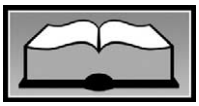
Review



Continuing Education Questionnaire, page 761
Meets Learning Need Codes 3020, 4000, 4150, and 5070

Breakfast Habits, Nutritional Status, Body Weight, and Academic Performance in Children and Adolescents

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ABSTRACT
Breakfast has been labeled the most important meal of the day, but are there data to support this claim? We summarized the results of 47 studies examining the association of breakfast consumption with nutritional adequacy (nine studies), body weight (16 studies), and academic performance (22 studies) in children and adolescents. Breakfast skipping is highly prevalent in the United States and Europe (10% to 30%), depending on age group, population, and definition. Although the quality of breakfast was variable within and between studies, children who reported eating breakfast on a consistent basis tended to have superior nutritional profiles than their breakfast-skipping peers. Breakfast eaters generally consumed more daily calories yet were less likely to be overweight, although not all studies associated breakfast skipping with overweight. Evidence suggests that breakfast consumption may improve cognitive function related to memory, test grades, and school attendance. Breakfast as part of a healthful diet and lifestyle can positively impact children's health and well-being. Parents should be encouraged to provide breakfast for their children or explore the availability of a school breakfast program. We advocate consumption of a healthful breakfast on a daily basis consisting of a variety of foods, especially high-fiber and nutrient-rich whole grains, fruits, and dairy products.
J Am Diet Assoc. 2005;105:743-760.

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0002-8223/05/10505-0001$30.00/0
doi: 10.1016/j.jada.2005.02.007

Current dietary behaviors and practices observed in children and adolescents may have detrimental consequences on their health. The adverse health consequences that may result from excessive intake of soda and sweetened beverages; fast-food consumption; inadequate intakes of fresh fruits, vegetables, fiber-rich foods, and dairy and other calcium-rich foods; reduced levels of physical activity; and increasing obesity rates indicate a need to revisit the diet and lifestyle characteristics of this age group (1,2). The consumption of breakfast is often recommended (3-7). In this age of evidence-based practice, a logical question is whether there is evidence to support the health benefits of this recommendation. Past reviews of the health or cognitive benefits of breakfast consumption in adults or children were published before 1999 (5,8-17) and do not include the results of more recent studies. Several studies have identified a possible role for breakfast consumption in maintaining normal weight status in children and adolescents, which may have important public health implications. We present an updated review and summary of the literature examining the associations between breakfast consumption and three important issues regarding children's health and life-

style: nutritional adequacy, body weight, and cognitive and academic performance.

An inherent problem with evaluating breakfast studies is how breakfast consumption is defined, particularly with regard to frequency, but also the types of foods consumed and time of day. A variety of definitions were used to characterize breakfast consumers in the studies in this review, including consuming breakfast every day, every school day, on the dietary survey day, a minimum number of days per week, or usual or habitual consumption. These inconsistencies present a challenge when evaluating and comparing studies, and the reader should bear these in mind throughout this review.

METHODS

Literature was initially gathered through the investigators' personal research files, then by scanning the references of the articles on hand, and finally by conducting a Medline search from 1970 through February 2004. All articles that included the word breakfast together with children or adolescents were considered for inclusion in this review. The primary articles reviewed were those that reported characteristics of regular breakfast consumers compared with irregular consumers with regard to the three primary review topics. A total of 47 articles were reviewed: nine related to nutritional adequacy, 16 related to body weight, and 22 related to cognitive or academic performance. Twenty-two studies were conducted in the United States. Additional articles were included to contribute pertinent information to the subject.

RESULTS

Breakfast Consumption in Children and Adolescents

Breakfast consumption by children and adolescents in the United States has declined over time. Between 1965 and 1991, breakfast consumption in preschoolers, children ages 8 to 10 years old, and adolescents declined by 5%, 9%, and 13% to 20%, respectively (18). Children and adolescents skipped breakfast more than any other meal (19-25). Based on a nationally representative sample from 1991 (18), the approximate percent of children and adolescents in each age group who skipped breakfast on the day of the survey (ie, any given day) was 8% (1 to 7 years), 12% (8 to 10 years), 20% (11 to 14 years), and 30% (15 to 18 years). The breakfast-skipping prevalence (day of survey) reported in other studies ranged from 12% to 34% (21,26-30). Fifty-nine percent of high school students indicated that they skipped breakfast more than three times the previous week (31). Twenty-one percent of 8- to 9-year-old children and 42% of 12- to 13-year-old children indicated that they do not eat breakfast every day (5). Four percent of children and adolescents reported that they habitually skip breakfast (32,33).

Skipping breakfast is typically more prevalent in girls (18,22,25,26,29-31,34-40), children from lower socioeconomic backgrounds (41-43), older children and adolescents (18,20,23,24,28,30,32,34,36,44), and some black (25,27) and Hispanic (25) youth, although this is not always supported (18). Breakfast-skipping behavior has been associated with other lifestyle factors such as smoking (39,40,45,46), infrequent exercise (39,47), and dieting or concerns about body weight (38,45,48). Common reasons cited by children for skipping breakfast include lack of time, lack of hunger, or dieting to lose weight (20,35,49). Overall, the literature to date suggests that breakfast skipping is common in children and adolescents, increases with age, may be more common among certain minority ethnic or low socioeconomic groups, and seems to be associated with other lifestyle factors that may be detrimental to health.

NUTRITIONAL ADEQUACY

Energy and Macronutrient Intake in Habitual Breakfast Consumption

Children require optimal nutrient intake to meet the basic demands of growth and development. However, micronutrient intakes also may play an important role in chronic disease risk (50,51), and recent nutrient intake recommendations take into account amounts that may be associated with disease risk reduction (52). Nutrient inadequacy or particular dietary patterns during childhood may be associated with adverse health outcomes during childhood, adolescence, and adulthood (53-56).

Reported energy and macronutrient intakes from habitual breakfast consumption vary widely and are influenced by demographic characteristics of the study population, foods consumed, and where breakfast is eaten (eg, home or school). Based on studies in US populations of children from 5 to 18 years of age, mean energy intake at breakfast ranged from 275 to 669 calories, and percentage contributions to total energy from carbohydrate, protein, and total fat ranged from 49% to 72%, 11% to 16%, and 14% to 40%, respectively (21,25,27,29,57-60). European studies of subjects 2 to 18 years of age reported remarkably similar findings (41,61-67). Overall, boys tended to have higher total energy, carbohydrate, protein, and fat intakes at breakfast compared with girls (21,41,61,62). However, when expressed relative to total energy, the differences were not statistically significant (21,61). When comparing breakfast quality in a group of Spanish children (ie, inclusion of foods from the cereal, dairy, and fruit food groups), scores were higher in younger compared with older children, and boys compared with girls (41).

The types of foods consumed at breakfast were similar across various population groups. Milk is one of the most commonly consumed foods by children at breakfast in the United States, Canada, and Europe (21,34,41,57,68-74). Breakfast cereals, which usually are consumed with milk, also are popular in the United States (34), Canada (68,70,73), the United Kingdom (61), Spain (71), and Croatia (72). Various breads also are commonly consumed (32,57,69,74,75). In the United States, changes observed in breakfast consumption patterns over a 26-year period include the increased consumption of low-fat milk, ready-to-eat cereals, and juices, and the decreased consumption of high-fat milk, whole-grain breads, and eggs (18).

Energy and Nutrient Intake of Breakfast Eaters and Breakfast Skippers

Figure 1 summarizes studies evaluating energy and nutrient intakes in breakfast eaters vs skippers. Breakfast eaters tended to have a higher total daily intake of energy compared with breakfast skippers (21,27-29,40,76,77), suggesting that skippers did not consume more calories at other meals to compensate for the deficit. Correspondingly, breakfast eaters tended to have higher daily intakes of total carbohydrate (21,29), total protein (21,28,29,40,76,77), total fat (21,34), and saturated fat (29). However, daily fat intakes expressed as the percentage of daily energy were lower in breakfast consumers in some (28,29) but not all (27) studies. Higher-energy breakfasts (>25% of daily energy allowance) were associated with a higher mean daily intake of carbohydrates and a lower intake of lipids (as percent of energy) compared with lower-energy breakfasts (<15% of daily energy allowance) (62). In preschool children, consuming a breakfast with more than 50% of energy as carbohydrates was associated with lower whole-diet fat intakes compared with breakfasts with less than 50% of energy supplied as carbohydrate, and a breakfast with higher fat intake (>35% of energy) was associated with higher total and saturated fat intakes throughout the day (78). However, mean fat intake in breakfast consumers often exceeds current dietary recommendations for children and adolescents (79) (ie, 25% to 35% of daily energy intake) (21,41,60).

Fiber intake was significantly higher in breakfast eaters vs skippers (29,37,40,80), and the inclusion of a ready-to-eat cereal seemed to contribute to daily fiber intake (61,81). Daily sugar intake was higher in breakfast eaters in some studies (29,34), but lower in others (27,40). Associations of breakfast habits on serum lipids have been inconsistent. Children and adolescents who skipped breakfast had lower total cholesterol intakes compared with breakfast eaters (27-29,34). However, mean plasma cholesterol concentrations were significantly higher in schoolchildren (ages 9 to 19 years) who skipped breakfast compared with children eating breakfast, although these results may have been attributable to higher body weights in breakfast skippers (32). Similarly, adults who skipped breakfast had higher serum cholesterol levels than those consuming breakfast (82).

Breakfast eaters have higher daily intakes of micronutrients and are more likely to meet nutrient intake recommendations compared with breakfast skippers (21,27-29,34,40,76,77). Nutrients that seem to be particularly affected across a variety of studies and population groups include vitamins A and C, riboflavin, calcium, zinc, and iron. Data related to the effects of breakfast on micronutrient status (ie, blood or tissue concentrations) are not widely reported except with regard to ready-to-eat cereal consumption (see below). Preziosi and colleagues (62) reported that only blood concentrations of thiamin were significantly higher in consumers of higher-energy breakfasts compared with consumers of low-energy breakfasts. The positive impact of breakfast consumption on micronutrient intake is supported by studies in adults (62,83,84).

Mean daily intakes of calcium were higher in breakfast eaters compared with skippers (21,27-29,34,40,76,77). The frequency of eating breakfast was significantly and positively associated with calcium intake in Asian-American adolescents (85), and calcium intake at breakfast predicted a higher calcium intake throughout the day in Spanish schoolchildren (86). Calcium intake is a critical nutritional issue for children and adolescents because bone calcium accretion is highest during adolescence (87). A significant number of children, particularly female adolescents, do not meet the Adequate Intake (established when a Recommended Dietary Allowance cannot be determined) recommendations for calcium (4,88-91).

Children and adolescents who skipped breakfast did not, on average, make up the nutrient deficits at other meals during the day (21,27-29,34,40,76,77), which has also been observed in adults (83,84). Population-based survey data indicate that children and adolescents tend to have similar nutrient intakes from daily meals other than breakfast, regardless of whether they skip or consume breakfast (34). However, female adolescents who skipped breakfast had lower intakes of nutrients at other meals compared with female adolescent breakfast consumers (34). This is of particular concern because key nutrients such as calcium may be missed not only at breakfast but throughout the day in this population group.

The inclusion of ready-to-eat cereals in the diet has a positive impact on total macronutrient and micronutrient intakes in adults (83,92,93) and children. Ready-to-eat cereals are commonly consumed in the United States. Eighty-six percent of children ages 5 to 12 years consumed cereal at least once in a 7-day period (57), over 90% of children ages 4 to 12 years consumed ready-to-eat cereals at least once during a 2-week period (94), and 30% of ninth graders (60) and 40% of low-income children in grades 2 through 5 (28) consumed ready-to-eat cereals on a particular day. In Canada, 45% to 55% of eighth graders consumed ready-to-eat cereals during the previous week (36), and cereal contributed over 25% to daily energy intake in 4-year-old children (73). Consumption of ready-to-eat cereals in Europe ranges from 77% to 95% in various population groups (61,64,81), whereas the 1-day consumption prevalence was 34% in Spanish children and adolescents (95). A study of Swiss teenagers reported that breakfast cereals were not commonly consumed (96).

Compared with children and adolescents consuming lower amounts of ready-to-eat cereals or with nonconsumers, ready-to-eat cereal consumers had higher whole-day intakes of carbohydrates (61,62,81,97) and sugars (61) (percent of total energy), lower whole-day intakes of fat (percent of total energy) (28,61,62,81,97,98), enhanced micronutrient intakes or a greater likelihood of meeting micronutrient intake recommendations (34,57,60-62,81,92,94,97-100), improved nutrient status based on biochemical measures (62,97,100), lower daily cholesterol intakes (28,34,57,94,99), and lower serum total cholesterol concentrations (32,100,101). Daily calcium intake was higher in ready-to-eat cereal consumers (34,62,81,94,98-100), although this was not observed in all studies (28,57,61,92,97). Observed increases in calcium intakes are partly caused by increased milk consumption (100). Iron intake also seems to be enhanced with the inclusion of ready-to-eat cereals in the diet (28,34,57,61,62,81,92,94,98-100).

Reference	Study subjects[a]	Data collection instruments and methods[b]	Definitions of skipping breakfast	Prevalence of skipping breakfast (%)	Key characteristics of breakfast consumers vs breakfast skippers
US studies					
Steele and colleagues, 1952 (76)	N=316 11-20 y 57% female Maine, New York, Rhode Island	Self-reported 7-d food record	Skipper=missed at least one breakfast during the 7-d survey	3-20	Higher mean daily intake (as percent of RDA[c]) of energy, protein, Ca, P, Fe, vitamins A and C, thiamine, riboflavin, and niacin
Hanes and colleagues, 1984 (77)	N=6,301 Grades 1-12	24-h recall (National Evaluation of School Nutrition Programs)	Skipper=missed a school or other breakfast on day of survey	Unknown	Higher daily intake of energy; protein; vitamins A, C, and B-6; thiamin; riboflavin; niacin; Ca; P; Mg; and Fe
Skinner and colleagues, 1985 (21)	N=225 16-18 y 49% female 94% white Tennessee	Self-reported 24-h food record and written questionnaire	Skipper=missed breakfast on day that food record was completed	34	Higher mean daily intakes of energy, protein, fat, carbohydrate, Ca, Fe, vitamins A and C, thiamin, riboflavin, and niacin
Morgan and colleagues, 1986 (34)	N=11,082 1-17 y	3-d food record (Nationwide Food Consumption Survey, 1977-1978)	Nonconsumer=ate breakfast $\leq$1 time during the 3-d reporting period	3.4-18.4 (depending on age group)	Higher mean daily intakes of fat, total sugars, total cholesterol, Na, vitamins A and B-6, Fe, Cu, Zn, Ca (except children 1-4 y), and Mg (except male subjects 13-17 y) Higher percentage met the RDA for many nutrients
Nicklas and colleagues, 1993 (27)	N=467 10 y 50% female 59% white Bogalusa Heart Study Louisiana	24-h recall	Skipper=missed breakfast on the day of the survey	16	Higher mean daily intakes of energy, fat (as percent energy), mixed protein, fructose, lactose, total cholesterol, Na, and P Lower mean daily intake of carbohydrate (as percent energy), total sugar More consumed at least two thirds of the RDA for vitamins A, E, D, and B-6; Ca; P; and Mg
Sampson and colleagues, 1995 (28)	N=1,151 Low income Grades 2-5 49% female 97% African American New Jersey	Self-reported eating behavior survey on 4 random days during a 2-wk period plus 24-h recalls	Skipper=missed breakfast on the day of the 24-h recall	12	Fewer had daily intakes $<$50% of the RDA for calories; protein; vitamins A, D, E, C, B-6, and B-12; thiamin; riboflavin; niacin; folate; Ca; Mg; and Fe Fewer had $>$30% of daily energy from fat Higher median total cholesterol, Na intake

(*continued*)

Reference	Study subjects[a]	Data collection instruments and methods[b]	Definitions of skipping breakfast	Prevalence of skipping breakfast (%)	Key characteristics of breakfast consumers vs breakfast skippers
Nicklas and colleagues, 2000 (29)	N=711 Grade 9 4.8 y (mean) 60% female 84% white Louisiana	24-h recall	Skipper=missed breakfast on the day of survey	19	Higher mean daily intakes of energy, protein, saturated fat, total cholesterol, total carbohydrate, sucrose, dietary fiber, and starch Lower percent of daily energy from fat Higher percent of daily energy from carbohydrate More consumed at least two thirds of the RDA for B vitamins (except niacin) and vitamins A, C, and D; Mg; Fe; Zn; P; and Ca
Non-US studies					
Serra-Majem and colleagues, 2002 (95)	N=2,855 2-24 y Spain	Questionnaires 24-h dietary recalls Food frequency questionnaire Height and weight measured	Breakfast=yes/no High nutritional risk = up to three nutrients falling below two thirds of the recommended nutrient intakes	Unknown	Decreased odds for high nutritional risk (not significant after controlling for age, sex, and social class)
Sjoberg and colleagues, 2003 (40)	N=1,245 15-16 y 51% female Sweden	Diet history and interview	Skipper (irregular breakfast eater) = missed breakfast at least once per week	18	Higher mean daily intake of energy, protein, fiber, Ca, Zn Higher mean daily intake of vitamin C, and Fe (females) Lower mean daily intake of sucrose (females) Higher mean daily intake of protein and lower of sucrose (as percent of energy)

[a]All studies were cross-sectional in design and included both male and female subjects unless otherwise noted.
[b]All interviews and/or dietary intake data were collected by professionals unless indicated as self-reported.
[c]RDA=Recommended Dietary Allowance.

Figure 1. Studies evaluating nutritional intake characteristics in children and adolescents who consume or skip breakfast.

Breakfast and Other Dietary Factors

Eating breakfast is associated overall with more healthful food choices or diet habits in children and adolescents. Breakfast skippers are more likely to have overall diets defined as poor or inadequate (95,102). Breakfast consumers tended to make better food choices throughout the day (21,37), such as consumption of more vegetables and milk, fewer soft drinks, and a lower intake of french fries (36). Breakfast consumers had better diet quality based on the US Department of Agriculture's Healthy Eating Index scores (103). Breakfast skipping also has been associated with increased snacking (40) or higher intakes of high-fat snacks (32). Omitting breakfast was associated with omission of other meals by adolescents (40), which may directly result in or exacerbate inadequate intake.

BODY WEIGHT

Although research strongly supports a relationship between breakfast consumption and nutritional adequacy, the relationship between breakfast consumption and body weight is less well established. The prevalence of overweight has doubled in children and has nearly tripled in adolescents over the past 2 decades (104), and is especially prevalent among non-Hispanic black and Hispanic youth (105-107). Overweight and obesity in children and adolescents pose significant health risks. Concurrent with increasing obesity rates, type 2 diabetes is now being documented in children and adolescents at alarming rates (108,109), thought to be attributable in large part to the increase in obesity in this age group (108-111). Overweight children are more likely to have one or several cardiovascular risk factors (112-115) and to become overweight adults (116-119).

Figure 2 presents studies that evaluated breakfast consumption habits with regard to overweight and obesity in children and adolescents. Some (18,39,40,120), but not all (32,75,121), cross-sectional studies reported that the body mass indexes (BMIs) or weights of children and adolescents who skipped breakfast were higher than of those who consumed breakfast. A large cross-sectional study (N>24,000) reported that a one-unit increase in BMI was associated with decreased breakfast consumption in adolescents 11 to 18 years of age (18). Usual breakfast consumption (eating breakfast on school days) was associated with approximately 30% lower odds of being overweight or obese in boys and of being obese in girls (122). Children in two-parent families who skipped breakfast were almost two times more likely to be overweight than were breakfast consumers (120). Overweight or obese children and adolescents are more likely to skip breakfast than their normal or underweight peers (25,31,42,43,71,122,123), particularly female subjects (31,42,71). A recent longitudinal study (33) reported that overweight breakfast skippers lost BMI over time compared with overweight breakfast eaters (eating breakfast 5 to 7 days per week) (P=.01). In normal-weight subjects, the BMI of breakfast skippers tended to increase compared with that of breakfast eaters, although the differences were not statistically significant. Data were adjusted for various confounding factors, including physical activity, although the dieting habits or behaviors of study subjects were unknown. Interestingly, a cross-sectional analysis of these data indicated that overall, breakfast skippers were heavier. Significant associations between breakfast consumption and body weight have been reported in some (124-126) but not all (127,128) studies in adults. To our knowledge, there have been no randomized controlled trials investigating breakfast consumption and weight control in children or adolescents.

The possible relationship between skipping breakfast and overweight and obesity cannot be explained by energy intake from self-reported diet. Daily energy intake is often reported to be lower in breakfast skippers than breakfast eaters, as reported herein. A higher energy intake at breakfast was associated with lower BMI in a small group of British adolescents (129), although breakfast energy intake was not related to BMI in a small group of Spanish children (63). Breakfast skippers had a lower daily energy intake compared with breakfast consumers, regardless of body weight status (33). Although total daily energy intake was similar, the percent of daily energy supplied by breakfast was lower in obese compared with average-weight or leaner French children (130). Ortega and colleagues (71) reported that overweight schoolchildren had a lower intake of energy at breakfast compared with normal-weight children.

Although research strongly supports a relationship between breakfast consumption and nutritional adequacy, the relationship between breakfast consumption and body weight is less well established.

Two studies report an association between body weight and ready-to-eat cereal consumption such that higher intakes are associated with lower BMIs (94,98), although other studies report no association (81,97,100). Again, these results could not be explained by energy intake, which is often higher in ready-to-eat cereal consumers vs nonconsumers or subjects consuming lower amounts of ready-to-eat cereals (81,98,99). Ready-to-eat cereal consumption may be associated with breakfast consumption in general, which may be a marker for other dietary habits that result in more healthful food choices, higher physical activity levels, and lower BMIs. It is possible that overweight children or adolescents tend to underreport their dietary intake relative to their normal-weight peers who are more likely to eat breakfast. Several studies showed such systematic bias in self-reported diet by body weight status (131-134). Dieting behaviors may play an important role because skipping breakfast is a popular method of losing weight among adolescents, especially female subjects (35,37,45,48,135). Adolescents who perceive their body weight as being too high (30,40) or who are concerned about their weight (38) may be more likely to skip breakfast. Breakfast skipping also has been associated with lower levels of physical activity in adolescents (38,39,47), which could affect energy balance and contrib-

Reference	Study subjects[a]	Data collection instruments and methods[b]	Definitions and prevalence of overweight/obesity	Results
US studies				
Resnicow, 1991 (32)	N=530 9-19 y 55% white Long Island, NY; Atlanta, GA	Self-reported food checklist for usual breakfast habits Height and weight measured	Skipper=usually skip breakfast	No difference in BMI[c] between breakfast consumers and skippers when controlling for age
Wolfe and colleagues, 1994 (120)	N=1,797 Grades 2 and 5 6-12 y 50% female New York	24-h recall Questionnaire completed by parents Height and weight measured	Skipper=missed breakfast on day of dietary recall OW[d] >90th percentile of BMI or arm fat area UW[e] ≤10th percentile of BMI or arm fat area Prevalence of OW, OB[f]: 16.9%, 9.8%	Association between breakfast skipping and higher BMI and arm fat area in two-parent famillies ($P<.05$) In two-parent families, skippers almost two times more likely to be OW (OR[g]=1.95, 95% CI[h]=1.17, 3.25) compared with consumers
Sampson and colleagues, 1995 (28)	N=1,151, Low income Grades 2-5 49% female 97% African American New Jersey	Self-reported eating behavior survey on 4 random days during a 2-week period 24-h recalls Height and weight measured	Skipper=missed breakfast on day of dietary recall OB=BMI 85th-95th percentile Super-OB=BMI >95th percentile Prevalence of OB: 36%	No significant association between the prevalence of OB or super-OB and breakfast eating behavior
Pastore and colleagues, 1996 (31)	N=1,001 66% black, 23% Hispanic 16 y (mean) 55% female New York, NY	Self-reported questionnaires Height and weight measured	Skipper=missed breakfast more than three times the prior week OW=110%-119% of IBW[i] OB ≥120% of IBW UW ≤85% of IBW Prevalence of OW, OB: 18%, 25%	Significantly more OB subjects skipped breakfast (72%) compared with UW subjects (30%) ($P<.001$)
Siega-Riz and colleagues, 1998 (18)	N=24,363 1-18 y	1 day of intake from the NFCS[j] (1965, 1977-1978) and CSFII[k] (1989-1991) Self-reported height and weight	Consumer=ate breakfast the day of the survey	A BMI increase of one unit was associated with decreased likelihood of eating breakfast ($P<.01$)
Dwyer and colleagues, 2001 (25)	N=1,493 Grade 8 14.1 y (mean) 51% female 70% white San Diego, CA New Orleans, LA Minneapolis, MN Austin, TX	24-h recall Height and weight measured	Consumer=ate breakfast on day of dietary recall OW=BMI >85th percentile as defined by NHANES I[l] Prevalence of OW: 34%	Significantly fewer OW subjects consumed breakfast (70%) compared with non-OW subjects (80%) ($P=.0004$)

(*continued*)

Reference	Study subjects[a]	Data collection instruments and methods[b]	Definitions and prevalence of overweight/obesity	Results
Boutelle and colleagues, 2002 (122)	N=8,330 Grades 7, 9, 11 51% female 74% white Connecticut	Self-reported questionnaire Self-reported height and weight	Usual breakfast consumption=usually eating breakfast on school days OW=BMI 85th to 95th percentile OB=BMI >95th percentile Prevalence of OW: 10.8% (females), 18.4% (males) Prevalence of OB: 5.1% (females), 9.2% (males)	Significantly lower percentage of OW or OB males and females have usual breakfast consumption ($P<.05$) Usual breakfast consumption was significantly associated with lower odds for being OB in females (OR=0.72, 95% CI=0.53, 0.97); OW in males (OR=0.72, 95% CI=0.60, 0.86); OB in males (OR=0.68, 95% CI=0.54, 0.86)
Berkey and colleagues, 2003 (33)	N=14,586 9-17 y 56% female 95% white Children of Nurses' Health Study II participants	Series of three annual self-reported questionnaires Self-reported height and weight	Skipper=never or almost never eat breakfast OW=BMI >85th percentile of CDC^{m} growth curves Prevalence of OW: 23.2% (males), 17.4% (females)	In OW subjects, breakfast skippers lost BMI over time compared with breakfast eaters ($P=.01$) In normal-weight subjects, the BMI of breakfast skippers tended to increase over time compared with breakfast eaters (NS^{n})
Non-US studies				
Walker and colleagues, 1982 (75)	N=4,717 16-18 y 51% female Racial mix (white, rural black, urban black, Indian, European-African-Malay) South Africa	Questionnaire Height and weight measured	No solid breakfast=no solid food as a usual breakfast habit	No difference between mean weight and height by breakfast consumption pattern (solid food breakfast vs no solid breakfast)
Ortega and colleagues, 1998 (71)	N=200 9-13 y 41% female Madrid, Spain	Self-reported consecutive 7-d food record Height and weight measured	OW (including OB)=BMI >75th percentile Prevalence of OW: 28.0% (females), 25.4% (males)	OW subjects, especially female subjects, omitted breakfast more frequently over the 7-d survey period than did normal-weight subjects ($P<.05$)
O'Dea and Caputi 2001 (42)	N=1,126 6-19 y 54% female New South Wales, Australia	Self-reported questionnaires Height and weight measured	Skipper=skip breakfast most days OW=BMI ≥85th percentile Prevalence of OW: 15.7% (females), 13.8% (males)	A higher percentage of OW children are breakfast skippers compared with normal weight children OW female subjects most likely to regularly skip breakfast (18%) and normal-weight male subjects least likely to skip (10%)

(*continued*)

Reference	Study subjects[a]	Data collection instruments and methods[b]	Definitions and prevalence of overweight/obesity	Results
Kovarova and colleagues, 2002 (123)	N=3,362 7-11 y 50% female Czech Republic	Self-reported questionnaires Height and weight measured	Breakfast consumption=habitual breakfast consumption UW=BMI $<10^{th}$ percentile OW=BMI 90^{th}-97^{th} percentile OB=BMI $>97^{th}$ percentile Prevalence of OW and OB (combined): 11.9% (females) and 13.1% (males)	Lower percentage of OW children consume breakfast (54.1%) compared with UW children (75.3%) ($P<.001$)
Abalkhail and Shawky, 2002 (121)	N=800 9-21 y 53% female Saudi Arabia	In-person interviews Height and weight measured	Regular breakfast=habitual OW=BMI $\geq 85^{th}$ to $<95^{th}$ percentile OB=BMI $\geq 95^{th}$ percentile Prevalence of OW, OB: 14.3%, 17.1%	No significant association between regular breakfast intake and BMI
Cartwright and colleagues, 2003 (43)	N=4,320 11-16 y 40% female 62% white South London, UK	Self-reported questionnaire Height and weight measured	Consumer=usually eats breakfast OW=includes OB as categorized by growth curves Prevalence of OW: 24%	OW subjects less likely to eat breakfast every day (OR=0.72, 95% CI=0.64, 0.81; $P<.01$)
Keski-Rahkonen and colleagues, 2003 (39)	N=5,448 16 y 52% female Finland	Self-reported questionnaire Self-reported height and weight	Skipper=eating breakfast ≤ 1 time/wk BMI ≥ 25=4.3%	Breakfast skippers two times more likely to have a BMI ≥ 25 (OR=2.00, 95% CI=1.32, 3.01; $P<.001$)
Sjoberg and colleagues, 2003 (40)	N=1,245 15-16 y 51% female Sweden	Diet history (habitual) and interview Height and weight measured	Irregular breakfast intake=omitting breakfast at least once per week OW=BMI ≥ 23.60 (males), 24.17 (females) Prevalence of OW: 12.0% (males), 10.8% (females)	BMI significantly higher for boys with irregular breakfast intake compared with males eating breakfast regularly ($P=.0006$; NS for females)

[a]All studies were cross-sectional in design except that of Berkey and colleagues (33), which was longitudinal. Studies included both male and female subjects unless otherwise noted.
[b]All interviews and/or dietary intake data were collected by professionals unless indicated as self-reported.
[c]BMI=body mass index.
[d]OW=overweight.
[e]UW=underweight.
[f]OB=obese or obesity.
[g]OR=odds ratio.
[h]CI=confidence interval.
[i]IBW=ideal body weight.
[j]NFCS=Nationwide Food Consumption Surveys.
[k]CSFII=Continuing Survey of Food Intakes by Individuals.
[l]NHANES I=First National Health and Nutrition Examination Survey.
[m]CDC=Centers for Disease Control and Prevention.
[n]NS=not significant.

Figure 2. Studies evaluating body weight characteristics in children and adolescents who consume or skip breakfast.

ute to excess body weight. Several observational studies did not seem to control for physical activity levels while reporting significant associations between breakfast habits and body weight (18,40).

Differences in study results also may be attributed to statistical methods. Four (32,39,120,122) of eight studies controlled for various combinations of confounding factors (eg, age, race, grade in school, parental socioeconomic status). Three of these studies reported significant associations between body weight and breakfast consumption (39,120,122), whereas none of the studies reporting a null association seemed to statistically control for confounding factors.

COGNITIVE AND ACADEMIC PERFORMANCE

The role of breakfast in enhancing cognitive and academic performance, psychosocial function, and school attendance has been studied widely. Breakfast consumption could impact cognitive performance by alleviating hunger (8,136), the prevalence of which is well documented (137,138) and has been associated with emotional, behavioral, and academic problems in children and adolescents (139,140). Breakfast may modulate the short-term metabolic responses to fasting conditions to maintain a supply of nutrients to the central nervous system, or through long-term effects on nutrient intake and status that may positively affect cognition (17). The effects might be attributable to enhanced blood glucose concentrations (17,141). However, several experimental studies have shown no significant overall association between test performance and blood glucose concentrations (142-145), suggesting that other mechanisms, possibly changes in neurotransmitter concentrations (146), may play a role. Cognitive and academic performance in children is linked to various socioeconomic status (SES) indicators. Indicators such as family income and parental education often predict academic achievement in children (147,148). It is important to account for these variables in cognitive or academic performance studies. Experimental and observational studies of the effects of breakfast on various performance variables are presented in Figure 3.

Cognitive Performance

There is some support for beneficial effects of breakfast on aspects of memory in short-term experimental studies conducted in a research center (145,149,150) or school environment (143,151,152), although several studies report no such effect (142,144,149,151,153,154). Positive effects were reported in various age groups using a variety of standardized or customized tests (see individual studies for descriptions of the testing instruments). Benefits have been reported regarding several aspects of memory function including recall (152), episodic memory (150), and both short-term (143,149,155) and long-term (151) memory. A randomized intervention study of 569 students ages 11 to 13 years reported that a school breakfast consumed 30 minutes before testing was helpful to recall even when subjects had eaten breakfast at home earlier in the morning, suggesting that the timing of breakfast may be important (152). However, breakfast enhanced memory function several hours after consumption compared with a fasting or lower-energy breakfast condition in randomized studies (143,145,150). Only one randomized controlled trial evaluated the longer-term (ie, 3 months) effects of a school breakfast program on aspects of memory and reported that breakfast provided no enhancement to memory function in Peruvian children (N=352; controlling for SES) (154). The positive effects of breakfast on aspects of memory function also has been shown in experimental studies in adults (156-159). Overall, data are less supportive for the effects of breakfast consumption on other cognitive variables, such as attention, problem solving, and reading or listening comprehension.

Breakfast consumption significantly contributes to whole-diet nutrient adequacy.

Children at nutritional risk were reported to especially benefit from breakfast consumption in randomized controlled studies conducted in a research center (145,149) and school environment (151). However, these studies were designed as short-term intervention trials. Randomized intervention trials conducted over two semesters (136) and 1 year (160) in a school environment reported that undernourished children gained no additional benefits from breakfast consumption compared with adequately nourished children with regard to achievement test scores (controlling for SES). In contrast, a controlled crossover trial conducted at a research center and with a similar population group (ie, rural, low-income Jamaican children with similar SES) found that breakfast benefited undernourished children on memory and fluency (idea generation) tests, but had no effect on adequately nourished children (149). These data suggest that undernourished children might preferentially benefit from breakfast in the short term, but not on a long-term basis. Analyses of long-term effects can be complicated by the various social, family, and academic factors that can affect school performance (160), including the effects of SES.

Academic Performance, School Attendance, and Tardiness

Two randomized controlled trials report the positive effects of a school breakfast on achievement test scores and school attendance rates in rural Jamaican children (136,160). Groups of children were followed up for two semesters (n=115) (136) or 1 year (n=814) (160) during the intervention and showed improved performance compared with the control group (ie, children not receiving a school breakfast). School attendance rates were improved in a trial of Peruvian children randomized to receive a school breakfast or no school breakfast for a period of 3 months (154). Both studies controlled for SES. The results of controlled trials are confirmed by observational studies, which consistently show a beneficial effect of breakfast consumption on academic and achievement test scores (161,162), grades (163-165), school attendance (161,163,164), and tardiness rates (161,163).

General cognitive or academic parameter measured	Studies reporting a significant effect of breakfast treatment (reference)	Studies reporting no significant effect of breakfast treatment (reference)
Attention, concentration	Conners and Blouin, 1982-1983, exp[a] (172) Michaud and colleagues, 1991, exp (143)[b] Wesnes and colleagues, 2003, exp (150)	Pollitt and colleagues, 1981, exp (155) Dickie and Bender, 1982, exp (153) Pollitt and colleagues, 1982-1983, exp (141) Simeon and Grantham-McGregor, 1989, exp (149) Cromer and colleagues, 1990, exp (142) Lopez and colleagues, 1993, exp (144) Chandler and colleagues, 1995, exp (151)
Memory	Pollitt and colleagues, 1981, exp (155)[c] Pollitt and colleagues, 1982-1983, exp (141)[c] Simeon and Grantham-McGregor, 1989, exp (149)[de] Michaud and colleagues, 1991, exp (143) Chandler and colleagues, 1995, exp (151)[d] Vaisman and colleagues, 1996, exp (152)[g] Cueto and colleagues, 1998, exp (145)[h] Wesnes and colleagues, 2003, exp (150)	Dickie and Bender, 1982, exp (153) Simeon and Grantham-McGregor, 1989, exp (149)[f] Cromer and colleagues, 1990, exp (142) Lopez and colleagues, 1993, exp (144) Chandler and colleagues, 1995, exp (151)[f] Jacoby and colleagues, 1996, exp (154)
Impulsivity	Pollitt and colleagues, 1981, exp (155)[i] Pollitt and colleagues, 1982-1983, exp (141)	Cromer and colleagues, 1990, exp (142) Simeon and Grantham-McGregor, 1989, exp (149)
Reasoning	Lopez-Sobaler and colleagues, 2003, obs[j] (65)	Wyon and colleagues, 1997, exp (166)
Creativity, idea generation	Simeon and Grantham-McGregor, 1989, exp (149)[d] Wyon and colleagues, 1997, exp (166)	Simeon and Grantham-McGregor, 1989, exp (149)[f]
Problem solving, addition, math	Conners and Blouin, 1982-1983, exp (172) Simeon and Grantham-McGregor, 1989, exp (149)[cf] Wyon and colleagues, 1997, exp (166)[k]	Dickie and Bender, 1982, exp (153) Simeon and Grantham-McGregor, 1989, exp (149)[d] Lopez and colleagues, 1993, exp (144) Jacoby and colleagues, 1996, exp (154) Cueto and colleagues, 1998, exp (145) Lopez-Sobaler and colleagues, 2003, obs (65)
Learning	Vaisman and colleagues, 1996, exp (152)[g]	Cromer and colleagues, 1990, exp (142)
Vocabulary	Jacoby and colleagues, 1996, exp (154)[l]	
Reading, listening comprehension		Simeon and Grantham-McGregor, 1989, exp (149) Jacoby and colleagues, 1996, exp (154)
Discrimination	Cueto and colleagues, 1998, exp (145)[h]	
Physical endurance	Wyon and colleagues, 1997, exp (166)	
Academic or achievement test scores	Powell and colleagues, 1983, exp (136) Meyers and colleagues, 1989, obs (161) Powell and colleagues, 1998, exp (160) Boey and colleagues, 2003, obs (162)	
Academic grades	Murphy and colleagues, 1998, obs (163) Kleinman and colleagues, 2002, obs (164)[m] Kim and colleagues, 2003, obs (165)	
School attendance	Powell and colleagues, 1983, exp (136) Meyers and colleagues, 1989, obs (161) Jacoby and colleagues, 1996, exp (154) Powell and colleagues, 1998, exp (160) Murphy and colleagues, 1998, obs (163) Kleinman and colleagues, 2002, obs (164)	
School tardiness	Meyers and colleagues, 1989, obs (161) Murphy and colleagues, 1998, obs (163)	Kleinman and colleagues, 2002, obs (164)
Psychosocial function	Murphy and colleagues, 1998, obs (163) Kleinman and colleagues, 2002, obs (164)	

[a]exp=experimental.
[b]Higher-energy breakfast negatively impacted measures of concentration.
[c]The control (fasting, no breakfast) group performed better than the treatment (breakfast) group on some aspects of testing.
[d]Children at nutritional risk or undernourished children.
[e]Children classified as wasted.
[f]Adequately nourished children.
[g]Effect of breakfast timing. Children eating breakfast at school 30 minutes before testing performed better than children eating breakfast at home 2 hours before testing.
[h]Children at nutritional risk or undernourished children. In adequately nourished children, the control (fasting, no breakfast) group performed better than the treatment (breakfast) group on some aspects of testing.
[i]Low-intelligence quotient group only.
[j]obs=observational.
[k]Effect of breakfast on addition but not multiplication skills.
[l]Children with higher body weights scored better after breakfast treatment. No other significant effects of breakfast treatment.
[m]Math only.

Figure 3. Experimental and observational studies evaluating breakfast intake and cognitive and academic variables in children and adolescents.

Psychosocial Issues and Mood

Two observational studies investigated the effects of participation in the school breakfast program on psychosocial issues (163,164). Both studies used the Pediatric Symptom Checklist, which was completed by parents (163,164) or children (164). Based on youth-reported (164) and parent-reported (163) Pediatric Symptom Checklist surveys, psychosocial function improved significantly in participants whose nutritional status improved with a school breakfast (164) or in those whose participation in the breakfast program increased (163). Changes in measures of child depression and hyperactivity were improved in children with increased school breakfast program participation (163). Breakfast was reported to have a positive effect on aspects of mood, including alertness (150,166) and contentment (150), but had no significant effect on alertness and feelings of tranquility (143) or anxiety (142).

CONCLUSIONS

Breakfast consumption significantly contributes to whole-diet nutrient adequacy. Breakfast consumers are more likely to have better overall diet quality, and micronutrient and macronutrient and fiber intakes that more often align with current dietary recommendations (79). Benefits may especially be enhanced with the inclusion of ready-to-eat cereals as part of a healthful breakfast. Although study results are inconsistent, breakfast consumption may be associated with more healthful body weights in children and adolescents, despite possibly higher daily energy intakes in breakfast consumers. Skipping breakfast is a common behavior observed in overweight or obese children and adolescents and may be related to dieting and disordered eating habits. Breakfast skippers may be less likely to engage in physical activity, which may contribute to positive energy balance and weight gain. Breakfast consumption may positively benefit cognitive function, particularly memory; academic performance; school attendance rates; psychosocial function; and mood. However, interpretation of results can be complicated by confounding factors such SES or other social or educational variables.

Several studies support the benefits of ready-to-eat cereals as reviewed herein. Because of their nutrient fortification levels and increased consumption, one could postulate that the health benefits observed with breakfast consumption may be mostly attributed to ready-to-eat cereals. However, most studies comparing breakfast consumers vs nonconsumers have not presented data in such a way to determine whether ready-to-eat cereal consumption is responsible for the observed benefits. Only Morgan and colleagues (34) reported that non–ready-to-eat cereal breakfast consumers had higher daily intakes of many nutrients compared with breakfast skippers. In contrast, ready-to-eat cereal consumers have the potential for higher daily intakes of refined grains and sugars found in many ready-to-eat cereals, especially those marketed to children. Most of the studies reviewed herein report that breakfast consumption in general was associated with favorable nutritional and health benefits. However, to maximize the potential benefits of breakfast consumption, it is important to distinguish between simply promoting breakfast vs the consumption of a healthful breakfast. Breakfast should include a variety of healthful foods that are high in nutritive value yet do not provide excess energy.

There is substantial evidence that breakfast consumption is associated with the health and well-being of children and adolescents, and the benefits seem to apply to a wide range of age, demographic, and socioeconomic groups. We propose the following recommendations for breakfast habits in children and adolescents.

- Children and adolescents should consume a healthful breakfast, at home or at school, on a daily basis, while not exceeding daily energy requirements.
- For a healthful breakfast, children should include foods from a variety of food groups (eg, whole grain, fruit, and dairy) to ensure that they receive a variety of nutrients and fiber (79). Longitudinal data indicate that as children age they tend to include fewer food groups at breakfast (44). Consumption of a high-fiber, low-sugar, fortified, ready-to-eat cereal likely will provide additional benefits to nutrient and fiber intakes.
- For children with low intakes of dairy products, alternative sources of calcium such as calcium-fortified 100% juices or other foods should be offered with the awareness that a decreased consumption of milk products could result in low consumption of other nutrients such as vitamin A and riboflavin (87). Children from populations with a higher prevalence of lactose intolerance (African Americans, Asian Americans) should be counseled concerning dairy foods that may be tolerated (eg, limited amounts of milk, certain cheeses) or alternative sources of calcium.
- Choice of dairy or meat products should include lower-fat versions of these foods to help reduce total fat and saturated fat intakes. An important exception is children between 1 and 2 years of age, who should consume whole milk instead of reduced-fat milk. Current dietary recommendations suggest that by age 4, healthy children should aim to consume between 25% and 35% of daily calories from fat (79), which is sufficient for normal growth and sexual maturity (167). This recommendation is supported by several organizations, such as the American Heart Association (168) and the American Academy of Pediatrics (169).
- Children who tend to skip breakfast because of a lack of time in the morning should eat breakfast either at school or on their way to school. Many breakfast foods can be consumed while on the go, for example, dry cereal, whole-grain toast or bagel, 100% juice in a to-go container, and fresh fruit.
- When appropriate, health practitioners who work with children should encourage parents to investigate the availability of school feeding programs, which seem to be underused (163,170).
- Breakfast consumption should be encouraged in groups who may be more likely to skip breakfast: older children and adolescents, especially teenage girls, and possibly black and Hispanic children. Practitioners should counsel adolescents who are dieting to ensure that they follow healthful and appropriate eating and exercise behaviors.

Parents can have a significant impact by planning for and encouraging family breakfasts that include healthful

foods from a variety of food groups. Parental breakfast eating was a significant predictor of adolescent breakfast eating (39). The frequency of family meals increased the likelihood that children (171) and adolescents (30) made more healthful food choices and was the most significant parental influence on adolescent eating habits (30). Finally, breakfast should be viewed as an important component of an overall preventive strategy aimed at reducing disease risk by enhancing the health of children and adolescents. This strategy should include a healthful diet, increased physical activity, and the reduction or elimination of other lifestyle factors (eg, tobacco use, time spent on sedentary activities) that may negatively impact health.

Future research needs include identifying the magnitude of the potential nutritional risks associated with skipping breakfast, especially in diverse populations. Current studies suffer from methodologic differences regarding collection of dietary intake data, how breakfast skipping is defined, and how breakfast is defined (types or amounts of foods eaten, time of day food is eaten). Studies should evaluate the composition of the breakfast meal in general, and for ready-to-eat cereals, studies should differentiate between the benefits of those high in whole grains and fiber from those high in refined grain and sugar. Reasons for breakfast skipping in different population groups should be elucidated to identify the best ways to promote breakfast consumption in children. Current studies regarding breakfast and body weight are almost entirely cross-sectional in nature, and more longitudinal studies are needed. The potential confounding effect of overweight children and adolescents who are dieting to lose weight should be investigated along with other lifestyle factors that might contribute to unhealthful weight, particularly physical activity levels. Regarding cognitive and academic performance, controlled trials using similar and age-appropriate cognitive tests should be conducted so that studies can be compared more readily. Intervention trials are needed to examine the long-term benefits of breakfast consumption on academic performance, especially in the school setting, while accounting for socioeconomic variables. The physiologic mechanisms that contribute to or are responsible for the observed effects should be explored more extensively.

Special thanks to Cristin Cuozzo for providing technical assistance.

This work was supported in part by the Florida Department of Citrus (FDOC), which assembled the Breakfast Advisory Board (of which all investigators are members), including consulting fees and travel reimbursement. The FDOC reviewed and approved the final version of the manuscript, but did not influence, or contribute anything to, its content. In addition, the lead investigator's position is funded jointly by the Institute of Food and Agricultural Sciences at the University of Florida, Gainesville, and the FDOC.

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