings

- C Low-income status was neither a predictor of breakfast-skipping nor of inadequate consumption. Income, location, and gender had no relationship to whether or not breakfast was consumed. However, low-income and city-dwelling children were more likely to consume an adequate breakfast than average income and town-dwelling children.
- C Children in the first grade were significantly more likely to skip breakfast than those in the second or third grades. Children in the second grade consumed the most adequate breakfasts. Children in the third grade were significantly more likely to make their own breakfast than those in the second grade, and second graders were significantly more likely to make their own breakfast than first graders.
- C English-speaking children were significantly more likely to skip breakfast than French-speaking children. Of those English-speaking children who consumed breakfast, it was significantly more likely to be vigorously adequate than that consumed by French-speaking children.
- C Boys were significantly more likely to make their own breakfasts.

Comments

Both the survey and the study were poorly designed. First of all, the study lacked adequate controls. Even the authors concede that the income ratings were determined subjectively. Moreover, they were not always able to determine the actual grade level of the respondent. As for the survey, there were a limited number of choices (rather than food categories) on the list of possible food items consumed for breakfast. This could confuse young children who had breakfast but did not eat anything on the list. This could lead them to underreport what they had eaten or to check off the item that most resembles what he/she had. This limitation, in turn, affects findings on adequacy (where “liberally adequate” meant that at least two food groups, one of which must be protein, were consumed and “vigorously adequate meant that three food groups, one of which must be protein, were consumed).

CITATION

McNulty, Helene, et al. "Nutrient Intakes and Impact of Fortified Breakfast Cereals in Schoolchildren." *Archives of Disease in Childhood*, vol. 75, 1996, pp. 474-481.

Objective of the Article

To report micronutrient intakes in Northern Ireland schoolchildren and to determine how much fortified breakfast cereal contributes to nutrient intakes and dietary recommendations.

Sample and Data Used

A sample of approximately 250 children from the following four groups were randomly selected: (1) 12-year-old boys, (2) 12-year-old girls, (3) 15-year-old boys, and (4) 15-year-old girls. A total of 1,015 subjects participated in the study.

Outcomes Examined

Dietary intakes and physiological characteristics, as well as their association with the consumption of fortified breakfast cereal.

Methodology

Dietary data were obtained by three trained field workers during an open-ended interview using the diet history method to record habitual mean and snack consumption, in conjunction with a food photographic atlas and published data to estimate portion sizes. Recorded food intakes were converted into energy and nutrient intakes using a computerized dietary analysis program.

The test protocol also included a medical examination of height and weight to determine body mass index, skinfold thickness measurements to determine body composition, blood pressure readings, cardiorespiratory fitness tests, and estimations of total blood cholesterol concentration.

Statistical comparisons between groups were based on the Kolmogorov-Smirnov two sample test at a 5 percent significance level on a Likert scale from 1 (much more hungry than usual) to 5 (much less hungry than usual). The one-way ANOVA was used for statistical comparisons between levels of breakfast cereal consumed.

Main Findings

- C Mean micronutrient intakes were generally adequate with the exception of folate in both boys and girls and iron in girls.
- C Fortified breakfast cereals (consumed by 94 percent of the boys and 83 percent of the girls in the sample) were associated with higher daily intakes of most micronutrients and fiber as well as with a macronutrient profile consistent with current nutritional recommendations.
- C A large proportion of subjects who did not consume breakfast cereals had daily intakes that fell below the lower reference nutrient intake for riboflavin, niacin, folate, vitamin B₁₂, and iron (in girls only).

Comments

Data for middle-school aged children may not be applicable to elementary school age. It is unclear if cereals consumed have similar fortification levels to U.S. cereals.

CITATION

Meyers, A.F. "Undernutrition, Hunger, and Learning in Children." *Nutrition News*, vol. 52, Fall 1989, pp. 5-8.

Objective of the Article

This paper presents a selective review of the literature regarding undernutrition, hunger, and learning.

Main Findings

Undernutrition and the Brain:

- C Seriously undernourished children have smaller heads and lower brain weights than their well-nourished counterparts, and their brains have fewer glial cells and synapses. These deficits will be lifelong if nutritional resuscitation is inadequate or delayed.
- C Children who suffer severe undernutrition in early life tend to have persistent deficits in measures of intellectual and behavioral function in later life, compared to their well-nourished peers. The more extreme the nutritional deprivation, the earlier deficits occur, and the longer they last, the greater the adverse effect on intellect. This effect may be substantially diminished by vigorous nutritional rehabilitation, especially when combined with socioenvironmental stimulation. However, some studies suggest that the damage may not be entirely reversible.

Nutrition, Environment, and Mental Development:

- C When a young child is deprived of adequate calories to meet her or his energy needs, the first effect will be a reduced expenditure of the energy utilized for activities not directly related to survival. The child becomes apathetic and listless. If prolonged, the consequences will be impaired mental development.
- C It is methodologically difficult to sort out the direct effects of under-nutrition from those of social deprivation. Frequently the child who is at risk for under-nutrition is usually also exposed to other adverse features of the social environment associated with poverty.

Mild forms of under-nutrition are common in the United States, especially among low-income children. Some of the consequences of mild-to-moderate under-nutrition are:

- C Growth retardation--Among low-income groups, approximately 5 percent of the children experience low height-for-age, or stunting. While this implies that a large number of poor children are receiving inadequate calories for optimal growth, the direct consequences on learning ability are less clear. Data from the U.S. Health Survey and from the Collaborative Perinatal Project do suggest a small, but statistically significant, association between height-for-age and scores on IQ and achievement tests. A direct causal relationship between the chronic mild undernutrition that results in stunting and reduced cognitive abilities remains to be established.
- C Iron deficiency--the most common nutritional deficiency seen in U.S. children. Prolonged iron deficiency that will result in anemia if untreated. Recent data from the Pediatric Nutrition Surveillance System of the Centers for Disease Control and Preventive show that, among low-income children ages 2-4 in certain public programs, anemia affects 11.4 percent of blacks, 8.2 percent of Hispanics, and 6.2 percent of whites. An additional number have iron deficiency without anemia. Infants, preschool, and school-aged children who are iron deficient show deficits in mental development, attention, and learning, and in educational achievement test scores, when compared to iron-replete children. Controlled experiments have shown that much of this deficit can be reversed with appropriate iron replacement therapy. However, several studies suggest that some aspects of developmental, behavioral, and cognitive impact of iron deficiency on the growing child may not be completely reversible even with adequate therapy.
- C Other micronutrient deficiencies--In a recent experiment by Benton and Roberts, 90 schoolchildren aged 12 and 13 years were given a multivitamin-mineral supplement, placebo, or no supplement over the course of a school year. Dietary histories showed that many children were consuming far less than the RDA of these nutrients. At the end of the year, the children receiving the supplement showed a significant increase in their scores on tests of non-verbal intelligence. The non-supplemented children did not. This study is a reminder of the limitations of our current knowledge of the relationships between nutrition and learning.
- C The effects of hunger--Several of the original Iowa Breakfast studies as well as recent studies by Pollitt and his associates suggest decreased performance among children who are hungry, for better nourished as well as undernourished children.
- C The impact of nutrition programs--A number of federally funded programs including WIC, the school meals programs, and food stamps are effective in increasing the nutritional adequacy of U.S. children's diets.

Comments

This summary of existing studies supports that nutrition plays an important role in children's learning.

CITATION

Meyers, A.F., A.E. Sampson, M. Weitzman, B.L. Rogers, and H. Kayne. "School Breakfast Program and School Performance." *The American Journal of Diseases of Children*, vol. 143, October 1989, pp. 1234-1239.

Objective of the Article

To test the effects of participation in the School Breakfast Program (SBP) on standardized achievement test scores and rates of tardiness and absenteeism among low-income children enrolled in public schools in Lawrence, Mass.

Sample and Data Used

Six of the 16 elementary schools in Lawrence participated in this study. The total sample was comprised of 518 males and 503 females in grade 3 through 6. Of these 1,021 students, 335, or 33 percent, were SBP participants.

Children in the study had to (1) be registered in grades 3 through 6 in the Lawrence public school system for the second semester of both the 1985-86 and 1986-87 school years; (2) qualify for free or reduced-priced school meals; and (3) have never been retained for a school year.

Students were evaluated for changes in academic functioning by examining the test scores from the Comprehensive Tests of Basic Skills (CTSB). Absenteeism and tardiness rates were examined from data collected from the central data registry for Lawrence public schools.

Since the SBP was implemented the second semester of the 1985-86 school year, only data from the second semester of these two school years was considered.

Outcomes Examined

The outcome variables included the CTSB scale score for battery total, as well as subtests for language, reading, and mathematics. Changes in scores were obtained by subtracting the score obtained in 1986 (pre-SBP) from the corresponding score for 1987 (post-SBP).

Absence and tardiness outcome variables were calculated for each child by dividing the days the student was absent or tardy by the number of days he or she was enrolled in school (expressed as a percentage) for the second semester of 1986 and 1987 separately. The 1986 rate was then subtracted from the 1987 rate. Children who were registered for fewer than half the total school days for either second semester were excluded from the study. Children were also excluded if they were absent or tardy for more than one-quarter of the days in either second semester.

Methodology

To determine the significance of the changes found in test scores, absence rates, and tardiness rates for the SBP participants and non-participants, a one-way ANOVA was used. A one-way ANOVA was also used to compare the two groups in regard to their 1986 (pre-SBP) test scores, attendance, and tardiness.

Demographic characteristics of SBP participants and non-participants were compared using the P^2 statistic. Multiple regression analysis was used to measure the contribution of the independent variables, including demographic characteristics, income, and SBP participation.

Main Findings

When compared with non-participants in the SBP program, SBP participants had significantly lower CTBS battery total, reading, and mathematics scores. Language scores were only marginally lower for SBP participants.

- C From 1986 to 1987 CTBS increases were significantly greater for the SBP participants than non-participants for battery total and language scores. Increases in mathematics and reading scores were only marginally greater for SBP participants.
- C Pre-SBP (1985-86) absence and tardiness rates did not differ between the SBP participants and non-participants.
- C Absenteeism and tardiness decreased from 1986 to 1987 for SBP participants and increased for non-participants.

Comments

This classic study has many implications for the proposed USBP evaluation although there are a number of caveats.

Since participation in this study was determined by self-selection, potential factors such as motivation may have confounded the results. Other potentially confounding variables include family income within the free or reduced-price meal categories, parental educational status, and family structure, e.g., single or two parent households. Thus causal inferences must be made with caution.

It should also be noted that it is unclear whether the improvements found in this study were due to the immediate effect of the morning meal eaten at the beginning of the school day or to an overall improvement in 24-hour dietary intake (or to a combination of both). Since this study was only in place for three months,

long-term effects were not measured. Measurements taken over a longer period of time would have likely been greater, if in fact the results were related to an overall improvement in dietary status.

Still, the findings that absence and tardiness rates decreased for SBP participants and actually worsened slightly for non-participants suggest that the SBP had measurable effects on important academic variables and that these variables can and should be used in the proposed USBP evaluation.

Similarly, the statistically significant improvements on a standardized academic achievement test suggest that such effects may be measurable in other settings and that the use of such tests, either from school records when the tests are already in use in a given school district or when the tests are administered de novo is something that should be considered.

CITATION

Michaud, C., Musse, N., Nicolas, J., and Mejean, L. "Effects of Breakfast-Size on Short-Term Memory, Concentration, Mood and Blood Glucose." *Journal of Adolescent Health*, vol. 12, January 1991, pp. 53-57.

Objective of the Article

The effect of breakfast-size on short-term memory, mood, concentration, and blood glucose in 13 to 20 year-old adolescents was examined.

Sample and Data Used

Three hundred and nineteen students, 150 boys and 169 girls, from one of four counties in Lorraine (France) took part in this study. The mean age of these adolescents was 16.1 years for boys and 15.9 years for girls (range: 13 to 20 years).

Each adolescent recorded dietary intake at breakfast on two identical days two weeks apart. The first day (D0) students consumed their usual breakfast. The second day (D14), the same students ate a school breakfast higher in energy than the one eaten on D0. On this second day students were instructed to "eat more than on D0". A specially designed dietary diary was given to each student. Students were instructed to describe all food and drinks taken at breakfast, the time and place of consumption, and an estimate of the amount consumed. They were then interviewed the following day to verify and expand on the information they recorded. Students were classified according to size of energy supplement between D0 and D14: 0-99 kcal, 100-199 kcal, 200-299 kcal, 300-399 kcal, and more than 400 kcal.

On days D0 and D14, short-term memory, concentration, and mood were tested at 11:00 a.m.; blood glucose was tested at 11:30 a.m. Six schools were randomly assigned an even number and five, an uneven number. Even numbered schools were tested in the order D0-D14; odd numbered schools were tested in the reverse order (D14-D0).

Outcomes Examined

The outcome variables included blood glucose measurements obtained by trained nurses. Blood samples (taken from the adolescent's finger) were taken from 223 students only.

Visual Rating Scales (VRSs), taken from Herbert et al., were used to measure mood. Students were instructed to assess their mood on eighteen items and indicate how he/she felt at the specified time. For this test students marked where they felt they stood in relation to two words, such as 'calm' and 'excited', on a bipolar scale.

To evaluate cognitive performance, two tests were used that were designed to explore two aspects of efficiency performance: memory and concentration. These tests were specifically developed for this study by experts in the field of psychology and consisted of : (1) the Short-term Memory Test (a scale test), and (2) the Concentration Test (a word test).

Methodology

Differences between D0 and D14 were tested by paired Students' t-test for blood glucose, mood and cognitive tests. Effects of breakfast-size difference on performance score, blood glucose, and mood were tested with an analysis of covariance on the D14 data with the D0 baselines as covariates.

Main Findings

Blood glucose means did not differ between D0 and D14, nor were there statistically significant differences in mood of subjects between D0 and D14.

The mean of the Short-term Memory Test increased significantly for the whole sample. The increase was found equally for boys and girls. On the other hand, the mean of the Concentration Test decreased significantly on D14.

Energy supplement size did not affect the mean of the difference obtained on memory test scores between D0 and D14. Similarly, energy supplement size from breakfast had no effect on Concentration Test scores.

Comments

While this study underscores the need for concomitant measures of several modes of behavior in order to obtain a complete picture of the effect of breakfast, the evidence is still insufficient for drawing any firm conclusions regarding the influence of breakfast on performance.

Although the concentration test that showed significant effects in the opposite from predicted direction is similar to the tests of attention used in a number of other studies it is not the same and therefore the paradoxical effect is difficult to interpret. The fact that this cognitive test had a negative effect undermines to some extent the impact of the positive findings on the short term memory test. Even more paradoxically, the memory and concentration tests used in this study had exactly the opposite effects from those reported by Pollitt et al. (1981).

Neither the socioeconomic status nor the baseline rate breakfast consumption of these French students was given in the paper but it appears likely that these were well nourished young people for whom a small amount of additional food for breakfast might have almost no impact.

CITATION

Miller, J. and S. Korenman. "Poverty and Children's Nutritional Status in the United States." *American Journal of Epidemiology*, vol. 140, no. 3, 1994, pp.233-43.

Objective of the Article

To describe deficits in nutritional status for poor children living in the United States.

Sample and Data Used

This study uses national data from the National Longitudinal Survey of Youth for children born in 1979-1988. The study oversampled poor and minority youth born to a nationally representative sample of women aged 14-21 years at baseline in 1979, with a 90 percent participation rate in 1988. The sample of women was over represented by low-income, minority, and less-educated women since the oldest childbearing ages were not included in the sample.

Outcomes Examined

Nutritional status was characterized by stunting and wasting.

Methodology

Estimates of stunting (low height for age) and wasting (low weight for age) were based on the NCHS growth reference charts and measured height and weight for 80 percent of the sample and reported by mothers for 20 percent of the sample. There was no evidence of systematic bias in the maternal reports of height and weight.

Main Findings

- C The prevalence of stunting and wasting was higher among children who were persistently poor.
- C Differentials in nutritional status were greater using long-term income rather than short-term or annual income measures, suggesting that annual income does not adequately reflect persistent poverty.
- C Differences in nutritional status between poor and nonpoor children persisted after controlling for family structure, maternal education and age, and race.

- C Children who are stunted or wasted have lower scores on tests of cognitive and socioemotional development, even after long-term income is controlled.

Comments

Long-term deprivation would be expected to have larger effects on nutritional status than short-term deprivation. Because of movements in and out of poverty, the use of current poverty status for persistent or long-term poverty may understate the relationship between poverty and nutritional status.

CITATION

Morgan, Karen J., Mary E. Zabik, and Gilbert A. Leveille. "The Role of Breakfast in Nutrient Intake of 5- to 12-Year-Old Children." *American Journal of Clinical Nutrition*, vol. 34, 1981, pp. 1418-1427.

Objective of the Article

To examine the breakfast habits of a cross-sectional sample of American 5- to 12-year-olds in order to determine the nutrient intake at this meal and its relationship to food consumption patterns for the rest of the day.

Sample and Data Used

The data were from the Bogalusa Heart Study in Bogalusa, LA. The food intake patterns of 657 5- to 12-year-olds were obtained from seven day food diaries collected from 1,434 families in 1977. The sample was representative of middle- to upper-middle class, two-parent families whose parents educational levels were higher than that of the general population.

Outcomes Examined

Nutrient intakes of children who consumed presweetened ready-to-eat cereal, non-sweetened ready-to-eat cereal, any ready-to-eat cereal, some ready-to-eat cereal, and no ready-to-eat cereal.

Methodology

The 657 children were first divided into two groups: breakfast eaters (i.e., those who consumed breakfast at least three times during the week) and non-breakfast eaters (i.e., those who consumed fewer than three breakfasts during the week). Because only 10 children were classified as non-breakfast eaters, the study went on to divide the sample into five groups: (1) those who ate presweetened ready-to-eat cereal (n=177); (2) those who ate nonsweetened ready-to-eat cereal (n=150); (3) those who ate any ready-to-eat cereal (n=349); (4) those who ate ready-to-eat cereal less than three times at breakfast (n=308); and (5) those who did not eat ready-to-eat cereal at breakfast (n=92).

Breakfast meals were also analyzed in order to examine the contribution of ready-to-eat cereal to nutrient intake. This analysis compared: breakfasts including pre-sweetened ready-to-eat cereals (n=941); breakfasts with non-sweetened ready-to-eat cereals (n=949); and breakfasts with no ready-to-eat cereals (n=2,527).

T-tests were run to identify statistically significant differences between the five groups. ANOVAs were used to test for statistically significant differences among means for groups one to three. Duncan's multiple range test was used to determine the source of the significant differences among breakfasts.

Main Findings

- C Breakfasts including ready-to-eat cereals had higher average contents of all vitamins and minerals (i.e., ascorbic acid, thiamin, niacin, riboflavin, folacin, calcium, phosphorus, iron, potassium, copper, zinc, magnesium, pyridoxine, and vitamins B₁₂, A, and D) except phosphorus and sodium than breakfasts that did not include ready-to-eat cereal. Breakfasts that did not include ready-to-eat cereal had higher average contents of calories, protein, fat, cholesterol, and sodium.
- C Non-sweetened cereal had the highest carbohydrate and crude fiber contents; presweetened cereal had the highest sugar content.
- C Breakfast contributed, on average, at least one-fourth of the RDA for all nutrients.
- C Children whose breakfasts include ready-to-eat cereal consume only slightly more sugar than those who do not; moreover, cereal-eaters do not consume significantly more sugar than non-cereal eaters throughout the day.

Comments

Some children were classified in more than one group. It was not always possible to separate the contribution of milk from the cereal in the nutrient intake analyses.

CITATION

Murphy, J.M., M. E. Pagano, J. Nachmani, P. Sperling, S. Kane, and R. E. Kleinman. "The Relationship of School Breakfast to Psychosocial and Academic Functioning: Cross Sectional and Longitudinal Observations in an Inner City School Sample." *Archives of Pediatric and Adolescent Medicine*, vol. 152, September 1998a.

Objective of the Article

This article attempts to determine if a relationship exists between participation in a school breakfast program, and measures of psychosocial functioning and academic performance in school age children.

Sample and Data Used

Three inner city public schools (one in Philadelphia, PA, and two in Baltimore, MD) participated in the universal free (UF) breakfast program. All 493 children in grade 3 or higher in these schools were invited to participate in the study. The schools were similar in socioeconomic and ethnic distribution. In the final sample, 133 low-income students had complete data before and after the UF breakfast program on program participation and school record measures, and 85 of these students had complete psychosocial interview data before and after the UF breakfast program. Teacher ratings of behavior before and after the UF breakfast program were available for 76 of these students.

Outcomes Examined

Each student's official school records were examined for (1) grades in math, science, social sciences, reading, and (2) rates of tardiness and absence from school. These data were compared to the student's level of participation before and after the implementation of the UF breakfast program.

Several tests were administered to the students. Hunger level was assessed through the CCHIP parent questionnaire. The Children's Depression Inventory (CDI), the Revised Children's Manifest Anxiety Scale (RCMAS), the Pediatric Symptom Checklist (PSC), and the Conners' Teacher Rating Scale-39 (CTRS-39) were used to assess the relationship between psychosocial problems and participation in the breakfast program.

Methodology

Ordinal logistic regression (a multiple regression model) was used for statistical analysis; ordinal breakfast participation variables served as a function of child adjustment measures.

Main Findings

- C Both higher baseline levels of participation in the SBP and larger increases in participation were associated with better student academic and psychosocial outcomes.
- C The overall mean breakfast participation in the three schools increased from 15 percent to 27 percent after the UF breakfast program was implemented; this increase was statistically significant.
- C At baseline, children who ate school breakfast “often” had higher grades in math (2.8) than those who ate school breakfast “sometimes” (2.0) or “rarely” (1.9). Children who increased their school breakfast participation after the UF breakfast program implementation showed significantly greater improvements in math scores compared to children whose participation did not change.
- C Children who ate school breakfast rarely were absent significantly more (2.8 days) than those who ate school breakfast sometimes (1.9 days) or often (1.5 days). Children who ate school breakfast rarely were also tardy significantly more (1.2 days) than children who ate school breakfast sometimes (0.1 days) or often (0.4 days). Children who increased their breakfast participation showed significantly greater decreases in their absence and tardiness rates compared with children whose participation did not change.
- C Children who ate school breakfast rarely had somewhat lower mean CDI and PSC scores than children who ate often, although these differences failed to reach statistical significance. Children who increased their school breakfast participation showed significantly greater decreases in their total symptom scores on the CDI, RCMAS, and PSC compared with children whose participation did not change.
- C The mean CTRS-39 Hyperactivity Index score for the children classified as eating school breakfast rarely (58.3) was significantly higher than it was for children who ate school breakfast sometimes (53.4) or those who ate school breakfast often (47.3). Children who increased their school breakfast participation showed significantly greater decreases in their total symptom scores on CTRS-39 compared with children whose participation did not change.

Comments

The article cites several limitations or possible confounding factors to interpreting the study findings. First, since this was not a randomized study, causal inferences cannot be made. Second, the relatively small sample size makes the study susceptible to variations due to chance. Third, the sample may not have been representative because of loss of subjects at various stages in the sampling. Fourth, the children involved in the study were predominantly African-American students from inner-city public school districts, and the impact of school breakfast participation may differ in other racial or ethnic groups from various income

levels in other locations. Fifth, some intervening or coincidental variable other than nutrition may be partly responsible for the improvement in student functioning. These findings of improvement also may or may not be sustained in the long run.

These caveats notwithstanding, this study provides data that have implications for the proposed USB evaluation. First, in the absence of classroom feeding or some additional manipulation, the overall increase in school breakfast participation was relatively modest in absolute terms (from 15 percent to 27 percent of all students), although in relative terms, this change amounted to an almost doubling of participation.

Second, this study was the second to suggest in a United States sample that school-record variables like attendance, tardiness, and even grades could be used as outcome variables. The implication here, as in Meyers et al., is that it may be possible to detect schoolwide changes in such measures following USB interventions.

This is the second study to find significant differences among students on the CTRS following a change in the school breakfast program, although the only subscale that showed a significant change (Hyperactivity Index) was also the only one that did not show a significant difference in the Lindeman and Clancy 1990 study.

The significant association between the baseline breakfast rate, and school breakfast increase and math grades raises the interesting possibility of using school grades in math and other subjects as outcome indicators.

The significant findings on the CTRS provide further confirmation of the validity of findings obtained from parent and student reports on the PSC, CDI, and RCMAS that student behavior and mood was better for students who were more frequent school breakfast participants and for students who increased their school breakfast participation.

CITATION

Murphy, J. M., C. A. Wehler, M. E. Pagano, M. Little, R. F. Kleinman, and M. S. Jellinek. "Relationship Between Hunger and Psychosocial Functioning in Low-Income American Children." *Journal of the American Academy of Child & Adolescent Psychiatry*, vol. 37, February 1998b, pp. 163-170.

Objective of the Article

This article reported on a study that examined the relationship between food insufficiency/hunger in school-age, low-income children and several measures of their psychosocial functioning using the CCHIP measure. The study also assessed the interinformant (parent versus child) reliability and time-to-time reliability of CCHIP.

Sample and Data Used

Two-hundred four school-age children and their parents from four inner-city public schools were interviewed using parent, teacher, and clinician report measures of psychosocial functioning. Ninety-six children and their parents were reinterviewed four months later. Of the 204 children in this sample, 82 percent were in elementary school (grades 3 through 5), and 18 percent were in middle school (grade 8).

Students and their parents were assessed on a battery of psychosocial, academic, and food insufficiency/hunger measures before the start of a free breakfast program in the schools. Interviewers were blind to the family's CCHIP hunger status (CCHIP hunger questions were asked at the end of the interviews after other measures had been administered). Teachers and all students in the study were asked to complete a standardized behavior problem questionnaire before and after the free breakfast program began.

In all four schools, the regular school breakfast was made available for free to all students at the beginning of the second semester. Students and their parents were interviewed in late January or early February prior to the start of the Universal Feeding Program (UF) and then again in late May-early June after the program was implemented. Students were randomly selected into three groups based on their pre-UF school breakfast participation (rarely, sometimes, often) in order to yield a reinterview sample that had the same proportion of participants from the three breakfast groups at the time of the initial interviews.

After the interviews were completed, the researchers reviewed all parent and child questionnaire data for each case (excluding the hunger questions) and provided ratings of each child's overall functioning using the Children's Global Assessment Scale (CGAS). For the assessment of time-to-time reliability, the CCHIP hunger category, based on parental response to the full eight-item CCHIP survey at time 1 and again at time 2, was used.

Outcomes Examined

The outcome variables for this study were the Pediatric Symptom Checklist (PSC), the Child Behavior Checklist (CBCL), and the Conners Teacher Rating Scale-39 (CTRS-39).

Data on absenteeism and tardiness were collected from official school records for the fall term prior to the implementation of the free school breakfast program.

Solely for the purpose of assessing interinformant reliability, a five-item scale, the Child Hunger Index Parent (or Child) report (CHI-P/CHI-C) was established. For parents and children, a total CHI-P or CHI-C score was computed by summing the yes answer to the five CCHIP questions. Children (or their parents) who responded positively to two or more of the questions were classified as “hungry”. When a child (or the child’s parents) responded positively to one of the questions, the child was classified as “at-risk for hunger”. For those who did not respond positively to one of the questions, the child was classified as “not hungry”.

Methodology

This is an interview study of low-income public school students whose parents gave permission for interviews.

Main Findings

Hungry children and children at-risk for hunger were twice as likely as not-hungry children to be classified as having impaired functioning on most measures by both parent and child reports.

Teachers reported higher levels of hyperactivity, absenteeism, and tardiness among hungry/at-risk children than among not-hungry children.

Parent and child reports of hunger were significantly related to each other, and time-to-time reliability of the CCHIP measure was acceptable.

Comments

The only data currently available on the impact of intermittent episodes of food insufficiency and hunger come from the CCHIP surveys. Prior to this study, there had been no published data on CCHIP’s validity and time-to-time reliability. This study supports the validity and reliability of the CCHIP measure for assessing hunger in children and estimating the prevalence of hunger and its relationship to other factors.

It should be noted that the prevalence rates of hungry and at-risk children in the current study is lower than that reported in previous CCHIP studies with low-income families. Since only about one-third of the parents of eligible students agreed to participate in the study, a sampling bias may have occurred in which poorer families may have been less likely to participate. However, even if low-income families or some other group were systematically less likely to participate, the relationship between CCHIP hunger and psychosocial impairment in this current sample would remain and would still be an important finding.

Two additional factors should also be considered when interpreting the results of this study. First, because there was a hunger-related feeding intervention between the first and second administrations of the CCHIP parent scale, parental ratings of their children's hunger may have been influenced prior to the second CCHIP administration. Second, because the current study is cross-sectional rather than longitudinal, causality cannot be inferred and it is possible that hunger itself may not be the only or even the major cause of the problems noted in these children.

Despite these caveats, however, the data from this study confirm the findings reported by this research team and the authors of the CCHIP measure that experiences of hunger are prevalent among low-income urban children in this country, and that children who have these experiences are more likely to have negative health, academic, and behavioral outcomes.

CITATION

Navia, B., A. M. Requejo, R. M. Ortega, A. M. Lopez Sobaler, M. E. Quintas, P. Andres, M. R. Redondo, and T. Rivas. "The Relationship between Breakfast and Whole Diet Energy Profiles in a Group of Preschool Children." *Annals of Nutrition and Metabolism*, vol. 41, 1997, pp. 299-306.

Objective of the Article

An investigation of the diets of preschool children was conducted to determine if the imbalance known to exist in the Spanish population's diet as a whole (excessive intake of fats and protein and an insufficient intake of carbohydrates) also exists in the children of this population. The relationship between breakfast and whole diet energy profiles in the preschool population was also examined.

Sample and Data Used

The study subjects were a group of 110 preschool children between 2 and 6 years of age, who attended two day care centers in Madrid, Spain. Two centers were selected at random, with the only requirements being that at least 100 pupils were enrolled in each center and that one center cared for children from a middle-class socioeconomic background, while the other cared for children from a low-to middle socioeconomic background.

Criteria for excluding subjects was the suffering of any disorder that might affect the parameters to be studied, absence from the center at the time of the study, and inconsistency answering of questionnaires.

All subjects ate their midday meal at the center during the experimental period (except for Saturday and Sunday) and ate their evening meals at home. Breakfast was eaten at the center by 32.7 percent of subjects. For the remaining children who ate their breakfast at home, parents were shown how to complete a questionnaire that registered all food and drinks consumed over the experimental period (seven days).

Trained personnel administered all meals at the center and recorded food intake for each child. Children were served different meals according to their age group.

Outcomes Examined

Foods were converted into energy and nutrients using the Food Composition Tables. The fatty acid content of foods was established using the table of Moreiras et al. 1995. Observed intakes were then compared to recommend intakes as published by the Departamento de Nutricion in order to determine the adequacy of the subject's diets.

Weight and height were determined using standard techniques and following the norms established by the World Health Organization (WHO).

Methodology

Where results were distributed homogeneously, differences between means were established using the Student's t-test. Where the distribution was not homogeneous, the Mann-Whitney test was used. Linear correlation coefficients were calculated for different dietetic data.

Main Findings

- C The children in this study had diets similar to those of the older population in Spain, i.e., excessive intake of fats and proteins and an insufficient intake of carbohydrates.
- C Subjects who consumed fewer carbohydrates (<50 percent of energy intake) or more fat (>35 percent of total intake) at breakfast showed poorer energy profiles and poorer fat quality over their whole diet.
- C Those with higher intakes of carbohydrates at breakfast had lower intakes of total fats and more balanced fat and energy profiles for the whole diet.

Comments

While this study suggests that the type of breakfast consumed does have an influence on diet as a whole, others report different results. For example, De Graaf et al. 1992 states that neither the energy content nor the macronutrient composition of breakfast has any influence on the energy and macronutrients consumed over the rest of the day, although Ikeda et al. 1992 showed that with adults, both food habits and food intake are conditioned by type of breakfast.

The authors conclude that the evidence suggests that the type of breakfast consumed is somewhat determinative of the type of foods consumed over the rest of the day, and that an attempt to improve breakfast would probably have a positive effect on the nutritional and health status of children.

These findings provide several other justifications for the importance of trying to improve the quality as well as the quantity of breakfast for children.

CITATION

Nicklas, Theresa A., Weihang Bao, Larry S. Webber, and Gerald S. Berenson. "Breakfast Consumption Affects Adequacy of Total Daily Intake in Children." *Journal of the American Dietetic Association*, vol. 93, no. 8, August 1993, pp. 886-891.

Objective of the Article

To compare the nutrient intake of children who do not eat breakfast with that of children who do and to examine the relationship of breakfast to total daily intake and dietary adequacy.

Sample and Data Used

Twenty-four-hour dietary recalls were conducted with 10-year-old children in cross-sectional surveys in 1984-1985 and in 1987-1988 as part of the Bogalusa Heart Study. There were 284 participants in each survey. Because only weekday breakfast consumption patterns were being studied, 63 children whose dietary recalls reflected only weekend intakes and 38 children who consumed breakfast from two or more sources were excluded from the analysis. This resulted in a sample of 467 10-year-olds (n=268 in 1984-1985 and n=199 in 1987-1988).

Outcomes Examined

Mean daily intake by breakfast consumption pattern, the effect of breakfast consumption patterns on other meals, and the effect of breakfast on dietary adequacy were studied.

Methodology

The 24-hour dietary recall method was adapted for use in interviewing children. Quality controls included a standardized protocol, trained interviewers, graduated food models, a product identification notebook for snack probing, school lunch, and family recipe collection, and the Extended Table of Nutrient Values (ETNV) for nutrient composition.

The sample was divided into three groups: (1) children who ate breakfast at home (n=193); (2) children who ate breakfast at school (n=200); and (3) children who did not eat breakfast (n=74).

Descriptive statistics (means, standard deviations, ranges, percentiles) were run. Log transformations were performed to improve the normality of the data. A nutritional breakdown over the 24-hour period by group was performed. ANOVA techniques were used to test for significant differences in nutrient intake levels for the three groups, adjusting for race and gender where appropriate.

Main Findings

- C The omission of breakfast or the consumption of an inadequate breakfast contributed to dietary inadequacies; inadequacies at breakfast were rarely made up by other meals during the day.
- C The mean daily intakes of energy or protein were significantly greater in children who consumed breakfast at school compared with that of children who consumed breakfast at home or not at all.
- C The mean daily intakes of carbohydrates, sugar, cholesterol, and potassium were significantly lower in breakfast skippers compared with those who ate breakfast either at home or at school.
- C The mean daily intakes of saturated fat and sodium were significantly higher in children who consumed breakfast at school compared with those who did not consume breakfast.
- C After adjusting for differences in energy intake, the percentages of energy from protein and fat were significantly greater for children who ate breakfast at school, compared with those who had breakfast at home or not at all.
- C Few race and gender differences in total daily intake of nutrients were found for the three groups.

Comments

The findings are applicable to workday breakfast patterns and indicate that about 17 percent of this sample reported two or more breakfast sources.

CITATION

Nicklas, Theresa A., Leann Myers, and Gerald S. Berenson. "Impact of Ready-to-Eat Cereal Consumption on Total Dietary Intake of Children: The Bogalusa Heart Study." *Journal of the American Dietetic Association*, vol. 94, no. 3, March 1994, pp. 316-318.

Objective of the Article

To compare the total dietary intake of energy and selected nutrients for children who consume ready-to-eat cereal with those who do not consume ready-to-eat cereal.

Sample and Data Used

The subjects were drawn from two cross-sectional surveys conducted in 1984-1985 and in 1987-1988 as part of the Bogalusa Heart Study. The survey had 10-year-old children complete a random 24-hour dietary recall interview (n=568). Fifty percent of the children examined came from each survey. Because no significant differences in nutrient intakes of the two cohorts were found, the data were combined for the analysis. The total study sample was 59 percent white and 41 percent black, with an equal number of males and females. The respondents were divided into two groups: those who ate ready-to-eat cereals and those who did not.

Outcomes Examined

Mean daily energy and nutrient intake of 10-year old children classified by ready-to-eat cereal consumption pattern.

Methodology

The 24-hour dietary recall method was used. Quality controls included a standardized protocol, graduated food models for estimating portion sizes, a product identification notebook for probing about snack consumption, collection of school lunch and family recipes, and the Extended Table of Nutrient Values for nutrient composition.

ANOVA techniques were applied to test for between-group differences after adjusting for race and gender differences. Significant interactions were analyzed using Studentized Newman-Keuls range tests.

Main Findings

- C In blacks and in white girls, the percentage of energy from saturated fat was higher in those who consumed ready-to-eat cereal (14 percent) than in those who did not (13 percent for blacks and 12 percent for white girls). The opposite was true in white boys.
- C Children who consume ready-to-eat cereal had significantly higher total daily intakes of vitamins A, B₆, B₁₂, and D, as well as thiamin, niacin, riboflavin, folate, and iron than those who did not consume ready-to-eat cereal.

Comments

Since most cereals contain little fat, unless it is added in preparation, for example, to hot cereal, the saturated fat findings are likely due to the use of higher fat milk consumed with the cereal.

CITATION

Nicklas, Theresa, Carol E. O'Neil, and Gerald S. Berenson. "Nutrient Contribution of Breakfast, Secular Trends, and the Role of Ready-to-Eat Cereals: A review of data from the Bogalusa Heart Study." *American Journal of Clinical Nutrition*, vol. 67, 1998, pp. 757S-763S.

Objective of the Article

To review the secular trends of breakfast consumption and the influence of breakfast consumption on the total daily nutrient intake of children and young adults using data from the Bogalusa Heart Study.

Sample and Data Used

Dietary recall data on 10-year-old children from each of six cross-sectional surveys conducted over the past decade and a half for the Bogalusa Heart Study in LA, were used. Six cohorts of 10-year-old subjects were examined during the 1973-74, 1976-77, 1978-79, 1981-82, 1984-85, and 1987-88 school years. There were 1,254 children in the sample, of which 66% were white and 51% were female. In the last two cross-sectional surveys (conducted in 1984-85 and 1987-88), data were combined for specific analyses (no significant differences were detected in the variables studied). From 1988 to 1991, dietary recall interviews were conducted on young adults between the ages of 19 and 28. There were 504 cases in the sample; 70 percent were white and 58 percent were female.

Outcomes Examined

Trends in breakfast consumption patterns, average daily intake by breakfast consumption patterns, nutrient contribution of breakfast by source, the effect of the national school breakfast program, and the effect of ready-to-eat cereal consumption were studied.

Methodology

A standardized protocol including the 24-hour dietary recall method was used. The protocol details all breakfast and lunch foods prepared at school during the 24-hour period immediately preceding the interview. Graduated food models, a product identification notebook for probing about snack consumption and family recipe collections were included as quality controls. The Moore Extended Nutrients (MENU--formerly the Extended Table of Nutrient Values) database was used for the analysis of the 24-hour recall data.

Main Findings

- C A large percentage of children who skipped breakfast did not meet two-thirds of the RDAs for calcium, thiamin, iron, folacin, zinc, and vitamins A and B₆.
- C About 17 percent of children skipped breakfast.
- C Black females were most likely to skip breakfast (26 percent skip) than whites or black males, and black males were more likely to skip than whites.
- C The tendency for children to skip breakfast increased from 9 percent in 1973-74 to 16 percent in 1976-77 to 30 percent in 1978-79.
- C Children eating school breakfast showed an increased intake of calories, protein, and carbohydrates (specifically, lactose), while children eating breakfast at home had a significant decline in intake of these nutrients, especially carbohydrates (specifically, lactose).
- C Children who skipped breakfast consumed significantly more calories at lunch from protein than children who ate breakfast at home; however, breakfast skippers did not make up the entire difference in energy intake at other meals.
- C School breakfasts contained significantly more calories, protein, and carbohydrates than breakfasts served at home. Breakfasts served at home contributed significantly more sucrose to the child's diet.
- C Children and adults who regularly consume ready-to-eat cereals increase their daily vitamin and mineral intake and lower their daily intake of energy, total fat, saturated fatty acids, and cholesterol.

Comments

These findings suggest that school breakfasts choices or consumption are different from home breakfasts.

CITATION

Norstrand, G. "A Study of the Effects of School Breakfast on Reading Achievement, Attendance, and School Adjustment of Pupils." Dissertation, *Brigham Young University*, 1971, pp. 1-81.

Objective of the Article

This doctoral dissertation was designed to determine if there were significant differences in Stanford Reading Test scores and rate of absenteeism between pupils in poverty-area elementary schools who had regularly received a school breakfast and similar pupils who had attended schools where a breakfast was not available. The dissertation also examined the opinions of teachers and school administrators regarding the effect of the School Breakfast Program (SBP) on the student's general adjustment to school.

Sample and Data Used

The dissertation was based on a study involving 92 subjects from the Los Angeles Unified School District. Eleven schools were involved in the study. All had entitlement for the SBP under the criteria of the Elementary and Secondary Education Act of 1966. Personnel from these 11 schools, 16 principals and vice-principals, and 43 teachers, also participated in the study.

The pupil subjects were divided into four groups based on the length of time of participation in the SBP. Group 1 was composed of 19 pupils from three schools that had participated in the SBP since the spring of 1967, a period of over three years at the time of this study. Group 2 was composed of 13 subjects from two schools that had participated since the spring of 1968, a period of over two years. Group 3 was composed of 30 pupils from three schools that had participated since the fall of 1969, a period of almost one year. Group 4 was composed of 30 pupils from three schools that had not participated in the SBP, although they satisfied the same criteria met by the other three groups for participation in the program. This final group acted as a control group. Principals, vice-principals, teachers, and cafeteria personnel identified pupils in the first three groups. Participants in group 4 were selected through random sampling.

All four groups were tested on the Stanford Reading Test in May of 1968 as first graders, in May of 1969 as second graders, and in May of 1970 as third graders.

The principals and vice-principals of the 11 schools were selected as subjects to respond to a questionnaire regarding the 'general adjustment of pupils'. Principals then selected four teachers as subjects in each of the 11 schools to respond to the questionnaire.

Outcomes Examined

The Stanford Reading Test yielded scores in three areas for each participant: word meaning, paragraph meaning, and total reading (each score was analyzed separately). The number of days absent for each of the three groups was gathered from cumulative records. A questionnaire was devised to measure the opinion of teachers, vice-principals, and principals on students' attendance, attitude toward school, general appearance, attention span and restlessness in class, academic performance, fighting, and school-community relations.

Methodology

Grade 1 reading test data were analyzed by ANOVA to determine initial differences. In order to establish statistical control of variables, analysis of covariance was used to analyze reading test data for grades 2 and 3. Corresponding grade 1 scores were used as covariates for grade 2 reading test data. Grade 3 reading test data were analyzed using corresponding grade 2 scores as covariates.

Attendance data for the three school years (1967-68, 1968-69, and 1969-70) were analyzed by ANOVA. The responses to the questionnaire were tabulated and reported. Tables were constructed showing relationships between groups.

Main Findings

- C In 1968, first graders in group 1 that participated in the SBP, had significantly higher reading scores in all areas.
- C In 1969, second graders in group 1 scored significantly higher in word meaning on ANOVA, but analysis of covariance disclosed no significant differences among groups.
- C In general, these results suggest that the SBP offers little consistent benefit in terms of student achievement test scores.
- C There was no significant difference among groups in attendance.
- C Teachers and administrators had a favorable opinion of the effect of the SBP on the pupils' general adjustment to school, and in general, the opinions were more favorable in the schools that had the program for the most years.

Comments

Several factors should be considered when interpreting the results of this study: (1) the test instrument or the testing conditions may not have been valid; (2) other variables directly related to achievement may have confounded the results; and (3) no attempt was made to determine which children were receiving breakfast at home. This was a relatively small and nonrepresentative sample in which there was little control over confounding variables.

However, although these caveats are important, this early study is relevant to the design of the USB evaluation in a number of ways. It provides further evidence that the effects of the SBP on standardized test scores or attendance are not easy to detect.

The design and wording of the staff survey questionnaire is quite similar to the surveys used in the Minnesota and Maryland USB evaluation. The results appear to be quite similar as well, with staff agreeing very strongly with statements — an indication that the SBP had positive effects on student attendance, academic performance, attitude, discipline, attention, and even appearance.

In summary, surveys of teachers, administrators, and other staff provide one of the most consistently positive sources of data on the beneficial effects of the SBP.

CITATION

Novello, A.C., C. Degraw, D. V. Kleinman. "Healthy Children Ready to Learn: An Essential Collaboration between Health and Education." *Public Health Reports*, vol. 107, January/February 1992, pp. 3-10.

Objective of the Article

This article outlines how the health goals of the Healthy People 2000 federal initiative and the educational goals of the America 2000 initiative overlap and points toward an additional set of goals that will enable U.S. children to be healthy and ready to learn. "Society is slowly coming to the realization that the health status of children and their educational development are inextricably linked."

The primary national educational goal is that by the year 2000, all children in America will start school ready to learn. Related health promotion and disease prevention objectives include all children receiving the nutrition and health care needed to start school with healthy minds and bodies, the reduction of dietary fat intake, the reduction of iron deficiency, and increase to at least 90 percent the proportion of school lunch and breakfast services with menus consistent with the Dietary Guidelines for Americans.

Main Findings

Statistics Regarding Poverty and Hunger in America:

The National Center for Health Statistics data shows that in 1988, 12.6 million children younger than 18 years were living in poverty; with black and Hispanic children three times more likely than white children to be living in poverty.

While there is debate over the prevalence of childhood hunger in America, with estimates of the number of children who experience hunger ranging from 2 to 5.5 million, the National Commission on Children found that the problem has increased during the past decade.

Healthy People 2000:

Healthy People 2000, developed under the leadership of the Public Health Service, is a set of 300 national health promotion and disease prevention objectives to be achieved by the year 2000. More than 170 of these objectives relate to the health of mothers, infants, children, adolescents, and youth. Similarly, many of the Healthy People 2000 objectives complement the National Education goals.

Every child, throughout his/her school career, should have the opportunity to arrive at school healthy and ready to learn each day. Children must be healthy in order to become educated and children must be educated in order to stay healthy. In order to realize the objectives of Healthy People 2000, two critical

systems -- those providing health services and those providing education -- need to collaborate, not only among themselves but also with social services.

Comments

Since the focus of this article is the first educational goal, which relates to school readiness, most of the implications for the USBP evaluation design are for preschool aged children. The links between learning and health, and between learning and nutrition in particular, are clear and have a direct application to school- age children. In particular, the assurance that children receive the nutrition they need to perform adequately at school is especially relevant to the school breakfast and lunch programs

CITATION

Pollitt, E. "Developmental Impact of Nutrition on Pregnancy, Infancy, and Childhood: Public Health Issues in the United States." *International Review of Research in Mental Retardation*, vol. 15, 1988, pp. 33-80.

Objective of the Article

This article reviews two major categories of research on nutrition and behavioral development. The first relates to the effects of different forms of under-nutrition prevalent in the United States; the other refers to the effects of a few selected constituents in the daily diet of American children.

Main Findings

Historical Background (Conceptual and Methodological Changes):

Recognition of the complex interactions between malnutrition, infection, and socioeconomic circumstances led many investigators to reject the main effects model in studies on the effect of under-nutrition on economically impoverished children. A conceptual shift toward multivariate approaches has been made as the need to include social and environmental factors as key intervening variables became clear. An optimal environment might protect against, and in some instances rectify, the cognitive impairment that appears to be one of the adverse effects of under-nutrition.

The second major conceptual change stemmed from the recognition of a selective and probably overemphasized focus on the measurement of behavioral outcomes, particularly on developmental and intelligence quotients. This focus prevented researchers from observing the interactions of under-nutrition and behavioral development in their entirety. It is now becoming apparent that developmental risk factors do not need to have a direct influence on the central nervous system to affect behavioral development. There is likely to be a developmental cost associated with the behavioral adaptation made by undernourished infants and children to maintain their energy balance.

Nutritional Supplementation:

Studies in developing countries on the effects of nutritional supplementation on infants and preschool children have shown that these effects on mental development up to the first 36 to 48 months of life are statistically significant while the intervention was implemented. These effects "washed out" as the children grew older. However, as observed in early intervention studies of educationally disadvantaged children in the United States, the possibility of dormant effects still exists.

In a Guatemalan study of children 8 to 10 years old, several aspects of social behavior appeared to be related to nutrition in early childhood. High levels of supplementation between birth and 2 years of age

were predictive of high levels of social involvement, happy and angry affect, and moderate levels of activity, while low supplementation was associated with passivity, dependency on adults, and anxious behavior.

One must be cautious when interpreting the results of this study due to the serious methodological problem of self-selection in the frequency of participation in the supplemental program.

School Feeding:

Data obtained under laboratory conditions suggest that food assistance programs in schools are likely to prevent educational problems among children who would not otherwise have breakfast. Arousal changes resulting from a fasting state may interfere with attentional processes and problem-solving competence. However, the cognitive deficits observed under laboratory conditions might not be observed in the classroom setting.

Iron Deficiency Anemia:

Iron-deficiency anemia represent the end point in a continuum that may have taken place over a period of weeks or months.

Three major national surveys conducted between 1968 and 1974 established iron-deficiency anemia as a serious public health concern among infants and young children.

In a study of preschool children in Cambridge, Massachusetts (Pollitt et al.), 3- to 6-year-olds were given a battery of psychological tests, including the Stanford-Binet Intelligence Scale, discrimination-learning and oddity-learning tasks, and short-term recall; 15 children were defined (post hoc) as iron deficient. Although no IQ differences were apparent between groups before or after iron treatment, there were statistically significant between-group differences in the number of trials required to reach a learning criterion in the three discrimination-learning tasks. Compared with controls, children in the experimental group took more trials to reach the learning criterion. These differences suggest a deficit among the iron-deficient preschool children in the capacity to attend to relevant information in problem-solving situations.

In a study of school-age children conducted in Semarang, Indonesia, iron-deficient 9- to 11-year-old children had lower educational achievement test scores than did iron-replete subjects. Following iron-repletion therapy for a 12-week period, the achievement scores of the iron-deficient anemic children increased significantly above those of anemic children treated with placebo. The deficits in attention and concentration that were exhibited by the iron-deficit children disappeared following treatment.

Comments

The food assistance programs in the U.S. were designed to address the perceived risk of malnutrition. Although evaluation was not a consideration in their implementation, the evaluations that do exist, especially of WIC, strongly suggest that these programs are likely to have preventive effects and that the risk of malnutrition in this country decreased significantly in the 1970s and 80s as a result of these programs.

CITATION

Pollitt, E. "Does Breakfast Make a Difference in School." *Journal of the American Dietetic Association*, vol. 95, October 1995, pp. 1134-1139.

Objective of the Article

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

Main Findings

Experimental Studies:

No matter what research setting was used, consumption of breakfast consistently benefited the cognitive performance of undernourished children, particularly in working memory tests. However, the influence of breakfast was not restricted to memory: performance in the verbal fluency test was enhanced in the two Jamaican studies, as was vocabulary in the Peruvian field study.

Among well-nourished children, the findings are not clear. Well-nourished, middle-class children and adolescents in the United States and Great Britain exhibited cognitive benefits from the consumption of breakfast. Conversely, well-nourished children in Jamaica and Huaraz, Peru showed no effects. This discrepancy cannot be explained by the available data in the different settings. A speculative conclusion is that the children in developing countries were accustomed to missing breakfast and were free of stress.

In some well-nourished, middle-class children in the United States and Great Britain, working memory was sensitive to the fasting condition. This finding concurs with the observations for at-risk subjects in Jamaica and Peru.

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

Field Studies--Evaluation of School Breakfast Programs:

The data from the three studies cited do not support definitive conclusions regarding the educational benefits of school breakfast programs. Although these studies are stronger than those available previously, they have some weaknesses. For example, the internal validity of the study in Lawrence, Massachusetts

was limited because the subjects were not assigned randomly to a breakfast and a no-breakfast condition. Weaknesses in design, however, must be weighed against the strengths of the overall study. The validity of the study is strengthened by a well-designed intergroup comparison of pretreatment and post-treatment scores generated from a standardized achievement test.

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

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

Most design and method limitations observed in the studies published before 1978 have been resolved in the research conducted since that year. In particular, study design has improved with the use of experimental, crossover strategies and strict control of confounders. Nevertheless, some limitations prevail. For example, a previous review of the literature suggested that an overnight and morning fast affected the emotional status of children, yet none of the new studies focused on this issue. Similarly, there is a lack of research on the relationships among fasting, activity level, and cognition.

Moreover, questions about the role of age, sex, and body composition as effect modifiers were not raised in the past, and the most recent studies have not accounted for these important variables either. Within the area of nutrition and behavioral research, perhaps the most important conclusion to be drawn at this time is that the data, as a whole, indicate that brain function is sensitive to short-term variations in the availability of nutrient supplies. This indication is particularly strong for nutritionally at-risk 9- to-11-year-old children. The data suggest that these alterations occur not only under controlled laboratory conditions but also in the classroom. The mechanisms that explain these effects need to be delineated.

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

Perhaps the widest gap in the more recent literature has to do with the effect that changes in nutrition attributable to the SBP may have on cognitive function and educational achievement. Data from other areas of nutrition and behavioral research suggest that highly prevalent nutrient deficiencies affect cognition, and that these deficiencies can be prevented or remedied by the SBP. Current evidence that breakfast makes a difference in school performance will be greatly enhanced by such new data.

Comments

Since this piece was published four years ago, little has been published that would substantively change the authors' conclusions.

CITATION

Pollitt, E., S. Cueto, and E. R. Jacoby. "Fasting and Cognition in Well- and Undernourished Schoolchildren: A Review of Three Experimental Studies." *American Journal of Clinical Nutrition*, vol. 67, 1998, pp. 779S-784S.

Objective of the Article

This article reviews three experiments on the effects of an overnight and morning fast on attention and memory processes among 9- to 11-year-old children

Experiments 1 and 2: These First Two Experiments Focus on Middle-Class, Well-Nourished Boys and Girls in the United States

Sample and Data Used

Unless otherwise noted, the following information applies to both experiments. The subjects were 9- to 11-year-old children meeting the following criteria: height and weight between the 10th and 90th percentiles of the National Center for Health Statistics standards, no history of hypoglycemia or any other metabolic disease, and a history of good health. There were 23 girls and 9 boys in the first experiment, and 20 girls and 19 boys in the second. Subjects were recruited through a university newsletter.

All subjects were admitted to a clinical research center on two evenings about seven days apart. At the first admission, medical personnel recorded complete medical histories and conducted physical examinations for all subjects. On both admissions, the subjects ate dinner at 5 p.m., went to bed at approximately 7 p.m., and were awakened at 7:20 the next morning for breakfast. The investigators randomly assigned the subjects to either breakfast (BR) or a placebo (NBR) on the morning of the first admission and reversed the treatments on the second. At 11:15 a.m., psychologists, blinded to the treatment, administered a series of behavioral tests. The investigators then took blood samples and discharged the children.

Outcomes Examined

The psychologic test battery included the Matching Familiar Figures Test (MFFT) and the Hagen Central Incidental Test (HCIT). The Peabody Picture Vocabulary Test (PPVT) was included in experiment 1, whereas experiment 2 used the Slossum Intelligence Scale.

Blood samples were used to determine glucose concentrations.

Methodology

Subjects were randomly assigned to groups of either breakfast or placebo for experiment 1 and to the reverse for experiment 2.

Main Findings

Experiment 1:

Although blood sample analyses did not show the clinical symptoms of low blood glucose after overnight fasting, other blood chemistry values -- like changes in lactate, BHB, and fatty acid concentrations -- did support the hypothesis that overnight fasting was stressful and had measurable effects.

In this experiment, the interaction between treatment (BR or NBR) and IQ accounted for a significant portion of the variance in errors on the MFFT.

Performance in the five easy tasks of the MFFT was poorer for those who fasted. In addition, the magnitude of the difference in glucose concentrations at 12:00 between those who ate breakfast and those who did not was negatively associated with a change in the number of errors. As glucose concentrations dropped, the number of errors increased.

As expected, the incidental scores on the HCIT were significantly higher after NBR than after BR. However, the HCIT yielded an unexpected finding: recall of the last central item in the series was significantly better after the overnight and morning fast than after breakfast consumption. Moreover, the subjects whose glucose value fell below the median for the respective distribution were also more likely to show the recency effect than those with glucose values above the median.

- C Neither the IQ test nor the continuous performance task showed any effects of treatment. The sex of the subjects also had no effect on the scores on any of the tests administered.

Experiment 2:

Independent of the subjects' IQs, the overnight and morning fast influenced performance on the MFFT: errors were significantly greater after NBR than after BR. Errors after NBR also showed a statistically significant negative correlation with insulin and glucose values.

The results of experiment 2 on the HCIT agreed, in part, with those of experiment 1. After NBR, incidental scores were higher than after BR, and insulin was negatively correlated with incidental recall. On the day of BR, neither glucose nor insulin concentration correlated with performance. The recency effect in memory observed in experiment 1 was not observed in experiment 2.

As in experiment 1, intelligence test scores did not discriminate between the BR and the NBR conditions, nor did they moderate the effects of treatment on the other cognitive tests or show any sex effects on performance.

Experiment 3: This Third Experiment Involved Boys from Low-Income Families in Huaraz, Perus With and Without Nutritional Risk.

Sample and Data Used

This experiment included well- and undernourished children of low-income parents without a college education, unlike the children in experiments 1 and 2. The subjects were 23 undernourished and 29 well-nourished 9- to 11-year-old boys. Criteria for sample selection were as follows: (1) male sex [girls were excluded to avoid the potential confounding effect of early menarche on cognitive function], (2) enrollment in the fourth or fifth primary school grade, (3) adequate nutritional status or at-risk nutritional status, (4) no signs of poor vision, delay in neuromotor development, or seizures, and no history of reactive hypoglycemia, and (5) a score of one or two on the sexual maturation scale to avoid the possible confounding effect of puberty. As in the first two experiments, the subjects in experiment 3 acted as their own controls.

Breakfast consisted of a small cake and a beverage. A diet soda without caffeine was used as a placebo for the NBR subjects. For glucose determinations, blood samples were taken at 11:30 a.m after the two treatments.

Outcomes Examined

The battery of psychologic tests included three paper-and-pencil tests [number discrimination, PPVT, and the Raven Progressive Matrices) and three computerized tests (Simple Reaction Time, Stimulus Discrimination (SDT), and Sternberg Memory Search Test (SMST)], which are included in the Cognitive Abilities Test Battery developed by Dettermanm. after the two treatments.

Methodology

Information on statistical methodology was not provided.

Main Findings

Performance on the SMST was adversely affected by the NBR treatment among the at-risk children; their speed in scanning memory was comparatively slower than that of the BR group after the overnight and morning fast. However, the at-risk subjects showed no treatment differences in increments of decision time

as a function of block size, and the intercept generated from the differences between treatment conditions was significantly different from zero. Performance on the SDT test was also affected among the nutritionally at risk children; decision time was shorter on the day they ate breakfast than on the day they fasted.

In contrast to experiments 1 and 2, the treatment in experiment 3 had no detrimental effects on cognition among the well-nourished children; contrary to expectations, the scores in the SDT and PPVT were better after NBR than after BR.

Comments

Results from these studies suggest, although somewhat inconclusively, that even in relatively well-nourished children, skipping breakfast results in biochemical stress and has an adverse effect on attention and memory, effects that are more pronounced among nutritionally at-risk children. These effects may be mediated by metabolic changes in blood glucose in the brain.

CITATION

Pollitt, E., M. Gersovitz, and M. Gargiulo. "Educational Benefits of the United States School Feeding Program: A Critical Review of the Literature." *American Journal of Public Health*, vol. 68, May 1978, pp. 477-481.

Objective of the Article

This article presents a selective review of the literature on studies that explore the extent to which U.S. school feeding programs promote educational progress or, more specifically, studies that examine how the behavior of students is affected by short-term hunger or by school feeding programs.

Main Findings from Literature Review

Short-Term Behavioral Effects of Morning Feeding and Hunger:

The review of studies on the short-term effects of hunger and feeding does not yield a uniform set of outcomes. Two researchers examined emotional dimensions of behavior, two others focused on cognitive components, and the remaining two concentrated on measures of physical activity. The studies on emotionality suggest that, at least among preschoolers and children up to the fifth grade, a morning snack or juice may be beneficial. However, it is not possible to specify from the studies on emotionality what these benefits really are. The researchers use vague terms, such as "nervousness" or "hyperactivity" and do not provide clear operational definitions of such variables. Thus, no conclusive inferences can be drawn.

In connection with the studies on the cognitive components of behavior, there is some discrepancy between the findings of Dwyer et al. and those of Matheson. The former found that breakfast had no detectable effect on attention, whereas the latter observed beneficial effects on arithmetic and a decoding task. Matheson concluded that "students score higher on school-type tasks undertaken shortly after food is given than when no food is given". It is not clear why these studies yielded contradictory results. One possibility is that they may have tapped different mental abilities with different sensitivities to the nutrition variable. It is also conceivable that the home food intake differed between the populations in the two studies.

These findings provide some indication that short-term hunger may have some adverse effects on emotional behavior, arithmetic and reading ability, and physical work output.

Long-term Behavioral Effects of School Feeding Programs:

As the studies of short-term effects of morning hunger and feeding, the work reviewed on the long-term effects of school feeding do not yield a uniform set of findings.

The data show that, while two investigators (Lininger and Krietzman) found a beneficial effect of school breakfast on school performance, five other investigators failed to detect this effect. It is impossible, however, to identify the reasons behind such contradictory findings because most of these reports present only brief descriptions of their samples and methods. Nonetheless, some of the data suggest that there are many important moderating variables (e.g., degree of participation in feeding programs, food intake on the day achievement tests were administered) that must be measured and controlled in order to have a valid assessment of the nature of the correlation between feeding and achievement. The differences in the designs and the samples of the various studies may also account for some of the differences between results.

In a study by Lieberman et al. 1976 there was no detectable difference between the experimental and control subjects in a series of school performance-related measures. However, school breakfast program participants were well-nourished before the initiation of the treatment, and therefore, the food program may not have brought additional nutritional benefit. This study illustrates how the nature of the sample may determine the nature of the results.

As a whole, the studies fail to provide a strong basis for making valid inferences regarding the long-term effects of the feeding programs on the school achievement and adaptation of children. It is immediately apparent that the studies have failed to monitor closely many important moderating variables and that their methods were not sound.

Conversely, the studies that focused on the short-term effects of hunger or morning feeding suggest that eating breakfast may benefit the student emotionally and enhance his or her capacity to work on school-type tasks.

Comments

Perhaps the major contribution of this piece is to demonstrate the lack of well-executed studies that could provide direct answers to questions about the educational impact of the school meals programs.

As the authors note in their conclusion, an important question that remains unanswered is whether a program that starts with poorly nourished children and brings about nutritional improvements would fail to benefit the educational status of the children.

This comment clearly points out the need to conduct well-designed studies that can, at a minimum, estimate the effects of the program separately for well-nourished and poorly nourished children and possibly control for the immediate, shorter-term effects of meal consumption.

CITATION

Pollitt, E., R. L. Liebel, and D. Greenfield. "Brief Fasting, Stress, and Cognition in Children." *The American Journal of Clinical Nutrition*, vol. 34, August 1981, pp. 1526-1533.

Objective of the Article

The effects of skipping breakfast on the speed and accuracy of responses in a number of problem-solving tasks were assessed in 9- to 11-year-old well-nourished children.

Sample and Data Used

Twenty-two girls and 12 boys, ages 9 through 11 (with a mean age of 10 years and 4 months) made up the total sample. Entry criteria for the study included (1) height and weight above the 10th and below the 90th percentile of the NCHS growth standards; (2) no history to suggest reactive hypoglycemia; (3) medical diagnosis of good health at the time of the study; and (4) an age of 9 through 11 years.

Participants were admitted twice at approximately seven-day intervals to the Clinical Research Center at the Massachusetts Institute of Technology. A complete medical history and physical examination were performed on the evening of the first admission. A brief exam was performed on the evening of the second admission. All participants were served dinner at 5 p.m. Blood samples were taken at 9 p.m. that night. At 8 a.m. the next morning, a random half of the sample received breakfast (the BR treatment condition), and the other half received no breakfast (the NBR treatment condition). On the second admission, this order of treatment was reversed. The behavioral battery was administered (see "Outcomes" section below for more details) at 11 a.m. Blood samples were obtained and analyzed afterwards at approximately noon.

Outcomes Examined

The outcome variables included performance on the Matching Familiar Figure Test (MFFT), the Continuous Performance Task (CPT), and the Hagen Central-Incidental task (HCI). The Peabody Picture Vocabulary Test (PPVT) was also administered with the purpose of using IQ as a possible moderating variable.

The blood samples were used to determine glucose, lactate, β -hydroxybutyrate (BOHB), and free fatty acid levels.

Methodology

The means and standard deviations of the plasma biochemical values at 9 p.m. and noon were compared for both the BR and the NBR conditions. Comparisons were made on the MFFT test between

the BR and NBR conditions using a two-way ANOVA. Similar analyses were performed for the CPT and the HCI.

Main Findings

- C There were no between-group treatment condition differences in mean glucose values. However, the differences between the fed and the fasted states in lactate, β -hydroxybutyrate (BOHB), and free fatty acids suggests that the fasted state constituted a considerable metabolic stress.
- C The study found neither a cognitive advantage nor disadvantage between the treatment and control groups. However, brief fasting induces arousal changes, which are believed to produce fast responses to problem-solving situations.
- C Among children with a high IQ, there was a negative correlation between glucose and response time to problem solving. There was no association between low glucose level and an increase in MFFT errors. Thus, the findings are inconclusive.

Comments

Though the study had a relatively strong experimental design, it made use of a small sample. Moreover, there may be limitations due to the self-selection of subjects into the study and, perhaps, inadequate background controls. A final limitation worth noting is that it was obvious to the subjects which of them had received the treatment and which the placebo, a phenomenon that could have influenced performance on the behavioral tests.

With these caveats in mind, we can draw some important inferences from the study. Under relatively strong laboratory conditions, there were no statistically significant differences between the subjects who fasted and those who had breakfast in terms of their scores on most cognitive tests of memory, attention, and intelligence. There was one significant effect based on an interaction when the sample was divided between lower and higher IQ children. For lower IQ subjects, the number of errors increased under fasting conditions, but for higher IQ subjects, the number of errors actually decreased.

Additionally, there were no statistically significant differences between the subjects who fasted and those who had breakfast in terms of their blood glucose scores resembling clinical symptomatology or in any other way. However, there were differences between the groups in lactate, BOHB, and free fatty acids, which suggests that the fasted state did constitute a considerable metabolic stress.

One of the author's overall conclusions is probably the most important for the design of a large school breakfast study: the nature of the differences between breakfast and no breakfast conditions is subtle. Another is that brief fasting does induce arousal changes, which do, in turn, affect cognitive functions.

CITATION

Pollitt, E., and R. Matthews. "Breakfast and Cognition: An Integrative Summary." *American Journal of Clinical Nutrition*, vol. 67, 1998, pp. 804S-813S.

Objective of the Article

This integrative summary includes key findings reported at the International Symposium on Breakfast and Performance held in Napa, CA in 1995 and data published since the meeting, and a review of related topics. In particular, research design, measurements, mechanisms, potential effect modifiers, and issues of public policy are discussed.

Main Findings from Literature Review

While data suggest that children perform certain tasks of cognition more successfully after eating breakfast than after fasting overnight, there are inconsistencies in the data, partly attributable to differences in study design, the cognitive measures used, and the characteristics inherent in the study population (i.e., nutritional status).

Research Design:

Short-term evaluations of breakfast and cognitive performance have used experimental and quasi-experimental research designs.

Cognitive Functions:

Theoretically, there are two plausible biological mechanisms by which breakfast may affect brain function and cognitive test performance. One involves metabolic changes associated with an extended overnight fast to make fuel and other nutrients available to the central nervous system. The other involves the long-term salutary effects that breakfast may have on nutrient intake and nutritional status, which in turn could affect cognition.

In children and young adults who did not eat breakfast, the following functions were diminished: speed and accuracy on tests of visual and auditory short-term memory, immediate recall, delayed recall, recognition memory, and spatial memory.

Three studies of children reported lower performance in the ability to visually discriminate between competing stimuli. The no-breakfast condition was also associated with a decline in performance on a verbal fluency test and in such tasks as arithmetic, continuous visual stimulus, and stimulus discrimination. Although the reported data do not lend themselves to a direct comparative analysis, the pooled findings

suggest that attentional processes are also vulnerable to a prolonged fast. On the other hand, neither tasks requiring sustained attention nor the speed of general knowledge retrieval were affected by not eating breakfast.

In some studies, none of the cognitive function measures related to memory, computational skill, or attentiveness were significant between the breakfast and the no-breakfast groups. However, the absence of statistically significant effects was primarily observed in those studies that did not control for potential confounders.

Apart from school feeding (breakfast) studies, long-term assessments of breakfast omission and cognitive function have not been conducted. It is plausible that repeated breakfast omission contributes to nutrient inadequacies, but the impact of repeated breakfast omission on nutritional status and subsequent cognitive performance is not clear.

Scholastic Achievement and School Attendance:

The three studies intended to definitively answer the question of whether the short-term effects of breakfast on cognition translate into long-term scholastic benefits have had design limitations. All three did report improved scores on other scholastic tests given in schools participating in a breakfast program. Improvements were observed in the following areas: overall combined scores of language, reading, and math in a study of U.S. low-income students; in arithmetic in a study of rural Jamaican schoolchildren; and in vocabulary scores in a study of undernourished Peruvian children. In all three evaluations, participation in the school breakfast program significantly increased school attendance.

Breakfast Composition, Size, and Timing:

No change in cognitive performance was observed when a cooked breakfast was compared with a cereal-and-toast breakfast, nor was there a change according to different fat and carbohydrate levels in breakfasts.

Research Data, Programs, and Policies:

We do not know how age, sex, nutritional status (past and current), and the timing, size, and composition of the morning meal modify the effects of breakfast consumption or omission.

Comments

The previous research suggests that eating breakfast improves nutritional status and specific cognitive tasks, especially those involving memory. Much less research has been done regarding the educational benefits of increased breakfast consumption, but improvements in school attendance have been noted, which should, in turn, eventually lead to improvements in scholastic performance over time.

Overall, the data suggest that omitting breakfast interferes with cognition and learning, an effect that is significantly more pronounced in nutritionally at-risk children.

CITATION

Pollitt, E., and M.S. Read. "Bridges Between Nutrition, Neuroscience, and Behavior." *The American Journal of Clinical Nutrition*, vol. 42, August 1985, pp. 348-351.

Objective of the Article

This article presents a brief summary of the presentations made at the 1984 Symposium of the American Society for Clinical Nutrition on Nutrient Intake, Brain Biochemistry, and Behavior.

Key Notes from Presentation

Books dating back to at least the turn of the century have provided qualitative and quantitative data based on the observation of poor urban children or victims of famine, suggesting that poor diet weakens a child's physical and mental stamina.

As consistent as some of these observations have been, the relationships among variables are so complex that it is easy to arrive at unjustified conclusions; prudence is required in this area of science given the profound implications for policy issues like the effects of the consumption of sugar on hyperactivity, and the effects of the consumption of food additives on attention deficit disorder.

For example:

Dr. Judith Rappaport has done studies on hyperactivity in children as they may relate to sugar or caffeine consumption. Controlled clinical evaluations of children defined by their parents as being hypersensitive to sugar failed to yield positive findings. However, by carefully defining hyperactive behaviors using replicable and scalable methods, this investigator was able to identify a group of children who warranted further investigation.

The children gave no indications of an abnormal glucose tolerance test, nor showed any evidence of unusual stress or other behavioral effects from a sugar challenge. However, regardless of the intervention, there was a significant decrease in motor activity over time for both placebo and sugar-challenged patients. This led Dr. Rappaport to caution that one should never believe any interpretation unless it is based on a double blind design randomized in the order of presentation of the challenges.

Comments

Findings from this study led the authors to conclude that there are relationships between dietary factors, biological processes, and behavioral outcomes, but that it is essential to employ research designs that fully control for the many historical and situational confounding factors.

CITATION

Powell, C.A., S. P. Walker, S. M. Chang, and S. M. Grantham-McGregor. "Nutrition and Education: A Randomized Trial of the Effects of Breakfast in Rural Primary School Children." *American Journal of Clinical Nutrition*, vol. 68, 1998, pp. 873-879.

Objective of the Article

This study reported in this article was intended to determine (1) the effect of providing a school breakfast on children's attendance, nutritional status, and achievement in arithmetic, spelling, and reading; (2) if nutritional status or children's age modifies the effect of school breakfast; and (3) if children spend less money in school if they are given breakfast. This project was conducted in a poor rural region of Jamaica in undernourished and adequately nourished primary school children.

Sample and Data Used

Four hundred seven undernourished children group in grades 2 through 5 from 16 rural Jamaican schools were matched for age, sex, school, and class with 407 adequately nourished children. Both groups were stratified by class and school, then randomly assigned to breakfast or control groups. The mean age was 107.6 ± 14.7 months.

Students were evaluated for changes in academic functioning by examining the test scores from the Wide Range Achievement Test (WRAT). All tests were administered by testers who were blinded to the children's group assignment. All subjects were tested, measured, and interviewed at the start of the 1994 academic year. The breakfast consisted of a cheese sandwich or a spiced bun and cheese, and flavored milk. The control group was given one-quarter of an orange, which served as a proxy for a placebo. The control and breakfast groups were served in separate rooms or at separate times under the supervision of a teacher who recorded the children's consumption. The measurements were repeated at the end of the school year.

A questionnaire was administered individually to each child to obtain information on their socioeconomic status, the amount of money they brought to school, and the type of breakfast they had eaten at home on the day of the interview (breakfast history). The quality of school uniforms and the number of books and writing materials each child brought to school were also observed.

Data on the children's school attendance for the current school year were collected from the school registers.

Outcomes Examined

The outcome variables included the children's scores on the WRAT, which is composed of three subscales: reading, spelling, and arithmetic.

Absenteeism was expressed as a percentage of total possible school days. School attendance during September and October, before the intervention began, was used as the baseline data.

Weight and height were measured according to standard procedures and converted to weight-for-age and height-for-age – scores. Body mass index (BMI) was also calculated.

Methodology

The effect of providing breakfast on the children’s growth was determined by using multiple regression analyses, controlling for the children’s initial measurements, age, sex, and nutritional group. Separate multiple regression analyses were calculated for height, weight, and BMI. Separate analyses were conducted in which the dependent variables were achievement in spelling, arithmetic, reading, and attendance.

Main Findings

- Ⓒ Compared with the control group, height, weight, and attendance improved significantly in the breakfast groups.
- Ⓒ Neither the control nor the breakfast group made significant progress in WRAT scores. However, younger children in the breakfast group did improve in arithmetic.
- Ⓒ There was no effect of nutritional group on the response to breakfast.
- Ⓒ In summary, the provision of a school breakfast produced small benefits in children’s nutritional status, school attendance, and achievement.

Comments

This is the first long-term, randomized, controlled breakfast trial from a developing country. On the positive side, children who received a school breakfast showed small but significant improvements in attendance and nutritional status compared with children in the control group.

On the negative side, WRAT scores for the children who received a school breakfast did not increase overall, nor did the scores of the undernourished children improve more than those of the better nourished children, unlike previous studies on the effects of breakfast on academic achievement in undernourished Jamaican school children, conducted by the same research team. The authors speculate that this anomaly may have occurred because the children in the present study were only moderately undernourished.

There was a significant grade-by-subject interaction for arithmetic achievement score, suggesting that for younger children (grades 2 and 3), those who were in the school breakfast group made greater gains than those in the control group.

One caveat is that WRAT, the school achievement test used for this study, was standardized and developed in the United States and has not been standardized in Jamaica. Aside from this caveat, there are a number of significant implications for the design of a USB program evaluation in the United States: attendance and nutritional status improved in this sample, which was more similar to low-income samples in the United States than to samples in most of the studies conducted in developing countries.

The impact on achievement was limited to arithmetic and to younger students, suggesting that it would only be in these areas that effects might be found in the United States.

CITATION

Rogers, P. J., and H.M. Lloyd. "Nutrition and Mental Performance." *Proceedings of the Nutrition Society*, vol. 53, 1994, pp. 443-456.

Objective of the Article

This article reviews the literature about the acute effects of food and fluid ingestion, including alcohol, caffeine, breakfast and other meals, and glucose drinks.

Main Findings

Lunch:

Tasks requiring sustained attention tend to suffer when lunch is skipped, although a host of confounding issues like Circadian rhythms and personality factors probably play an important role.

Breakfast:

Early work including the Iowa breakfast studies provide only limited support for the widely held belief that skipping breakfast can have an adverse effect on cognitive efficiency. Although the work of Pollitt et al. in the early 1980s provides some evidence for the negative effects of skipping breakfast on cognitive attentional tasks, the lack of stronger effects given the long fast involved provide as much support for the opposite interpretation, namely, that cognitive performance is relatively invulnerable to short-term fasting.

Other Meals:

It has been hypothesized that there is a relationship between the proportion of protein relative to carbohydrates in a meal that can modify the plasma concentration of tryptophan to the other large amino acids. However, the results have been contradictory and/or weak.

The same kind of complex and unclear set of findings holds for other hypothesized mechanisms that model the action of meals.

Results of breakfast studies support the hypothesis that alertness is increased and performance efficiency is improved following a high-carbohydrate breakfast. A high-carbohydrate lunch has, if anything, the opposite effect.

Glucose Drinks:

The majority of studies support the hypothesis that cognitive performance, especially on tasks requiring vigilance, is significantly better following the ingestion of a glucose drink than a “placebo” drink, although the mechanisms underlying this effect are not well understood.

Comments

From alcohol and caffeine to glucose and meals, there is accumulating evidence that dietary interventions do show acute effects on cognitive performance, although there is a general tendency to overestimate the effects. A large number of factors need to be controlled for in future studies, including the timing of the meal.

Findings like these also suggest that a priority for future studies should be the investigation of the consequences of longer-term dietary changes as well as continuing to explore and understand the effects of meals on mood and performance.

CITATION

Sampson, Amy E., D. Sujata, A. F. Meyers, and R. Houser, Jr. "The Nutritional Impact of Breakfast Consumption on the Diets of Inner-City African-American Elementary School Children." *Journal of the National Medical Association*, vol. 87, no. 3, 1995, pp. 195-202.

Objective of the Article

The study documented in this article was designed to determine the contribution of breakfast consumption patterns to dietary adequacy among low-income African-American children in four inner-city elementary schools in East Orange, NJ.

Sample and Data Used

A total of 1,151 children participated in the study. The study participants were enrolled in grades 2 through 5 in four elementary schools in East Orange, NJ. Ninety-seven percent, or 1,119 children, were African-American. The four schools had similar numbers of total students in the study grades and were located in comparable neighborhoods with demographically similar student bodies. Seventy-nine percent of all children in the study schools qualified for free or reduced-price meals. Ninety-eight percent spoke English as their first language, 51 percent were male, 21 percent were in the second grade, and 79 percent were in grades 3 to 5.

Outcomes Examined

The outcomes examined in the study include breakfast consumption patterns, daily nutrient intakes (by breakfast-eating behavior), and height and weight.

Methodology

Twenty-four-hour dietary recalls were conducted on all study children in October 1989. Women from East Orange and neighboring communities were hired and trained in dietary recall methods, including the use of models and measuring tools. All interviews were monitored by an investigator (i.e., Sampson). The dietary recall data were entered into the Nutriquest II nutrient analysis system.

The height and weight of the study children were recorded by school nurses and compared against the National Center for Health Statistics (NCHS) growth standards. Children were classified as either "breakfast eaters" or "breakfast skippers." Nutrient adequacy was defined as >80 percent of the Recommended Dietary Allowance (RDA) using sex- and age-specific standards found in the 10th edition of the RDAs.

Dietary recall data obtained for second-grade students and students in higher grades were compared using nonparametric tests. The proportions of children achieving dietary adequacy for nutrients of interest within each breakfast-eating behavior category were compared using the chi-square statistic. The proportion of children in the two breakfast-eating behavior categories consuming less than half of the RDA for study nutrients was also compared with the chi-square statistic to determine the prevalence of extremely low nutrient intakes. The relative nutrient contribution toward daily intakes and the percentage RDAs provided by different types of morning meals were compared using nonparametric tests.

Main Findings

- C Twenty-two to 26 percent of children responding on each of the four study days reported not eating breakfast before arriving at school.
- C The mean age of the breakfast skippers was greater than that of the breakfast eaters (9.8 years vs. 9.3 years).
- C Less than 10 percent of all children studied failed to achieve dietary adequacy for protein and vitamin B₁₂; more than 40 percent consumed inadequate amounts of calories, and of vitamins A, E, B₆, and calcium; and more than 90 percent consumed inadequate amounts of vitamin D. Significantly more breakfast skippers consumed inadequate amounts of all nutrients studied except vitamin B₁₂.
- C More than a third of breakfast skippers consumed less than 50 percent of the RDA for vitamins A, E, B₆, and folacin; nearly one-quarter consumed less than 50 percent of the RDA for calories, vitamin C, calcium, and iron.
- C Breakfast skippers consumed significantly less sodium and cholesterol, but a greater percentage of their daily calories come from fat compared with breakfast eaters. More breakfast skippers than breakfast eaters were below the RDA for cholesterol but above the recommended daily percentage of calories from fat.

Comments

These findings suggest that skipping breakfast at home increases with age; a relatively high percentage (22 percent to 26 percent) of children in grades 2 through 5 did not eat breakfast before school.

CITATION

Shaw, M.E. "Adolescent Breakfast Skipping: An Australian Study." *Adolescence*, vol. 33, Winter 1998, pp. 851-861.

Objective of the Article

This article reports on the findings of an Australian survey of 699 13-year-olds concerning the extent of skipping breakfast.

Sample and Data Used

The sample used for this investigation came from the Mater Hospital-University of Queensland (longitudinal) Study of Pregnancy. Initially, 8,556 pregnant women were involved in this study (from 1981 through 1984). A total of 5,146 respondents completed questionnaires when the child was 5 years old, and the present results were taken when the child was age 13. For the most recent data collection, both mother and child completed questionnaires. Of the items reported here, the sociodemographic variables were taken from the mother's questionnaire; all other reported items were asked of the children themselves.

Only those children who completed a subsection of the questionnaire on food and eating habits (n=721) and for whom there was a corresponding maternal questionnaire were included in this investigation. As income was considered a central variable, only those cases where this information was provided were used. This left 699 valid cases.

Supplementary data were collected via a telephone survey approximately one year after questionnaires were completed. The 82 respondents who reported not eating breakfast formed the sample for this follow-up; 56 of them completed interviews, and 26 could not be contacted. Respondents were asked how often they ate breakfast, and if they did not, their reasons for skipping.

Sociodemographic patterns of skipping breakfast were examined by dividing total family income into low income (\$399 or less per week) and average to high income (\$400 or more per week). The mothers were classified by education according to whether they had completed compulsory education or less (up to the age of 16) or whether they had some further education.

Outcomes Examined

Outcome variables included attitudes toward body shape and weight. Adolescents were asked whether they thought they were overweight (responses were coded as yes or no). They were also asked to identify which of four body shapes they most resembled and which one they would most like to be (recoded as satisfied with body shape, want to be smaller, and want to be larger). The reasons for skipping breakfast were also considered an outcome measure.

Methodology

Sociodemographic patterns of skipping breakfast were examined using the chi-square test. That test was also used to examine the relationship between health-related behaviors and attitude for a pattern that related to breakfast skipping.

Main Findings

- C The only statistically significant sociodemographic variable found was gender ($p < .00001$): females skipped breakfast at over three times the rate of males. Moreover, it was found that females were also more likely than males to skip lunch or to have been on a diet to lose weight ($p < .00001$).
- C While males and females were equally likely to consider themselves overweight (31.8 percent and 33.3 percent, respectively), females were significantly more likely to be dissatisfied with their body shape and to want to be smaller ($p < .00001$). Nearly half of the females wanted to be smaller; males were more likely to want to be larger.
- C Of the 56 adolescents who participated in the telephone interview, 27 percent always or almost always ate breakfast, while 16 percent sometimes ate breakfast, and 57 percent rarely or never ate breakfast.
- C The primary reason most commonly offered for skipping breakfast was lack of time in the morning (52 percent), followed by not being hungry (22 percent) and “not feeling like it” (14 percent).

Comments

For this Australian sample, breakfast skipping was related to gender but not income. Thus, if the results of this study are valid, breakfast skipping for some children seems to be a matter of personal choice and convenience rather than socioeconomic position.

For the USBP study, several factors emerge as being relevant. First of all, it is not clear whether this sample had a low-income component that was equivalent to most U.S. samples, not only because it was Australia but also because only 12 percent of the sample was from single-parent families, only 10 percent of fathers were reported to be unemployed, and 30 percent of the original sample (more likely to be the lowest income and least functional) had been lost to follow-up.

CITATION

Siega-Riz, Anna M., Barry M. Popkin, and Terri Carson. "Trends in Breakfast Consumption For Children in the United States from 1965 to 1991." *American Journal of Clinical Nutrition*, vol. 67, no. 4, April 1998, pp. 748S-756S.

Objective of the Article

To examine breakfast consumption patterns and trends between 1965 and 1989-91 for children from the ages of 1 to 10 and for adolescents from the ages of 11 to 18 in the U.S.

Sample and Data Used

Nationally representative samples were obtained by pooling data from the 1965 and 1977-78 Nationwide Food Consumption Surveys (NFCS) and the 1989-91 Continuing Survey of Food Intakes by Individuals (CSFII). Resulting sample sizes of subjects aged 1 to 18 include 7,513 cases surveyed in 1965; 12,561 surveyed in 1977-78; and 4289 surveyed in 1989 to 1991. (All results are weighted.)

Respondents were drawn from stratified area probability samples of noninstitutionalized US households in the 48 conterminous states. Four data collection waves (one in each season of the year) were conducted for the 1977 NFCS and the 1989-1991 CSFII. The 1965 NFCS collected individual dietary intake data from a single spring sample only. In the 1965 NFCS, one 24-hour recall was collected in the home for each sample member by asking the household respondent to recall the previous day's food intake for selected household members. In the 1977 NFCS, the individual food intake was obtained for individual family members through a 24 hour recall and two one day food records. For individuals under the age of 12, the female head of household reported dietary intake. The 1989-1991 CSFII followed the same format as the 1977 NFCS, collecting three consecutive days of dietary data. The first day of intake data from each survey period was used since the authors believe there is little difference between dietary intake on days 1 and 3.

Outcomes Examined

In the 1965 NFCS, the time of consumption of each food was recorded, but not the type of meal. In the 1977 and 1989-1991 data sets, for each food consumed, the respondent reported the time of consumption and the name of the meal, as well as information for identifying the nutrient content of the food and other dimensions of eating behavior.

Methodology

A chi-square test was used to determine whether declines in breakfast consumption between 1965 and 1989 are significant. A logistic regression was run to analyze determinants of breakfast consumption.

Data were pooled from the three time periods and time interaction terms were included for the key independent variables in order to examine shifts in the importance of explanatory variables over time. Age and sex interactions were examined as well. The model was then trimmed by dropping non-significant terms ($p < 0.05$ for the main effect and $p < 0.1$ for interaction terms). The final specification included all variables that had either a direct effect on breakfast consumption at any point in time or a significant time-interaction effect. Each age group (1-4, 5-10, and 11-18) was modeled in a similar manner.

Simulations were used to gauge the effect of several variables on the probability of breakfast consumption. This involved calculating the probability of breakfast consumption for each individual based on the estimated logistic regression coefficients and averaging over the sample of individuals.

Main Findings

- C Participation in the School Breakfast Program did not have a statistically significant impact on breakfast consumption. (This result may be explained, in part, by the small percentage of individuals--18 percent in 1977 and 42 percent in 1989-1991 who attended a school that served breakfast.)
- C Breakfast consumption has declined for children and adolescents in the US. This decline was greatest among adolescents.
- C Among breakfast consumers, the morning meal's contribution to total energy intake has remained fairly stable, except for adolescents.
- C Breakfast consumption trends are more a reflection of the adoption of new behaviors by certain subgroups than of the changing sociodemographic characteristics of the U.S.

Comments

This article provides national data on breakfast consumption patterns in U.S. children between 1965 and 1989-91; one-day intakes were based on 24-hour recall data.

CITATION

Simeon, D.T. "School Feeding In Jamaica: A Review Of It's Evaluation." *American Journal of Clinical Nutrition*, 1998; 67 (suppl): 790S-4S.

Objective of the Article

This article covers two studies designed to evaluate the school feeding program in Jamaica that has been in place since 1973. The first study examined the effects of the Jamaican school meal on achievement, attendance, and physical growth. The second study aimed to determine whether the omission of breakfast adversely affected the cognitive functioning of the undernourished and adequately nourished children, testing to see if gains in arithmetic resulted from the alleviation of hunger from the classroom.

Sample and Data Used

The first study examined 115 children aged 12-13 years (grade 7); these children were enrolled in a poor rural school that had not participated in the school meal program, and were in the three lowest classes in terms of scholastic ability. They were the group with the lowest attendance rates and highest prevalence of under nutrition.

The second study included 90 children aged 9-10 years and of differing nutritional status; this second study was conducted in a metabolic ward. Three groups of children were used as subjects, with 30 children in each group: 1) children who had been hospitalized for severe malnutrition during their first two years of life, 2) children who were stunted, and 3) children who were nonstunted. Stunted and nonstunted children were matched for sex, age, class, and area of residence.

Outcomes Examined

In the first study, the outcome variables included school achievement, attendance, and weight gain. One class was served a school meal in the morning, and the other two classes served as controls.

The first class of 44 received the school meal; the second class of 33 received a syrup drink; the third class of 38 received nothing. The three groups were followed over two semesters: first semester information was used as a baseline, and at the beginning of the second semester intervention was implemented.

In the second study, the outcome variables included a battery of seven tests, including three subtests of the revised Wechsler Intelligence Scale For Children: mental arithmetic, digit span (auditory short-term memory), and coding (visual short-term memory) tests.

The verbal fluency (retrieval from long-term memory) and listening comprehension tests were obtained from the Clinical Evaluation of Language Functions. The other two tests, Matching Familiar Figures test

(MFFT) and Hagan's Central Incidental Task, measured visual short-term memory and attention, and impulsiveness and problem-solving efficiency, respectively. The Peabody Picture Vocabulary test was used to measure the child's intelligence quotient. On a given visit, each child either received breakfast in the metabolic ward, or breakfast was omitted.

Methodology

Multiple regression was used in this longitudinal study (first study) to test any beneficial effects on the various outcome measures. Dependent variables were the measures at the end of second semester; independent variables were those at the start of first and second semester (to control for changes during first semester).

The second study used a crossover design, with each child serving as his or her own control. To test the effects of breakfast on cognition, the investigators analyzed the data by using analyses of covariance with repeated measures. The dependent variables were the children's cognitive test scores on the initial visits. The covariates were the potentially confounding variables, such as the children's intelligence quotient and their usual breakfast intake.

Main Findings

First Study:

- Ⓒ The class receiving the meal showed improved arithmetic scores and school attendance compared with the control classes. Arithmetic gains were still significant when attendance and weight gain variables were controlled for.
- Ⓒ The first class showed no weight gain differences from the control groups, nor were the spelling score increases statistically significant.

Second Study:

- Ⓒ Undernourished children were more likely to benefit from school feeding programs than were adequately nourished children. When severely malnourished, stunted, or wasted children received no breakfast, their performance in various cognitive tests deteriorated.
- Ⓒ The omission of breakfast effected a decline in performance on the verbal fluency and coding tests for both the stunted and the previously severely malnourished children, and a similar decline on the digit-span-backward test for wasted children.

- C The omission of breakfast had adverse effects on the MFFT performance for the wasted members of the stunted and severely malnourished groups as well as on the performance on the digit-span-forward test for the wasted members of the nonstunted group.
- C Unexpectedly, the omission of breakfast was accompanied by improved performance in mental arithmetic tasks among the nonstunted children and on the digit-span forward test among the nonwasted, nonstunted children.

Comments

Although the finding that the school breakfast program led to improved academic outcomes on the WRAT test of math (but not spelling) is relevant to the proposed USBP evaluation in the United States, the overall conclusion of the author, that programs that alleviate hunger in schools are likely to produce improvements in school achievement needs to be taken with some caution.

The 44 subjects who received the school breakfast intervention were probably far more nutritionally at risk than the students who would be found in most U.S. schools. These were the students in the three classes with the lowest levels of scholastic ability out of 10 rural Jamaican schools. They also had the lowest levels of attendance and the highest levels of malnutrition as defined by weight for age < 80 percent of the reference standard.

Three months of giving these students breakfast is probably a much more impactful intervention than providing breakfast to even the poorest U.S. school child. Nevertheless, the fact that a small daily breakfast for a month could lead to improved academic outcomes is documentation that such effects are possible.

Another finding that Pollitt and others have reported and deserves mention again: fasting actually significantly improved the functioning of non malnourished children on the mental arithmetic and digit span forward tasks of the WISC-R and this kind of improvement under stress phenomenon must be taken into account. For certain types of tasks like mental arithmetic, the fasting state may actually promote heightened attention.

CITATION

Simeon, D.T., and Grantham-McGregor, S. "Effects of Missing Breakfast on the Cognitive Functions of School Children of Differing Nutritional Status." *American Journal of Clinical Nutrition*, vol. 49, 1989, pp. 646-653.

Objective of the Article

The effects of omitting breakfast on the cognitive functions of three groups of children: stunted, non stunted controls, and previously severely malnourished were examined.

Sample and Data Used

The study comprised three groups of children aged 9-10.5 years; each group had 30 subjects. Only one child was selected per household. Children were excluded from participation if any obvious mental or physical handicaps were noted.

Group 1 consisted of previously severely malnourished children; group 2 was the stunted group; and group 3 acted as the control group (nonstunted children). Subjects for group 1 were children who had been admitted to the University Hospital of the West Indies (UHWI) during the first 2 years of life. Groups 2 and 3 were identified from three primary schools located in poor areas close the UHWI. The stunted children were identified first and then the control children were selected from the same class. They were matched for gender and area of residence. There were 19 boys and 11 girls in group 1, 15 boys and 15 girls in each of groups 2 and 3.

Details of the children's social background were obtained and their housing was scored on a scale that gave equal weighting to quality of water supply, sanitation, and crowding. The rating ranged from 3.0 (worst housing) to 9.0 (best housing).

The subjects were then admitted overnight, two at a time, to a special research ward on two occasions 1-week apart. They entered in the afternoon and at 5 p.m. and received a standard dinner of ~ 940 kcal. On the afternoon of their first visit they were given the Peabody Picture Vocabulary Test (PPVT) to measure their IQs.

At 8 a.m. the next day one-half of the children were given a standard breakfast providing ~ 590 kcal (~25 percent of their daily caloric requirement). The other half received a cup of tea sweetened with aspartame (children were given breakfast or tea based on systematic random assignment). The treatment order was reversed the following visit for the other half of the children. At 11 a.m. cognitive function tests were given by a study official that was unaware of the children's group or fasting state.

Outcomes Examined

The outcome variables consisted of a battery of tests intended to measure both fine-grained levels of cognitive functions and more global or classroom-type tasks. They included three subtests of the Wechsler Intelligence Scale for Children: arithmetic, digit span, and coding.

Two subtests of the Clinical Evaluation of Language Functions were also used: fluency and listening comprehension. The Matching Familiar Figures Test (MFFT) and the Hagen's Central-Incidental task (HCI) were previously shown to be sensitive to the omission of breakfast and were thus also used for this study.

Methodology

Group differences in mean age, anthropometric variables, IQ scores, and social-background variables were examined by ANOVA or chi-square tests where appropriate. The experimental findings for the tests of cognitive function, with the exception of the HCI incidental task, were examined by factorial repeated-measures analyses of variance and covariance. Because there were no significant differences between the previously severely malnourished and stunted groups for any of the cognitive tests, they were combined and compared with the control group to test for treatment-by-group effects.

The scores on the children's first and second visits were the dependent variables in the repeated-measures analyses. Therefore the test-retest effect was the within-subject factor. Treatment and nutritional group were used as between-subjects factors. To examine the effects of wasting, the sample was divided into a wasted and nonwasted set. There were 30 wasted children who were evenly distributed among the original three groups. The ANOVAs with repeated measures were then rerun with wasting as an added between-subjects factor.

IQ was used as a covariate because there was a group difference, however, it did not significantly change the main findings. Weight-for-height was also used as a covariate when treatment and group were used as factors and it too did not change the main findings.

Main Findings

With no breakfast, groups 1 and 2 had lower scores on the verbal fluency and coding test than with breakfast. Similarly, wasted children had lower scores on the MFFT test and digit span test with no breakfast.

Breakfast omission did not significantly impact performance in adequately nourished children, with the exception that higher arithmetic test scores were observed.

Comments

This important study may help explain some of the varied results obtained from other studies that have been done in only well-nourished children.

In considering a USBP evaluation design, in U.S. samples it will be important to control for socioeconomic status and body mass index as well as nutritional intake and/or other indicators of nutritional risk status.

CITATION

Smith, A., A. Kendrick, and A. Maben. "Effects of Breakfast and Caffeine on Cognitive Performance, Mood and Cardiovascular Functioning." *Appetite*, vol. 22, 1994, pp. 39-55.

Objective of the Article

The results from two experiments that examined the effect of breakfast and caffeine on cognitive performance, mood, and cardiovascular functioning are presented.

Experiment 1: The Effects of Breakfast Type on Sustained Attention Tasks, Mood, and Cardiovascular Functioning

Sample and Data Used

Forty-eight university students (24 male, 24 female) took part in this study. Subjects were either assigned to a no-breakfast condition, a cooked breakfast condition, or a cereal/toast breakfast condition. After breakfast, subjects were given either caffeinated or decaffeinated coffee. This amounted to a total of six conditions subjects could be assigned to.

Subjects were asked to fast from midnight prior to the experimental sessions. They were also asked not to drink caffeinated drinks before coming to the laboratory.

At the start of each session blood pressure and pulse were recorded. Following this, subjects rated their mood and carried out three performance tests that involved sustained attention. The first testing session was carried out at 8 a.m. or 8:30 a.m. Subjects then consumed breakfast (unless they were assigned to the no breakfast condition) which was followed by coffee (the coffee manipulation was double-blind). Subjects then remained in the laboratory until 9:30 a.m. (or 10 a.m.) at which time they carried out another testing session. Subjects completed the experiment with a final testing session at 10:30 a.m. (or 11 a.m.).

Prior to the experiment subjects were asked to complete several questionnaires to assess various personality traits, levels of minor psychiatric symptoms in the last 6 weeks, and frequency of everyday errors of attention, memory, and motor function (the Cognitive Failures Questionnaire).

Outcomes Examined

The outcome variables consisted of the Cognitive Failures Questionnaire as well as the following sustained attention tasks: (1) the Variable Fore-period Simple Reaction Time Task; (2) the Five-choice Serial Response Task; (3) the Repeated-digits Vigilance Task. Changes in blood pressure and pulse were also considered as outcome variables.

Methodology

Analyses of variance were performed on the questionnaire data to determine whether the groups of subjects differed in personality, length of previous night's sleep, or other baseline data.

Analyses of covariance, with the first-session data as covariates, were performed on the data from sessions 2 and 3. The following between-subject factors were included in the analyses: breakfast type, caffeine/no caffeine, and time of testing.

Time on task was considered as a within-subject factor for the analyses of the performance tasks.

Main Findings

Breakfast had no effect on performance of sustained attention tasks, although it increased pulse rate and influenced mood.

Caffeine improved performance of sustained attention tasks and increased mental alertness. Improvement in mood was also observed with some of the breakfast groups.

Authors' Conclusions to Experiment 1:

Breakfast did produce changes in physiological state and mood changes, and changes in attention were measurable under these circumstances as evidenced by the fact that caffeine did improve attention, so perhaps the wrong cognitive measures were being used. Since Benton and Sargent had found changes in memory, this outcome was tested in Experiment 2.

Experiment 2: To examine the effects of breakfast and caffeine on mood and cardiovascular functioning

Sample and Data Used

Forty-eight university students (24 male, 24 female) took part in the study. No subjects in this study had participated in the previous one.

A similar design was used as in the previous experiment. There were two main differences, the first being the nature of the performance tasks used, the second being that the cereal breakfast condition was dropped. Again, "early" and "late" groups were used and test times were Session 1: early-7:45 a.m. (late-8:30 a.m.); Breakfast: 8:45 a.m. (9:30 a.m.); Session 2: 9:30 a.m. (10 a.m.); Session 3: 10:30 a.m. (11:15 a.m.). The cooked breakfast was identical to that given in the previous study and the same dose of caffeine was given in the caffeinated coffee condition. Subjects followed a similar procedure to that used in experiment 1. In the week prior to the experiment, subjects carried out a practice session and filled in the questionnaires. Subjects then fasted prior to testing and drank no caffeinated beverages before the start

of the experiment. Information on normal eating and drinking habits and nature of the previous night's sleep (length and quality) were also recorded.

Four memory tasks were used in this study. Again, mood and cardiovascular functioning were measured.

Outcomes Examined

The outcome variables consisted of the Cognitive Failures Questionnaire as well as the four cognitive tests designed to assess free recall, delayed recognition memory, logical reasoning, and semantic processing. Changes in blood pressure and pulse were also considered as outcome variables.

Methodology

Separate analyses of covariance were performed on the session 2 and session 3 data, with the baseline data as the covariates. Type of breakfast, caffeine/no caffeine and early/late test times were the between-subjects factors.

Main Findings

Breakfast improved subjects' performance on recognition memory tasks. Breakfast was also found to have a significant effect on free recall in the mid-morning, but no effect was noted in the late morning.

Breakfast had no significant effect on the semantic memory task. Breakfast decreased performance on the logical reasoning task.

Comments

There were no differences noted in the groups prior to the experimental manipulations between the groups, thus any difference in effects found for caffeine or breakfast could not be attributed to differences in groups prior to experimental manipulation.

Authors' Conclusions to Experiment 2:

A consistent pattern emerged from two experiments on effects of breakfast on cardiovascular functioning, mood, and performance in the morning. Breakfast generally increased the pulse rate, influenced mood, and improved the performance on some of the memory tests, but had little effect on sustained attention.

These results clearly demonstrate that the effects of breakfast are dependent upon the types of tasks the person carries out. The authors speculate that breakfast increases the supply of glucose to the brain and that glucose may selectively enhance memory but not attentional tasks. The authors also conclude that the effects of breakfast and lunch are independent of each other.

CITATION

Strupp, B.J., and D.A. Levitsky. "Enduring Cognitive Effects of Early Malnutrition: A Theoretical Reappraisal." *Journal of Nutrition* 1995, vol. 125, pp 2221S-2232S.

Objective of the Article

This article describes how views of the effects of early malnutrition have changed with evolving research over the past 30 years.

Sample and Data Used

A Medline search of over 1,100 articles since 1966 indicated that most studies of the effects of malnutrition on brain function or behavior have involved animals. Animal data must then be extrapolated to infer the potential effects of malnutrition in humans.

Outcomes Examined

Experimental studies have focused on motivational and emotional effects, cognitive inflexibility, and cognitive dysfunction with respect to the effects of early malnutrition.

Main Findings

Since the mid 1960s views about how malnutrition affects long-term nutrition and health have changed. It used to be thought that early malnutrition during critical times of brain development endured and would result in brain damage or impaired brain function. However, more recent findings indicate that brain structures may recover in the environment of improved nutrition. The kinds of behaviors and cognitive functions impaired by malnutrition may be more related to emotional responses to stressful events than to cognitive deficits per se.

Comments

This review suggests that the age range of vulnerability to long-term effects of malnutrition may be greater than suspected. The minimal amount of malnutrition necessary to produce long-term changes in cognition is unknown.

CITATION

Subar, A.F., S.M. Krebs-Smith, A. Cook, and L. Kahle. "Dietary Sources of Nutrients Among US Children, 1989-91." *Pediatrics*, vol. 102, no. 4, October 1998, pp.913-923.

Objective of the Article

To identify major food sources of nutrients and dietary constituents for U.S. children.

Sample and Data Used

The study used cross-sectional, nationally representative 24-hr dietary recall data from the 1989-91 Continuing Survey of Food Intakes by Individuals (CSFII). Dietary data for children ages 2-18 years (N=4,008) were analyzed for food group consumption, which included reporting the the contribution of ready-to-eat cereal and other breakfast foods to the total diet.

Outcomes Examined

Dietary data are reported by age and gender for 16 dietary constituents and 116 food groups. The relative contribution of each food group to total daily nutrient intake is reported for children 2-5 years, 6-11 years, and 12-18 years.

Methodology

Dietary intake data (24-hr recalls) for 1 day of intake was analyzed for 2,436 individual foods which were then classified into 113 food group categories. About 36% of all foods were food mixtures (e.g., pizza, casseroles, and sandwiches) which were disaggregated and counted in the appropriate individual food category. The contribution of food groups was obtained from summing the amount of the food group intake over all individuals and then dividing by total intake for all food groups for all individuals. Food group data are reported in rank order as a percent of total intake of individual nutrients.

Main Findings

Ready-to-eat (RTE) cereal was a high contributor to the children's intakes of folate, vitamins A and C, iron, and zinc. RTE cereals contributed 4.5% of energy and 27% of iron in children 2-18 years.

Comments

These data provide national reference data on the contribution of RTE cereals and other food groups often consumed for breakfast such as juices and breads to total daily nutrient intakes in school-aged children in 1989-91. In addition, a potential food group classification scheme for use with 24-hr recall data is described.

CITATION

Vaisman, N., H. Voct, A. Akivis, and E. Vakil. "Effect of Breakfast Timing on the Cognitive Functions of Elementary School Students." *Archives of Pediatric & Adolescent Medicine*, 150, 1996, 1089-1092.

Objective of the Article

To explore the effect of breakfast timing on selected cognitive functions of elementary students.

Sample and Data Used

The study population comprised 491 subjects for test 1, and 503 subjects for test 2. The children were Israeli public school students aged 11 to 13 years, 51% of them boys, in grades 5 through 6. The subjects lived in different areas and had different socioeconomic backgrounds.

Two thirds of the subjects received 200 ml of 3%-fat milk and 30 g of sugared cornflakes for 14 consecutive days. Subjects were tested on the 1st day and then reexamined on the 15th day with a variety of cognitive tests. On the first day of testing, prior to any nutritional intervention, subjects were asked to complete a questionnaire about their food intake on that day.

Outcomes Examined

Subjects were tested with two versions of the Rey Auditory-Verbal Learning Test, two alternative forms of the logical memory subtest of the revised Wechsler Memory Scale, and two versions of the Benton Visual Retention Test. Student's performance on the 15th day of testing was compared to the baseline score (score from the 1st day). The test scores on day 1 were also compared with those who did not eat breakfast on the day of the test.

Methodology

Groups of subjects were compared in an analysis of variance that included the test version and gender as additional factors. Group means were adjusted for the nonproportional allocations on these two factors.

Factor analysis was used to reduce the dimensionality of the cognitive function measurement, based on the correlations between the scores of the different trials. The factors were then subjected to variance maximization (VARIMAX) rotation to emphasize the trials with the greatest contribution to each factor.

Main Findings

After 15 days, children who ate breakfast at school scored notably higher on most of the test modules than did children who ate breakfast at home and children who did not eat breakfast.

Comments

The authors conclude that both the timing of the school breakfast (just an hour before testing) and its known composition were important. When one considers that three quarters of the subjects consumed breakfast at home, the lack of standardization in assessing what they ate or its timing presents a significant limitation in the design of this study. There was no reported control for socioeconomic status.

Still the strength of the association between the school breakfast condition and improved learning has clear and direct implications for the USB. So does the fact that the school breakfast was sweetened cornflakes and low fat milk. Both the Rey Auditory Verbal test and the subtests of the WMS used appear to simulate well the types of material that elementary school students are required to learn.

CITATION

Wyon, D.P., L. Abrahamsson, M. Jartelius., and R.J. Fletcher. "An Experimental Study of the Effects of Energy Intake at Breakfast on the Test Performance of 10-year-old Children in School." *International Journal of Food Sciences and Nutrition*, vol. 48, 1987, pp. 5-12.

Objective of the Article

The effect of energy intake on school performance was studied in a group of 10-year-old students.

Sample and Data Used

One hundred-ninety-seven children from five classes of 10-year-old children at five different schools took part in this field experiment. Entry criteria for the study included: (1) parents and children needed a solid grasp of the Swedish language; (2) no prior history of dietary problems in the child; (3) no history of diabetes; and (4) no religious or other reasons for not eating any of the breakfast ingredients.

To determine the effect of breakfast on various aspects of school performance, standard breakfasts were delivered to each child's home, ostensibly as part of a marketing survey. Children were offered a standard breakfast each day, but were free to eat as little or as much as they chose. Parents were fully informed of the true nature of the study, and at the end of the week they returned all uneaten breakfast food for quantitative evaluation of their child's actual energy intake.

Children were randomly assigned to one of two breakfast conditions. Breakfast A provided 567 kcal for girls and 832 kcal for boys, while breakfast B provided only 147 kcal for girls and 197 kcal for boys. All children received breakfast A on Tuesday to continue the marketing impression. On Wednesday, Thursday and Friday, children answered questions via phone relating to the previous day's breakfast and how they had felt after eating it.

Teachers, blind to the children's treatment conditions, carried out the performance assessments at school. Performance tests were given during two 40-minute school periods immediately before lunch on Wednesday-Friday of the experimental week.

Just before lunch on Friday, the last day of the experimental period, the class teacher had each child complete eight visual analogue scales (VA-scales), consisting of pairs of end-labels such as: feeling good/bad; have headache/no headache; feeling alert/tired; hungry/not hungry.

Physical endurance was also evaluated, but this part of the experiment was voluntary. Children were led in a series of five successive exercises by a female experimenter. The regular gymnastics teacher discreetly noted the order in which children dropped out to rest. When only 30% remained, the exercise

was terminated, and the next exercise was started with the whole class. This has the effect of rank-ordering the children in terms of voluntary endurance, the 30% still active tying for first place.

Outcomes Examined

The outcome variables included five performance tests: addition, multiplication, grammatical reasoning, number-checking and creativity (instances). The other outcomes considered were the responses children gave in the interviews, responses to the visual analogue scales, as well as performance on the physical endurance tests.

Methodology

The 11 performance criteria thus derived were analyzed for a significant effect of breakfast type (A or B) in five ways: (1) overall, (2) boys and girls separately, (3) each class separately, combining probabilities across classes, (4) omitting those evidencing non-compliance by an energy intake at breakfast A of < 400 kcal, (5) omitting 'outliers' with a score more than 1.645 x SD from the mean.

These analyses were performed using the non-parametric Mann-Whitney U-test, to avoid the assumption of a normal distribution of test scores, which in many cases would have been unjustified. Three additional analyses were performed: Pearson correlation of score with energy intake; Pearson correlation with energy intake for boys and girls separately after breakfast A; and Pearson correlation with energy intake for boys and girls separately after breakfast B. Analyses 1 and 2 were carried out on the VA-scales data, and Analysis 3 on the physical endurance rankings. Questionnaire results were analyzed using the Chi-square test for independence.

Main Findings

The error rate in the addition task was negatively correlated, while the rate of working in the number-checking task was positively correlated, with individual energy intake from the low-energy breakfast.

- C Significantly fewer children reported feeling bad and self-estimates of hunger sensation were lower during the morning at school after the high-energy breakfast. Estimates of energy intake at breakfast based on phone interviews with the children showed good correlation with estimates based on returned food.
- C Energy intake at breakfast as estimated from returned food had no significant effect on energy intake at school lunch as estimated by dietary recall.

Comments

Although the results indicate that the performance of certain tests was worse after the reduced energy breakfast, it does not necessarily follow that children cannot perform optimally on lower intakes if they are habituated to them, as the present results could be accounted for by poor performance in children who were habituated to a larger energy intake than was provided by the reduced energy breakfast. No information on habitual energy intake was obtained in the present experiment.

As the authors note, previous work by Pollitt, et al. showed that breakfast omission can actually improve certain cognitive functions like immediate recall in short term memory and sustained attention tasks.

In terms of the USBP study, there was evidence that these 10-year-olds, non disadvantaged children were relatively accurate reporters of their own breakfast consumption based on telephone interviews. Also, the energy intake for students at lunch was not correlated with energy intake at breakfast, suggesting that the increased energy breakfast resulted in a net increase in energy, not just a shifting of the energy intake into breakfast and away from lunch.

Voluntary physical endurance, accuracy on an addition test, and rate of work on a number checking tasks were better in the breakfast group.

Also in terms of potential USBP effects, the effects on mood was significant as they have been in a number of other previous studies, with more of the low energy breakfast group stating that they felt bad and felt hungry. Creativity was significantly lower for low energy breakfast children. This study used covert manipulation similar to double blind to insure that teachers and children's expectations were not responsible for observed differences.

This article provides an excellent literature review of major findings of studies of the effects of breakfast skipping. Even in well-nourished children, increased energy of additional breakfast may lead to better physical energy, creativity, mood, and attention to details.