Current Research

The Relationship of Breakfast and Cereal Consumption to Nutrient Intake and Body Mass Index: The National Heart, Lung, and Blood Institute Growth and Health Study

BRUCE A. BARTON, PhD; ALISON L. ELDRIDGE, PhD, RD; DOUGLAS THOMPSON, PhD; SANDRA G. AFFENITO, PhD, RD; RUTH H. STRIEGEL-MOORE, PhD; DEBRA L. FRANKO, PhD; ANN M. ALBERTSON, MS, RD; SUSAN J. CROCKETT, PhD, RD

ABSTRACT

Objective To describe changes in breakfast and cereal consumption of girls between ages 9 and 19 years, and to examine the association of breakfast and cereal intake with body mass index (BMI) and consumption of nutrients.

Design Data from the National Heart, Lung, and Blood Institute Growth and Health Study, a longitudinal biracial observational cohort study with annual 3-day food records.

Subjects/setting The National Heart, Lung, and Blood Institute Growth and Health Study recruited 2,379 girls (1,166 white and 1,213 black), ages 9 and 10 years at baseline, from locations in the Berkeley, CA; Cincinnati, OH; and Washington, DC, areas.

Main outcome measures Frequency of consumption of breakfast (including cereal vs other foods) and cereal; BMI; and dietary fat, fiber, calcium, cholesterol, iron, folic acid, vitamin C, and zinc.

Statistical analyses Generalized estimating equations methodology was used to examine differences in the frequency of breakfast and cereal eating by age. Generalized estimating equations and mixed models were used to examine whether breakfast and cereal consumption were predictive of BMI and nutrient intakes, adjusting for potentially confounding variables.

Results Frequency of breakfast and cereal consumption decreased with age. Days eating breakfast were associated with higher calcium and fiber intake in all models, regardless of adjustment variables. After adjusting for energy intake, cereal consumption was related to increased intake of fiber, calcium, iron, folic acid, vitamin C, and zinc, and decreased intake of fat and cholesterol. Days eating cereal was predictive of lower BMI.

Conclusions Cereal consumption as part of an overall healthful lifestyle may play a role in maintaining a healthful BMI and adequate nutrient intake among adolescent girls.

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Children benefit from breakfast in a myriad of ways. Research supports a role for breakfast in improved cognition and learning in children (1,2). In addition to the cognitive benefits, there are nutritional benefits as well. Breakfast consumption has been consistently associated with favorable nutrient intakes and improved diet quality in children and adolescents (3-7). Trends since 1965 indicate that breakfasts of children and adolescents now include more low-fat dairy foods; more whole-grain breads and cereals; and more citrus fruits, other fruits, and juices (6). Children who consume breakfast are much more likely to meet recommended intakes for vitamins and minerals than those who skip breakfast (8-10).

The relationship between breakfast and positive health outcomes may be due to the specific foods consumed at breakfast, rather than breakfast per se (11). In children, cereal ranks high among breakfast foods eaten (5,10). Based on a single 24-hour recall, 21% of the 10-year-olds from the Bogalusa Heart Study reported eating ready-to-eat cereal (RTEC) sometime during the day, most often at breakfast (12). Over a 14-day period, more than 90% of 4- to 12-year-olds reported eating RTEC at least once (10). Breakfasts that include cereal ("cereal breakfasts") may have a particularly positive effect on overall nutrient intake. Most cereals are fortified with essential nutrients and many cereals provide dietary fiber. Children who eat

B. Barton is president and chief executive officer and D. Thompson is a senior research scientist, Maryland Medical Research Institute. A. Eldridge is manager, Nutrition Science, A. Albertson is a senior nutrition scientist, and S. Crockett is senior director, General Mills, Bell Institute of Nutrition, Minneapolis, MN. S. Affenito is an assistant professor, Department of Nutrition and Family Studies, Saint Joseph College, West Hartford, CT. R. Striegel-Moore is a professor, Department of Psychology, Wesleyan University, Middletown, CT. D. Franko is a professor, Department of Counseling and Educational Psychology, Northeastern University, Boston, MA.

Address correspondence to: Douglas Thompson, PhD, Maryland Medical Research Institute, 600 Wyndhurst Ave, Baltimore, MD 21210. E-mail: dthompson@mmri.org

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Table 1. Number and percent of National Heart, Lung, and Blood Institute Growth and Health Study participants by basic demographic characteristics

	White		Black		
	No.	%	No.	%	Total No.
Total enrolled	1,166	49.1	1,213	50.9	2,379
Annual family income ($)					
<10,000	88	7.5	317	26.1	405
10,000-19,999	105	9.0	218	18.0	323
20,000-29,999	174	14.9	182	15.0	356
30,000-39,999	185	15.9	153	12.6	338
40,000-49,999	185	15.9	94	7.8	279
50,000-74,999	258	22.1	147	12.1	405
≥75,000	115	9.9	24	2.0	139
Unknown	56	4.8	78	6.4	134
Maximum education of household					
Did not complete high school	48	4.1	107	8.8	155
High school graduate/equivalent	188	16.1	275	22.7	463
Post high school	49	4.2	68	5.6	117
College 1-3 y	302	25.9	506	41.7	808
College graduate	198	17.0	121	10.0	319
Graduate school	380	32.6	135	11.1	515
Unknown	1	0.1	1	0.1	2
Number of girls living with both natural parents	786	67.4	508	41.9	1,294

cereal consume significantly less fat and cholesterol (3,10).

Less is known about the relationship between breakfast, cereal consumption, and body mass index (BMI) in children. In cross-sectional studies, breakfast skipping is significantly more common among overweight and obese children and adolescents compared with normal-weight youth (13-15). In addition, children who consumed RTEC eight or more times in 2 weeks had significantly lower BMIs than those consuming three or fewer servings in 14 days (10). One longitudinal study examined changes in breakfast consumption in a cohort of females between the ages of 9 and 19 years (7). Girls ate breakfast less often as they grew older. Frequency of breakfast consumption was predictive of BMI in models controlling for study site, ethnicity, and age. However, the effect of breakfast fell below significance when physical activity, total energy intake, and parental education were added to the model, suggesting that breakfast consumption may be a marker for lifestyle and/or socioeconomic factors that are related to BMI.

Although these studies suggest a beneficial association between breakfast, cereal, and BMI in children, no longitudinal studies have explored the frequency and health outcomes of both cereal and breakfast consumption. The first objective of the current research, therefore, was to describe the frequency of breakfast and cereal consumption, separately and in combination, among black and white girls over a 10-year period (from childhood through adolescence). A second objective was to examine the effect that cereal breakfast had on nutrient intake for key nutrients including calcium, total fat, fiber, and cholesterol. The third objective was to examine the relationships between breakfast, cereal consumption, and BMI as these girls matured.

MATERIALS AND METHODS

As previously reported, the National Heart, Lung, and Blood Institute (NHLBI) Growth and Health Study is a 10-year longitudinal study of 2,379 girls who were 9 or 10 years old at study entry (Table 1) (16). Girls were recruited from three study sites: University of California at Berkeley; University of Cincinnati/Cincinnati Children's Hospital Medical Center, Cincinnati, OH; and Westat Inc/Group Health in Rockville, MD. The study protocol was approved by the Institutional Review Boards of all participating sites. All girls who entered the Growth and Health Study had assented and a parent or guardian consented to their participation. Only instruments of relevance to the present report are described here.

Procedures and Measures

Three-day food records that had been previously validated (17) were collected at visits (years) 1 through 5 and then again at visits 7, 8, and 10. Dietitians instructed girls to record all food and drink and time of intake for 3 consecutive days (2 weekdays and 1 weekend day). Dietitians reviewed completed food records individually with the girls, using standard probes to clarify incomplete responses. Food records were coded and analyzed for nutrient content (18). Nutrient values were updated annually to reflect changes in the nutrient composition of individual foods.

BMI was calculated based on measurements of girls' height and weight by trained research staff. Two BMI-based measures were used. First, BMI-for-age z scores indicated girls' BMI relative to other girls of the same age. Second, based on Centers for Disease Control and Prevention guidelines (http://www.cdc.gov/nccdphp/dnpa/bmi/bmi-for-age.htm), "at risk of overweight" was coded