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Association of breakfast consumption patterns with weight status, nutrient intake, and dietary adequacy in African American children 1-12 years of age and adolescents 13-18 years of age

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ASSOCIATION OF BREAKFAST CONSUMPTION PATTERNS WITH WEIGHT STATUS, NUTRIENT INTAKE, AND DIETARY ADEQUACY IN AFRICAN AMERICAN CHILDREN 1-12 YEARS OF AGE AND ADOLESCENTS 13-18 YEARS OF AGE

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ABSTRACT

The purpose of these studies was to determine whether weight status, nutrient intake, and dietary adequacy were associated with breakfast consumption patterns. A representative sample of African American (AA) children and adolescents who participated in 1999-2002 National Health and Nutrition Examination Survey (NHANES) was used in a secondary data analysis. Participants were first grouped by age: 1-12 years of age (y) (n=1,389), 13-18 y (n = 988) and then by breakfast consumption category: breakfast skippers, ready-to-eat cereal (RTEC) consumers, and other breakfast consumers. A single multiple-pass 24-hour dietary recall was conducted using computer-assisted software to record dietary intake. To estimate dietary adequacy, the mean adequacy ratio (MAR) was calculated by expressing micronutrient intake as a percentage of the Estimated Average Requirement , truncated to no more than 100%, and averaged over 13 micronutrients: vitamins A, E, C, B1, B2, B6, B12; niacin; folate; phosphorus; magnesium; iron; and zinc. Sample-weighted data were used in all statistical analyses.

In children, 7.4% of AA 1-5 y and 16.9% of AA 6-12 y, respectively, skipped breakfast while RTEC consumers included 45% and 38%, respectively. In AA 13-18 y, 36.8% skipped breakfast and 19.4% consumed RTEC at breakfast. Ready-to-eat cereal consumers 1-12 y had the lowest mean body mass index (BMI) ($p \leq 0.05$) and mean waist circumference (WC) ($p \leq 0.05$). They also had the highest mean intakes of vitamins A, B-6, and B-12; thiamin; riboflavin; niacin; folate; calcium; iron; and zinc; highest MAR ($p \leq 0.05$); and the highest intake of carbohydrates and total sugars, and the lowest intakes of total fat ($p \leq 0.05$). RTEC consumers 13-18 y had lower mean WC ($p \leq 0.05$) and BMI ($p \leq 0.05$) than breakfast skippers. Adolescent RTEC consumers and other breakfast consumers had higher mean energy intakes than breakfast skippers ($p \leq 0.05$) and had the highest MAR, while breakfast skippers had the lowest MAR

($p \leq 0.05$). Adolescent RTEC breakfast consumers had higher intakes of vitamins A, B-6, B-12; thiamin; riboflavin, niacin; folate; and minerals calcium, phosphorus, magnesium, iron, zinc, and potassium than breakfast skippers and other breakfast consumers ($p \leq 0.05$). Consuming an RTEC breakfast was associated with improved weight, nutrient intake, and dietary adequacy in AA children and adolescents.

CHAPTER 1

INTRODUCTION

During 2003 to 2006 the prevalence of overweight was 10.4% among children 2- 5 years of age (y), 15.3% among 6- 11 y, and 15.5% among 12 -19 y, compared with 7.2%, 11.3%, and 10.5%, respectively, in 1988-1994[1, 2]. Overweight children have a body mass index (BMI) greater than the 95th percentile of BMI-for-age using the CDC Growth Charts. Overweight in childhood and adolescence is associated with conditions such as elevated blood pressure levels[3], type 2 diabetes mellitus[4], and reduced insulin sensitivity[5], that are associated with a high risk for the development of atherosclerosis and cardiovascular complications in adulthood[6]. Further, overweight in childhood is predictive of obesity in early adulthood; the relative risk of becoming an obese adult is significantly greater for overweight children compared with children of a healthy weight[7]. It is likely that secular increases in childhood overweight will greatly increase the burden of adult diseases, such as diabetes, hypertension, and other weight related, and largely preventable consequences[8]. Thus, increasing rates of overweight in children and adolescents need to be addressed to avoid deleterious health problems that may persist into adulthood.

In addition to health risks that accompany overweight, many children and adolescents in the United States have diets that lack adequate amounts of several nutrients[9-11]. The diets of children and adolescents have large amounts of high energy, low nutrient dense foods, possibly at the expense of foods that are low energy, nutrient dense[12]. The failure of children and adolescents to meet recommendations for essential vitamins and minerals needed for proper growth and development jeopardizes their health status[13-17].

Breakfast has been described as the most important meal of the day[18-22]. Breakfast consumption improves diet quality, nutrient intake, and diet adequacy; as well as cognition in children and adolescents[18, 19, 23-30]. However, breakfast is the most commonly skipped meal of the day, particularly in adolescents[31-33]. Compared to children who regularly consumed breakfast, those who did not were more likely to have poorer nutrient intakes, and less likely to consume lunch or dinner on a regular basis[34, 35]. Additionally, breakfast consumption in children was associated with improved behavior and school performance[36-40]. Children who skipped breakfast were more likely to have an inadequate diet[21]. When compared to breakfast skippers, breakfast consumption was associated with higher mean daily energy intakes[19, 23, 29]. However, breakfast skipping has been associated with higher body mass index (BMI) and infrequent exercise[18, 19, 25-29, 41].

With over 90% percent of ready to eat cereals (RTEC) fortified with essential micronutrients, they are reliable source of nutrients in the diets of children and adolescents[42]. Among various breakfast choices, eating RTEC has been associated with higher intakes of micronutrients and lower intake of fat[19, 21, 41, 43-45]. Further, a decrease in energy intake at lunch, and an increase in milk and calcium intake in all age groups who consumed RTEC for breakfast has been shown[46, 47]. Cereal consumption was related to increased intake of fiber, calcium, iron, folic acid, vitamin C, and zinc, and decreased intake of fat and cholesterol[48]. Thus, RTEC for breakfast as a part of an overall healthful lifestyle may play a role in maintaining a healthful body BMI and adequate nutrient intake in children and adolescents[48].

Justification

The role that breakfast consumption patterns have on weight status, nutrient intake, and dietary adequacy in AA children and adolescents has been understudied. Studies in recent nationally representative samples are lacking. This study examined potential association of these factors with skipping breakfast, consuming RTEC at breakfast, and consuming other foods for breakfast in AA children and adolescents.

Research Question

Is consumption of RTEC for breakfast associated with improved weight status, nutrient intake, and dietary adequacy, compared to skipping breakfast or consuming other types of food for breakfast, in AA children and adolescents?

Objectives

1. To determine if weight measures, nutrient intake, and dietary adequacy of AA children 1-12 y and adolescents is associated with skipping breakfast, consuming RTEC at breakfast, or consuming other foods at breakfast.
2. To determine if weight measures, nutrient intake, and dietary adequacy of AA adolescents 13-18 y is associated with skipping breakfast, consuming RTEC at breakfast, or consuming other foods at breakfast.

Limitations

1. NHANES is a cross-sectional study and causal inferences cannot be made.
2. Dietary intakes were self-reported using a multiple-pass 24 hour recall and, thus, relied on the memory of participants; 24 hour recalls are also subject to reporting errors.
3. A parent or guardian reported or assisted children 12 years of age and younger with 24 hour recalls and these adults may not have been aware of all foods that children in daycare or school consumed on the previous day.
4. 24 hour dietary recalls do not reflect the usual dietary patterns of the participants.
5. Physical activity is an important contributor to weight status, but was not used in the analysis.

6. RTECs were grouped together in the analysis. Although most are fortified, the cereals consumed could have varied widely in energy, carbohydrate, fiber, and total and added sugar content. Further, whether the RTEC was pre-sweetened was not considered in the study.
7. Other foods consumed at breakfast by the RTEC consumers may have contributed to nutrient intake.
8. RTEC may have been consumed at other meals and contributed to nutrient intake and weight of all breakfast consumption groups, but was not considered.

Assumptions

1. The sample size was large enough to reflect dietary intake in the population accurately.

Definitions

1. African American (AA): according to U.S. Census Bureau, a category of people having origins in any of the black racial groups of Africa, including people who self-report race as 'Black'
2. At risk of overweight: BMI ≥ 85th percentile of BMI-for-age using the Centers for Disease Control (CDC) Growth Charts; Body Mass Index (kg/m^2)
3. Body Mass Index (BMI): body weight (kg) divided by height (m^2) used as a practical marker to assess body fatness
4. Breakfast/brunch meal occasion: breakfast or brunch meal occasion self-reported by participant in a 24 hour dietary interview
5. European American (EA): a person who resides in the United States and is either from Europe or is the descendant of European immigrants

6. NHANES: The National Health and Nutrition Examination Survey is a continuous program that collects information about the nutrition and health status of the US population using a complex, multi-stage, probability sampling design
7. Overweight: BMI $\geq$ 95th percentile of BMI-for-age using the CDC Growth Charts
8. Ready to eat cereal (RTEC): a grain product that has been processed to the point where no other preparation is needed

CHAPTER 2

REVIEW OF LITERATURE

The prevalence of overweight in AA children and adolescents is higher than and increasing more rapidly compared to their EA counterparts[8, 49-53]. From 1971-1974 to 1999-2002, the prevalence of overweight increased approximately 4% to 13% among 6- to 11-year-old EA children, and 4% to 20% among AA children. The prevalence of overweight in AA boys 6-11 years of age increased from 12.3% in 1988-1994 to 17.0% in 1999-2002, while the prevalence of overweight in AA girls increased from 17.0% to 22.8% in this age group[2].

Overweight is a leading indicator of health status[54]. Overweight in childhood and adolescence is associated with chronic diseases traditionally seen only in adults, such elevated blood pressure[3] dyslipidemia[55], metabolic syndrome[56], type 2 diabetes mellitus[4], and insulin resistance[5]. An overweight child or adolescent is likely to become an obese adult[7, 50]. Over 80% of overweight AA 5-14 years of age will be obese in early adulthood[50]. Increases in overweight among children and adolescents will increase the burden of weight-related adult diseases[8].

In addition to disparities in the prevalence of overweight, AA and EA children have different feelings about their weight. AA children are more likely to report anxiety and body dissatisfaction than their EA counterparts[57]. Compared to normal weight AA children, overweight AA children have more behavioral and psychosocial problems[58]. Teasing of children by their peers is more common for overweight than normal weight children[59]. Compared to adolescents who eat breakfast, skipping breakfast has been associated with increased likelihood that adolescents have dieted to lose weight and expressed dissatisfaction with their body shape[60]. Recommending dietary consumption patterns and foods that improve weight status in AA will indirectly benefit AA children's emotional and psychological well-being, as well as directly benefiting their physical health.

The 2005 Dietary Guidelines Advisory Committee (DGAC) has recognized vitamin E, calcium, magnesium, potassium, and fiber as shortfall nutrients of particular concern in the diets of children[13]. African Americans and EA have disparities in nutrient intakes[9, 10]. African Americans are less likely than EA to meet the recommended daily allowances (RDA) for several essential nutrients[14, 15, 61-64]. Young AA females are especially at risk for inadequate intakes of vitamins A and E, calcium, iron, and zinc[11]. Further, compared to EA males of the same age, AA males 1-10 years of age are more likely than to have intakes of vitamin E, calcium, and zinc two-thirds or less than the RDA[11].

During adolescence, young people experience rapid growth and development and have high nutrient demands[65]. They also attain more control over food choices[66], and poor dietary patterns are common[67-70]. African American adolescents are at particular risk for poor dietary patterns. Discretionary fat and added sugars made up more than 40% of total energy intake in the diet of a typical American adolescent[69].

The most important meal of the day is traditionally thought of as breakfast[18-22]. Children and adolescents who skipped breakfast were more likely to have an inadequate diet, with inferior nutrient intakes, and a decreased likelihood of eating lunch or dinner on a regular basis, compared to children who consumed breakfast regularly[21, 34]. Higher BMI was associated with skipping breakfast, but also with lower intakes of energy and infrequent exercise[19, 23, 29, 41]. This may be attributable to breakfast skippers having had a less healthy lifestyle than breakfast consumers. Compared to children and adolescents who did not consume breakfast, breakfast consumers had improved behavior and school performance[22, 28, 31, 71]. Research on the benefits of breakfast consumption on diet quality and adequacy is consistent, yet it remains the most commonly skipped meal[31, 33].

Compared to their EA counterparts, AA children and adolescents skip breakfast more often[41, 72, 73]. Improved nutrient intake was associated with regular breakfast consumption, and breakfast skippers did not make up missed nutrients throughout the day[35, 43]. One study of AA children found that skipping breakfast resulted in substantial deficits in dietary intakes of nutrients[21]. Further, more than one third of breakfast skippers consumed less than 50% of the RDA for vitamins A, E, B6, and folate, and nearly one fourth consumed less than 50% of the RDA allowance for energy, vitamin C, calcium, and iron[21].

Children may be more likely to skip breakfast as they get older[48, 74]. This may be, in part, due to environmental or behavioral changes that occur with increasing age, such as the changes in foods choices available at school or changes in behavior that are influenced by peers[33, 74, 75]. Adolescents, particularly adolescent girls, may skip breakfast to lose weight[25]. Skipping breakfast may also be attributable to lack of monetary resources[73], poor health and nutrition knowledge[76]; or lack of time or hunger to eat and prepare breakfast[77].

Skipping breakfast in adolescence is associated with a higher prevalence of health-compromising behaviors including smoking[41] and physical inactivity[25, 41], compared with breakfast consumption. A study of ninth-grade students showed that the percentage of total daily energy intake from fats was higher, and energy from carbohydrates was lower for adolescents who skipped breakfast, compared with adolescents who consumed breakfast[35].

Because RTECs are a convenient, low-fat food, with more than 90% of RTEC fortified with essential micronutrients, they may be an excellent food source for aiding children and adolescents in meeting their nutrient recommendations[78, 79]. Breakfast that included RTEC has been associated with lower body mass index (BMI) [30, 45, 48]. Higher intakes of iron, folic acid, vitamin C, and zinc, and lower intakes of total fat and cholesterol are associated with RTEC consumption[28, 35, 43, 45]. Further, increased intakes of milk and calcium have also been observed in children who eat RTEC for breakfast[47].

The frequency of RTEC consumption over a two week period was positively associated with micronutrient intake in British children 4-12 years of age[45]. In British children 4-18 years of age, intakes of iron, and vitamins B and D were positively associated with daily percentage of energy obtained from RTEC[80]. Van den Boom *et al.* found the frequency of RTEC consumption in Spanish children was associated with improved nutritional profiles[81]. The increased nutrient intake associated with RTEC consumption is likely due to fortification of RTEC or milk that is commonly consumed with RTEC.

Journal Articles

Of the two articles presented as part of this thesis, one has been published and the other is in press. The objectives of the two articles were to determine if weight measures, nutrient intake, and dietary adequacy of AA children and adolescents was associated with skipping breakfast, consuming RTEC at breakfast, or consuming other foods at breakfast. The first is entitled "Are breakfast consumption patterns associated with weight status and nutrient adequacy in African-American children?" and was published in *Public Health Nutrition* on May 27, 2008[30]. Williams *et al.* found that consuming a RTEC breakfast was associated with improved weight and nutrient adequacy in AA children[30]. African American children in all breakfast categories still had mean intakes of most nutrients below recommended levels. Consuming a breakfast meal should be encouraged in these children, and RTEC at breakfast provides important nutrients and may help promote a healthy weight.

A second article, entitled "Ready-to-eat cereal breakfasts are associated with improved nutrient intake and dietary adequacy, but not body mass index in African-American adolescents," examined the role that RTEC breakfast played in maintaining a healthy weight status, nutrient intake, and dietary adequacy in AA adolescents. It is in review in the *Journal of Adolescent Health*.

CHAPTER 3

ARE BREAKFAST CONSUMPTION PATTERNS ASSOCIATED WITH WEIGHT STATUS AND NUTRIENT ADEQUACY IN AFRICAN-AMERICAN CHILDREN?*[30]

Introduction

The prevalence of overweight in children has increased markedly over the past several decades, with African American (AA) children having a higher percentage of overweight or at risk for overweight than their European American (EA) counterparts[8, 49-51]. Over the 30-year period from 1971-1974 to 1999-2002, the prevalence of overweight increased approximately 3-fold (4% to 13%) among 6- to 11-year-old EA children but 5-fold (4% to 20%) among AA children[8].

The prevalence of overweight in AA boys 6-11 years of age increased from 12.3% in 1988-1994 to 17.0% in 1999-2002, while the prevalence of overweight in AA girls increased from 17.0% to 22.8% in this age group[2]. Overweight and obesity in childhood is associated with elevated blood pressure[3], dyslipidemia[55], metabolic syndrome[56], type 2 diabetes mellitus[4], and reduced insulin sensitivity[5]. Overweight in childhood is also predictive of obesity in early adulthood, and the relative risk of becoming an obese adult is significantly greater for overweight children compared with normal weight children[7]. A longitudinal analysis showed that 84% of overweight AA girls and 82% of AA boys 5-14 years of age will be obese in early adulthood, as compared with 65% and 71% of EA girls and boys, respectively[50]. Secular increases in childhood overweight are predicted to increase the burden of adult disease[8]. In addition to disparities in the prevalence of overweight, AA and EA children have dissimilar nutrient intakes[9, 10]. AA males 1-10 years of age are more likely than EA males of the same age to have intakes of vitamin E, calcium, and zinc two-thirds or less than the Recommended Dietary

Allowance (RDA)[11], while AA girls are at risk for inadequate intakes of vitamins A and E, calcium, iron, and zinc[11]. Vitamin E, calcium, magnesium, potassium, and fiber have been identified as shortfall nutrients for all children by the 2005 Dietary Guidelines Advisory Committee (DGAC)[13]. Breakfast has been described as the most important meal of the day[18-22]. Compared to children who consumed breakfast regularly, those who skipped breakfast were more likely to have an inadequate diet, with poorer nutrient intakes, and a decreased likelihood of eating lunch or dinner on a regular basis[21, 34]. Skipping breakfast was associated with lower energy intakes, but higher body mass index (BMI)[19, 23, 29]. Skipping breakfast was also associated with infrequent exercise[41] suggesting that those who skipped breakfast had a less healthy lifestyle than those that did not. Compared to breakfast skippers, children who ate breakfast also had improved behavior and school performance[22, 31]. Although research has consistently shown that breakfast consumption improved diet quality and adequacy, it was the most commonly skipped meal[31, 33].

In the United States (US), 92 % of ready-to-eat cereals (RTEC) are fortified with essential micronutrients[42] and these may be an excellent food source to help children meet their nutrient recommendations. Consuming RTEC at breakfast has been associated with higher intakes of iron, folate, vitamin C, and zinc, and with lower intakes of total fat and cholesterol[21, 43, 45, 48]. Increased intakes of milk and calcium have also been observed in children who eat RTEC for breakfast[47]. Additionally, breakfasts that include RTEC have been associated with lower BMIs[45, 48]. Thus, RTEC breakfast may play a role in maintaining a healthy weight status and adequate nutrient intake in children[45, 48]. The impact of breakfast consumption patterns on weight and dietary adequacy in AA children has been understudied. The aims of this study were to determine the association between weight status, nutrient intake, and dietary adequacy in AA children skipping breakfast, consuming breakfast that includes RTEC, or consuming breakfast without RTEC.

Subjects and Methods

Data Collection

The National Health and Nutrition Examination Survey (NHANES) is a continuous program that collects information about the nutrition and health status of the US population using a complex, multi-stage, probability sampling design. In the 1999-2002 cohort, each participant represented approximately 50,000 non-institutionalized civilian Americans[82]. Trained examiners completed an in-person interview, and a physical examination of participants. The physical examination protocols used to obtain anthropometric measures are described in detail in the National Health and Nutrition Examination Protocol manual[83]. A single multiple-pass 24-hour dietary recall was conducted during the interview using 80 computer-assisted software to record dietary intake data from participants[84]. Detailed descriptions of the dietary interview methods are provided in the NHANES Dietary Interviewer's Training Manual, which includes pictures of the Computer-Assisted Dietary Interview system (CADI) screens, measurement guides, and charts used to collect dietary information[85]. Parents or caretakers reported dietary intakes for children less than 6 years of age, while subjects 6-11 years of age were assisted by an adult. The name of the meal occasion, *e.g.*, breakfast, brunch, lunch, dinner/supper, drink/snack, was self-reported as such.

Subjects and Breakfast Categories

The NHANES data collected from 1999-2002 was used in a secondary analysis to compare weight measures and nutrient adequacy in AA children 1-12 years of age. Classification of race was self-reported and based on US census categories[86]. Children were categorized into one of three breakfast consumption groups: breakfast skippers (those who did not eat breakfast or brunch), RTEC breakfast consumers (regardless of what else was consumed at the breakfast/brunch meal), and other breakfast consumers (no RTEC was consumed at the breakfast/brunch meal). Due to the nature of the analysis (secondary data analysis), and the lack of personal identifiers, this study was exempted by the Institutional Review Boards of the Louisiana State University AgCenter and the Baylor College of Medicine.

Nutrient Analysis

The USDA Food and Nutrient Database for Dietary Studies (FNDDS), version 1[87] was used in NHANES, 2001-2002, while the USDA 1994-98 Survey Nutrient Database was used to process the dietary interview data in NHANES, 1999-2000. In the original release of NHANES, 1999-2000, data on vitamin A intake were only available in µg retinol equivalents, vitamin E intake data were only available in mg alpha-tocopherol equivalents, only total folate (µg) intake data, and no vitamin K (mg) or sugars (g) intake data were available. Currently, Dietary Reference Intakes for vitamin A, vitamin E, and folate are expressed as µg retinol activity equivalents (µg RAE), mg alpha-tocopherol (mg AT), and dietary folate equivalents (DFE), respectively[62, 63]. We used the special database released by USDA to determine vitamin A as mg RAE and vitamin E as mg AT[88]. The FNDDS was used to append the intakes of folate (DFE), vitamin K (µg), and total sugars (g) to the NHANES, 1999-2000 database. Added sugars food composition data were obtained from the Pyramid Servings Database for USDA Survey Food Codes version 2.0[87]. Added sugars were defined by the USDA as white sugar, brown sugar, raw sugar, corn syrup, corn syrup solids, high fructose corn syrup, malt syrup, maple syrup, pancake syrup, fructose sweetener, liquid fructose, honey, molasses, anhydrous dextrose, crystal dextrose, and dextrin that are eaten separately or used as an ingredient in processed or prepared foods. In order to rule out the possibility that the nutrient contribution of eating RTEC for breakfast was attributable to milk added to the cereal, the daily nutrient intake of breakfast consumption groups was compared after deleting the nutrient intake from milk combined with RTEC consumed at breakfast. Daily nutrient intake from all foods except milk combined with RTEC consumed at breakfast was determined by summing the nutrient intake from all foods reported in the 24-hour recall after excluding any fluid milk other than soy milk combined with RTEC eaten at breakfast.

The Mean Adequacy Ratio (MAR) was calculated by expressing micronutrient intake as a percentage of the Estimated Average Requirement (EAR), truncated to no more than 100%, and averaged over 13 micronutrients: vitamins A, E, C, B1, B2, B6, B12; niacin; folate; phosphorus; magnesium; iron; and zinc[89, 90]. A score of 90 and above was considered nutritionally adequate for MAR[91].

Statistical Analysis

Sample-weighted data were used in all statistical analyses, and all analyses were performed using SUDAAN Release 9.0.1 (Research Triangle Institute, Research Triangle Park, NC) to adjust the variance for the complex sample design. The sample-weighted percentages (and standard error [SE] of the percentages) of children in breakfast consumption groups were calculated using PROC CROSSTAB of SUDAAN. Unadjusted means and SE for total energy were also calculated using PROC DESCRIP of SUDAAN. Least-square means and SE were calculated using PROC REGRESS of SUDAAN. The energy-adjusted prevalence of overweight was determined by calculating the least-square mean of a dichotomous variable using PROC REGRESS of SUDAAN. Children with BMI ≥ 95th percentile of BMI-for-age on the Centers for Disease Control and Prevention (CDC) Growth Charts were classified as overweight. Percentiles and z-scores of BMI-for age and weight-for-age were calculated using the Statistical Analysis Software (SAS) program for CDC Growth Charts[91]. Sample-weighted LSMEANS and SE were estimated for micro- and macro-nutrients consumed. In comparing the three breakfast consumption groups, covariates were energy (kcal), gender, and age (years); covariates were not used for MAR calculations. The unadjusted means for total energy and adjusted means of breakfast consumption groups were compared using the Bonferroni method to adjust the significance level for multiple comparisons. Because there were three comparisons, *i.e.*, breakfast skippers vs. RTEC breakfast consumers, breakfast skippers vs. other breakfast consumers, and RTEC breakfast consumers vs. other breakfast consumers, the alpha value of $p < 0.05$ was divided by 3, and the means of the groups were significantly different only if the p-value of the contrast was <0.01667. Guidelines for statistical procedures for analysis of NHANES data are available online[92].

Results

<u>Percentage of AA Children in Breakfast Consumption Groups by Age and Gender</u>

The percentages of AA male and female children who were assigned to each breakfast consumption category are shown in Table 1. There were 7.4% of 1-5-year-old children and 16.9% of children 6-12 years of age who skipped breakfast. The percentage of children 1-5 years of age who consumed RTEC at breakfast was 45%, compared to 38% of children 6-12 years of age. There were 47.6% of children 1-5 years of age and 45.2% of children 6-12 years of age who consumed other breakfasts.

Table 1. Percentages (Mean ± SE) of US African American children in breakfast consumption group by age (years) and gender. NHANES 1999-2002.

	1-5 years (n=521)			6-12 years (n=868)		
	Both Genders	Males	Females	Both Genders	Males	Females
Breakfast Skippers	7.4 ± 1.7	8.0 ± 2.4	6.6 ± 1.8	16.9 ± 1.0	14.4 ± 1.2	19.4 ± 1.7
RTEC Breakfast	45.0 ± 3.0	46.2 ± 4.1	43.9 ± 3.3	38.0 ± 1.9	40.5 ± 2.4	35.4 ± 2.3
Other Breakfast	47.6 ± 3.4	45.8 ± 4.6	49.5 ± 3.5	35.4 ± 2.3	45.2 ± 1.8	45.1 ± 2.3

Mean Weight Measures

AA children who consumed RTEC for breakfast had lower mean BMI ($p<0.05$) and waist circumference ($p<0.05$) than those who either skipped breakfast or those who consumed other types of breakfast (Table 2). There were a lower percentage of overweight children in the RTEC breakfast consumption group (13.1%) compared to breakfast skippers (26.1%), but there were no differences in the prevalence of overweight between the RTEC breakfast and other breakfast consumption groups. No differences in percentiles or z-scores of BMI-for-age or weight-for-age were observed between breakfast consumption groups in children.

Table 2. Weight Measures (Mean ± SE) in US African Americans children by breakfast consumption group, NHANES 1999-2002.

	Breakfast Skippers	RTEC Breakfast	Other Breakfast
Mean Body Mass Index			
2-12 yr	19.8 ± 0.4 [a] n=180	17.7 ± 0.2 [b] n=492	18.5 ± 0.2 [c] n=565
2-5 yr	16.0 ± 0.3 n=29	16.1 ± 0.1 n=170	16.4 ± 0.1 n=181
6-12 yr	20.5 ± 0.4 [a] n=151	18.5 ± 0.3 [b] n=322	19.5 ± 0.2 [ab] n=384
Mean Waist Circumference			
1-12 yr	65.5 ± 1.2 [a] n=179	58.8 ± 0.6 [b] n=485	61.2 ± 0.6 [c] n=560
1-5 yr	50.7 ± 1.0 n=28	50.2 ± 0.4 n=171	51.0 ± 0.4 n=182
6-12 yr	68.2 ± 1.1 [a] n=151	63.0 ± 0.6 [b] n=324	65.6 ± 0.7 [a] n=383
Percent of Overweight Children			
2-12 yr	26.1 ± 2.9 [a] n=180	13.1 ± 1.7 [b] n=492	18.5 ± 1.5 [ab] n=565
2-5 yr	12.3 ± 3.7 n=29	7.1 ± 2.3 n=170	10.2 ± 2.1 n=181
6-12 yr	28.8 ± 3.2 [a] n=151	16.2 ± 2.1 [b] n=322	22.1 ± 1.8 [ab] n=384
Mean Percentile Weight-for-Age			
2-12 yr	68.0 ± 3.1 n=180	63.9 ± 1.5 n=493	67.2 ± 1.1 n=566
2 -5 yr	55.7 ± 5.7 n=29	61.3 ± 1.7 n=171	63.0 ± 1.9 n=182

(Table Continued)

6-12 yr	70.4 ± 3.0 n=151	65.2 ± 2.1 n=322	69.1 ± 1.2 n=384
Mean Percentile of BMI for Age			
2-12 yr	65.4 ± 3.2 n=180	59.7 ± 1.7 n=492	63.6 ± 1.3 n=565
2-5 yr	48.5 ± 6.1 n=29	55.1 ± 2.7 n=170	57.9 ± 1.9 n=181
6-12 yr	68.7 ± 3.1 n=151	62.1 ± 1.9 n=322	66.1 ± 1.4 n=384
Mean z-score of BMI for Age			
2-12 yr	0.61 ± 0.12 n=180	0.36 ± 0.06 n=492	0.51 ± 0.05 n=565
2-5 yr	-0.02 ± 0.23 n=29	0.20 ± 0.10 n=170	0.28 ± 0.07 n=181
6-12 yr	0.73 ± 0.11 n=151	0.44 ± 0.07 n=322	0.61 ± 0.06 n=384
Mean z-score of Weight for Age			
2-12 yr	0.75 ± 0.12 n=180	0.51 ± 0.06 n=493	0.68 ± 0.04 n=566
2-5 yr	0.24 ± 0.21 n=29	0.42 ± 0.07 n=171	0.51 ± 0.06 n=182
6-12 yr	0.85 ± 0.12 n=151	0.56 ± 0.08 n=322	0.76 ± 0.05 n=384
Means not sharing an alphabetic character differ significantly (p<0.05); breakfast skippers vs. RTEC breakfast consumers, breakfast skippers vs. other breakfast consumers, RTEC breakfast consumers vs. other breakfast consumers			

Mean Daily Energy and Micronutrient Intake

Table 3 shows mean daily energy and micronutrient intakes by breakfast consumption group for children 1-12 years of age. Breakfast skippers had lower mean energy intakes than children who consumed RTEC or other breakfasts; energy intakes of children in the other two groups did not differ significantly. Compared to those who either skipped breakfast or consumed other breakfasts, children in the RTEC breakfast category had the highest mean daily intakes of vitamins A and B-12, thiamin, riboflavin, folate, and iron ($p<0.05$ for all). No differences were found in mean daily intakes of vitamin B-6, niacin, calcium, and zinc between breakfast skippers and other breakfast consumers; however, RTEC breakfast consumers had higher intakes of these nutrients ($p<0.05$) than the two other groups. RTEC breakfast consumers had a lower intake of vitamin E than breakfast skippers ($p<0.05$). Comparisons of micronutrient intakes among breakfast consumption groups without milk on RTEC showed that calcium, phosphorus, and potassium in RTEC breakfast consumers were lower than other breakfast consumers, but not significantly different from breakfast skippers (data not shown). AA children 1-12 years of age who ate RTEC breakfast had a higher percent MAR than breakfast skippers or those consuming other breakfasts ($p<0.05$).

Table 3. Mean daily intake of energy and selected nutrients[1] (Mean ± SE) in US African American children 1-12 years of age by breakfast consumption with milk on RTEC eaten at the breakfast meal, NHANES 1999-2002.

	Breakfast Skippers (n = 188)	RTEC Breakfast (n=560)	Other Breakfast (n=641)
Nutrient[2]			
Total Energy (kcal)[3]	1662 ± 74 [a]	1919 ± 27 [b]	1940 ± 32 [b]
MAR[2] (%)	84.3 ± 1.2 [a]	95.7 ± 0.2 [b]	93.2 ± 0.4 [c]
MAR[2] (%) w/o milk on RTEC eaten at breakfast meal	84.3 ± 1.2 [a]	94.3 ± 0.3 [b]	93.2 ± 0.4 [b]
Vitamin A (µg RAE)	357 ± 22 [a]	581 ± 18 [b]	443 ± 17 [c]
Alpha Tocopherol (mg)	6.1 ± 0.2 [a]	5.0 ± 0.2 [b]	5.4 ± 0.1 [b]
Vitamin C (mg)	95.9 ± 5.9	105.7 ± 4.0	99.3 ± 3.9
Thiamin (mg)	1.19 ± 0.04 [a]	1.74 ± 0.03 [b]	1.36 ± 0.03 [c]
Riboflavin (mg)	1.49 ± 0.04 [a]	2.26 ± 0.04 [b]	1.71 ± 0.03 [c]
Niacin (mg)	16.8 ± 0.4 [a]	21.9 ± 0.4 [b]	17.2 ± 0.4 [a]
Vitamin B-6 (mg)	1.28 ± 0.03 [a]	1.91 ± 0.03 [b]	1.32 ± 0.02 [a]
Folate (µg DFE)	357 ± 15 [a]	675 ± 24 [b]	411 ± 11 [c]
Vitamin B-12 (µg)	3.2 ± 0.1 [a]	4.9 ± 0.2 [b]	3.7 ± 0.1 [c]
Calcium (mg)	719 ± 19 [a]	866 ±17 [b]	741 ± 15 [a]
Phosphorus (mg)	1002 ± 16 [a]	1084 ±13 [b]	1076 ± 11 [b]
Magnesium (mg)	198 ± 4 [ab]	205 ± 3 [a]	195 ± 2 [b]
Iron (mg)	11.0 ± 0.3 [a]	16.6 ± 0.3 [b]	12.6 ± 0.2 [c]
Zinc (mg)	8.6 ± 0.3 [a]	11.4 ± 0.2 [b]	9.0 ± 0.2 [a]
Sodium (mg)	2930 ± 74	3031 ± 43	3129 ± 35
Potassium (mg)	2037 ± 45	2111 ± 29	2050 ± 32
Vitamin K (µg)	57.6 ± 12.0	50.8 ± 4.7	66.4 ± 10.5

[1]Means not sharing an alphabetic character differ significantly ($p<0.05$); breakfast skippers vs. RTEC breakfast consumers, breakfast skippers vs. other breakfast consumers, RTEC breakfast consumers vs. other breakfast consumers
[2] Adjusted for age, gender, and energy.
[3] Unadjusted

Protein, Carbohydrate, Fat, Cholesterol, and Fiber Intake

Children who consumed RTEC for breakfast had the highest intakes from carbohydrate or total sugars and the lowest intake from total fat when compared with either breakfast skippers or other breakfast consumers ($p<0.05$) (Table 4). RTEC breakfast consumers had lower saturated fat intake than breakfast skippers, and lower cholesterol intake than other breakfast consumers ($p<0.05$). Breakfast skippers and other breakfast consumers had higher intakes of monounsaturated and polyunsaturated fatty acids than RTEC breakfast consumers ($p<0.05$). When RTEC consumption at breakfast without milk on cereal was considered for children 1-12 years of age, macronutrients followed the same patterns of association with breakfast consumption groups, except mean saturated fatty acid (SFA) intake was lowest in RTEC breakfast consumers compared to both breakfast skippers and other breakfast consumers (data not shown). No differences were seen in total dietary fiber among breakfast consumption categories.

Table 4. Daily Protein, Carbohydrate, and Fat Intake (% ± SE)[1], Cholesterol (mg ± SE), and Total Dietary Fiber (g ± SE) in U.S. African American children 1-12 years of age by breakfast consumption group, NHANES 1999-2002.

	Breakfast Skippers (n =188)	RTEC Breakfast (n = 560)	Other Breakfast (n = 641)
Protein[3] (g)	62.4 ± 1.2 [ab]	61.9 ± 0.7 [a]	64.9 ± 0.9 [b]
Protein[4] (%)	13.2 ± 0.4 [ab]	13.1 ± 0.2 [a]	13.8 ± 0.2 [b]
Carbohydrate[3] (g)	249 ± 3 [a]	266 ± 2 [b]	248 ± 2 [a]
Carbohydrate[4] (%)	53.2 ± 1.0 [a]	56.6 ± 0.4 [b]	52.7 ± 0.5 [a]
Total Sugars[3] (g)	128.7 ± 3.2 [a]	139.7 ± 1.9 [b]	127.0 ± 3.0 [a]
Total Sugars[4] (%)	28.0 ± 0.8 [ab]	29.7 ± 0.3 [a]	27.3 ± 0.6 [b]
Added Sugars[3] (g)	85.9 ± 3.5 [ab]	89.6 ± 1.5 [a]	80.1 ± 2.5 [b]
Added Sugars[4] (%)	18.2 ± 0.7 [ab]	18.8 ± 0.3 [a]	16.8 ± 0.5 [b]
Total Fat[3] (g)	74.7 ± 1.1 [a]	67.1 ± 0.9 [b]	73.5 ± 0.8 [a]
Total Fat[4] (%)	34.8 ± 0.7 [a]	31.5 ± 0.4 [b]	34.5 ± 0.4 [a]
Saturated Fatty acids[3] (g)	25.8 ± 0.4 [a]	24.2 ± 0.4 [b]	25.1 ± 0.3 [ab]
Saturated Fatty acids[4] (%)	11.9 ± 0.3	11.4 ± 0.2	11.8 ± 0.1
Monounsaturated Fatty Acids[3] (g)	29.6 ± 0.6 [a]	25.4 ± 0.4 [b]	28.7 ± 0.4 [a]

(Table Continued)

Monounsaturated Fatty Acids[4] (%)	13.9 ± 0.3 [a]	11.9 ± 0.2 [b]	13.4 ± 0.2 [a]
Polyunsaturated Fatty Acids[3] (g)	13.8 ± 0.5 [a]	12.2 ± 0.4 [b]	13.8 ± 0.3 [a]
Polyunsaturated Fatty Acids[4] (%)	6.4 ± 0.2 [a]	5.7 ± 0.1 [b]	6.5 ± 0.1 [a]
Cholesterol[3] (mg)	186 ± 7 [a]	180 ± 4 [a]	267 ± 8 [b]
Total Dietary Fiber[3] (g)	11.4 ± 0.4	11.3 ± 0.2	11.1 ± 0.3

[1]Means not sharing an alphabetic character differ significantly ($p<0.05$); breakfast skippers vs. RTEC breakfast consumers, breakfast skippers vs. other breakfast consumers, RTEC breakfast consumers vs. other breakfast consumers
[2]MAR = Mean Adequacy Ratios were the %EAR for each of 13 nutrients (vitamins A, E, C, B1, B2, B6, B12; niacin; folate; phosphorus; magnesium; iron; and zinc) but truncated at 100 prior to averaging.
[3]Least square mean and standard error (LSM ± SE) nutrient intakes were adjusted for age, gender, and energy intake.
[4]Least square mean and standard error (LSM ± SE) percent energy from nutrients were adjusted for age and gender only.

Discussion

Our data suggest that older children are more likely to skip breakfast. This finding is consistent with results from other studies[48, 74]. Further research is needed to determine reasons, but breakfast skipping may be partially attributable to environmental or behavioral changes that occur with increasing age, such as the changes in foods choices available at school, or changes in behavior that are influenced by peers[33, 74, 75]. Investigation into why children 6-12 years of age skip breakfast more than those 1-5 years of age may help to identify correlates that can be then used to implement appropriate interventions.

The lower mean BMI and waist circumference observed in AA children who ate RTEC for breakfast suggests that consumption of RTEC at breakfast may contribute to a healthier weight status. Despite having higher weight measures, breakfast skippers had a lower energy intake than RTEC and other breakfast consumers. This finding also confirms other research[41, 81]. The lower mean BMI and waist circumference suggest that children who consume breakfast may have healthier lifestyles than those who skipped breakfast. Underreporting of energy intake may also have occurred in these children, since the BMI of the parent or child may affect reporting in a 24 hour recall[93].

Children 1-12 years of age who skipped breakfast also had significantly lower intakes of most of the micronutrients when compared with RTEC breakfast consumers or other breakfast consumers. Although there is a lack of published research on the relationship of weight and diet adequacy to breakfast and RTEC breakfast consumption in AA children, comparisons of our findings to those conducted with other age and ethnic groups reveal similar findings[43, 45, 80, 81]. In a representative sample of children 4-12 years of age, Albertson *et al.* found the frequency of RTEC consumption over a two week period was positively correlated with micronutrient intake[45]. van den Boom *et al.* concluded that frequency of RTEC consumption was positively related to improved nutritional profiles in Spanish children[81]. Further, a representative sample of British children 4-18 years of age found that intakes of iron, and vitamins B and D were positively associated with daily percentage of energy obtained from RTEC[80]. The increased nutrient intake associated with RTEC consumption may be due to fortification of RTEC or milk that is commonly consumed with RTEC, if children who did not consume these foods did not obtain these nutrients from other foods consumed during the day. The Bogalusa Heart Study showed that children who skipped breakfast did not make up the differences in dietary intakes at other meals[43]. Similarly, a study of AA children found that skipping breakfast resulted in substantial deficits in dietary intakes of nutrients; more than one third of breakfast skippers consumed less than 50% of the RDA for vitamins A, E, B6, and folate, and nearly one fourth consumed less than 50% of the RDA allowance for energy, vitamin C, calcium, and iron[21].

Mean calcium intake was higher for RTEC breakfast consumers than for breakfast skippers and other breakfast consumers. Milk consumption, which is high in calcium and potassium, and is commonly consumed with cereal, may explain this finding as it is consistent with other research[47]. Calcium and potassium were identified by the 2005 DGAC as two of the shortfall nutrients in the diets of children 9 years of age or older[13]. AA males1-10 years of age were more likely than same age EA males to have intakes of calcium two-thirds or less than the RDA[11], while AA girls were at risk for inadequate intake of calcium[11]. Consumption of milk with RTEC could improve calcium intake in this group.

Although our study did not show differences in fiber intake among breakfast consumption groups, others have shown RTEC as a significant source of fiber for children[48, 94, 95]. Children in our study may have consumed low fiber cereals, which would suggest the need to promote increased intake of RTEC with higher fiber content or the need to supplement RTEC with additional fiber[94].

This study had several limitations. NHANES is a cross-sectional study and causal inferences cannot be drawn. Dietary intakes were self-reported and relied on memory of participants or their parent or guardian, and, therefore, data were subject to non-sampling errors, such as underreporting of energy and examiner effects[86]. Parents or guardians, who reported or assisted children with the recalls, may not know all foods that children in daycare or school consumed the previous day. Further, 24-hour dietary recalls may not accurately reflect the usual dietary patterns of participants[96, 97]; however, the collection of group data from 24 hour recalls with mean reporting, as used by the NHANES, is an appropriate use of 24 hour diet recalls[98]. Children's self-reported portion size estimates are appropriate for ranking children's relative intakes, but may result in sizable errors in quantitative estimates of food and energy intakes[99]. Another limitation was that physical activity, an important contributor to weight status[100], was not used as a covariate since physical activity information was not collected using a standardized method across the age groups. Further, RTECs were grouped together; and although the majority were fortified, those consumed may have varied considerably in energy, carbohydrate, fiber, total and added sugar content[27]; whether RTEC were pre-sweetened was also not considered in this study. It was also not considered that RTEC consumed at other meals may make an additional positive contribution to nutrient intake and weight of all the breakfast consumption groups. Finally, foods other than RTEC and milk that were consumed by individuals in the RTEC breakfast group may have influenced nutrient intake. A study to determine the effects of other foods consumed with RTEC is necessary to determine contributions to nutrient intake.

Conclusion and Implications

In this study, improved weight measures and nutrient adequacy were associated with eating RTEC for breakfast in AA children. The implications are that consuming a breakfast meal should be encouraged in these children, and that RTEC at breakfast provides important nutrients and may help promote a healthy weight.

CHAPTER 4

READY-TO-EAT CEREAL BREAKFASTS ARE ASSOCIATED WITH IMPROVED NUTRIENT INTAKE AND DIETARY ADEQUACY, BUT NOT BODY MASS INDEX IN AFRICAN AMERICAN ADOLESCENTS

Introduction

Adolescence is a time of rapid growth and development making this a period of nutritional vulnerability. Adolescents demonstrate increasing control over their own food choices[65, 101]; however, poor dietary patterns are widespread[66, 102]. Discretionary fat and added sugars make up more than 40% of total energy intake in the diet of adolescents[102]. African-American (AA) adolescents may be especially vulnerable to poor diets, since they are less likely than European-Americans (EA) to meet dietary recommendations for several essential nutrients[14-16].

Skipping breakfast is an example of a poor dietary practice commonly seen in adolescents[26]. Although breakfast has been called the most important meal of the day, it is the meal that is skipped most frequently[19, 22]. African-American adolescents tend to skip breakfast more often than their EA counterparts[41, 72, 73]. The importance of breakfast is underscored since regular consumption of breakfast is associated with improved cognition[71] and nutrient intake in adolescents. Skipping breakfast may result in inadequate nutrient intake that is not compensated for at other times during the day[35]. Paradoxically, skipping breakfast is also associated with lower energy intake, but higher body mass index (BMI) [19, 25-27].

The prevalence of overweight in adolescents increased markedly from 1999 to 2002[53] and from 2003 to 2006 [1] with the prevalence of overweight and obesity higher, and increasing more rapidly in AA adolescents compared to their EA counterparts[53]. Overweight is a leading indicator of health status[54], and is associated with elevated blood pressure, dyslipidemia, metabolic syndrome, type 2 diabetes mellitus, and reduced insulin sensitivity[103]. Childhood overweight tracks into young adulthood [104] and tracking may show racial differences. Eighty-four percent of overweight AA girls and 82% of overweight AA boys will be obese adults; these rates are higher than their EA counterparts[50], suggesting it is important to assess factors associated with overweight in AA children and adolescents. Increases in overweight adolescents will increase the burden of adult diseases associated with unhealthy weight status[8].

Consumption of ready-to-eat cereals (RTEC) at breakfast may help adolescents maintain a healthy weight and improve nutrient intake. RTEC are convenient, low-fat, and more than 90% of RTEC are fortified with essential micronutrients[78, 79]. Consumption of RTEC has been associated with higher intakes of iron, folic acid, vitamin C, and zinc, and with lower intakes of total fat and cholesterol[15, 45]. Adolescents who consume RTEC for breakfast also had increased intakes of milk and calcium[47]. Breakfasts that include RTEC have been associated with lower BMI in individuals 9 to 19 years of age[25, 26, 53]. Thus, RTEC may be an excellent food choice for adolescents.

Recently, the importance of consumption of RTEC for nutrient intake and dietary adequacy at breakfast in the diets of AA children was demonstrated; however, the association of breakfast consumption patterns of AA adolescents with diet and weight status has been understudied. The objectives of this study were to examine nutrient intake, dietary adequacy, and weight status in a nationally representative sample of AA adolescents who skipped breakfast, consumed a breakfast that included RTEC, or consumed other foods at breakfast.

Methods

Data Collection

The National Health and Nutrition Examination Survey (NHANES) is a continuous data collection program that obtains information about the nutrition and health status of the US population using a complex, multi-stage, probability sampling design. Each participant represented approximately 50,000 non-institutionalized civilian Americans in the 1999-2002 cohort. Trained examiners conducted an in-person interview and a physical examination of participants. The National Health and Nutrition Examination Protocol Manual describes in detail the physical examination protocols used to obtain anthropometric measures[83].

A single multiple-pass 24-hour dietary recall was conducted during the interview using computer-assisted software to record dietary intake data from participants. Participants self-reported the meal occasion, *e.g.,* breakfast/brunch. The NHANES Dietary Interviewer's Training Manual includes detailed descriptions of the dietary interview methods, as well as pictures of the Computer-Assisted Dietary Interview system screens, measurement guides, and charts used to collect dietary information[85].

Subjects and Breakfast Consumption Categories

Data collected in the 1999-2002 NHANES were used in a secondary analysis to examine nutrient intake, nutrient adequacy, and weight measures in AA adolescents 13-18 years of age by breakfast consumption group. Race classifications were self-reported and based on United States (US) census categories. Adolescents were categorized into one of three breakfast/brunch consumption groups: breakfast skippers (those who did not eat breakfast/brunch), RTEC breakfast consumers (regardless of what else was consumed at the meal), and other breakfast consumers (no RTEC was consumed at the breakfast meal). Due to the nature of the analysis (secondary data analysis) and the lack of personal identifiers, this study was exempted by the Institutional Review Boards of the LSU AgCenter and Baylor College of Medicine.

Nutrient Intake Assessment

In NHANES, 2001-2002, food composition data from the United States Department of Agriculture (USDA) Food and Nutrient Database for Dietary Studies (FNDDS), version 1, were used to process the dietary interview data, while NHANES, 1999-2000, data were processed using the USDA 1994-98 Survey Nutrient Database. In the original release of NHANES, 1999-2000, vitamin A intake data were only available in µg retinol equivalents and vitamin E intake data were only available in mg alpha-tocopherol equivalents. In addition, only total folate (µg) intake data and no vitamin K (mg) or sugars (g) intake data were available in NHANES, 1999-2000. Dietary Reference Intakes for vitamins A and E and folate were expressed as µg retinol activity equivalents (µg RAE), mg alpha-tocopherol (mg AT), and dietary folate equivalents (DFE), respectively. Therefore, a special database released by USDA in which vitamin A was expressed as mg RAE and vitamin E as mg AT was used[87]; and the FNDDS was used to append the intakes of folate (DFE), vitamin K (µg), and total sugars (g) to the NHANES, 1999-2000, database. Added sugars food composition data were obtained from the Pyramid Servings Database for USDA Survey Food Codes version 2.0[30]. Added sugars were defined by USDA as all caloric sweeteners that were eaten separately or used as ingredients in processed or prepared foods.

To rule out the possibility that the nutrient contribution of consuming RTEC for breakfast was due to milk added to the cereal, the daily nutrient intakes of breakfast consumption groups were compared after excluding the nutrient intake from fluid milk combined with RTEC consumed at breakfast.

Mean adequacy ratio (MAR) was calculated by expressing micronutrient intake as a percentage of the Estimated Average Requirement, truncated to no more than 100%, and averaged over 13 micronutrients: vitamins A, E, C, B1, B2, B6, B12; niacin; folate; phosphorus; magnesium; iron; and zinc[30].

Anthropometric Assessment

Children with BMI ≥ 95th percentile of BMI-for-age on the Centers for Disease Control and Prevention (CDC) Growth Charts were classified as overweight. Percentiles and z-scores of BMI-for age and weight-for-age were calculated using the Statistical Analysis Software (SAS) program for CDC Growth Charts.

Statistical Analysis

All analyses were performed using SUDAAN Release 9.0.1 (Research Triangle Institute, Research Triangle Park, NC) to adjust the variance for the complex sample design. Sample-weighted data were used in all statistical analyses. The sample-weighted percentages (and standard error [SE] of the percentages) of adolescents in breakfast consumption groups were calculated using PROC CROSSTAB of SUDAAN. Unadjusted means and SE were calculated using PROC DESCRIP of SUDAAN. Least-square means and SE were calculated using PROC REGRESS of SUDAAN to adjust micronutrient and macronutrient (gram) intakes for gender and energy (Kcal) intake. Gender was the only covariate used with the breakfast consumption variable in analyses of percent energy from macronutrients. The unadjusted mean anthropometric measures and adjusted mean nutrient intakes of breakfast consumption groups were compared using the Bonferroni method to account for multiple comparisons when determining the significance level. Because there were three comparisons, *i.e.*, breakfast skippers vs. RTEC breakfast consumers, breakfast skippers vs. other breakfast consumers, and RTEC breakfast consumers vs. other breakfast consumers, the alpha value of ≤ 0.05 was divided by 3, so that the effective p value was ≤ 0.01667.

Results

Percentage of AA adolescents by Breakfast Consumption Groups

Table 1 shows the percentages of AA adolescents by gender in the breakfast consumption groups. Thirty seven percent of AA skipped breakfast, 19% consumed RTEC at breakfast, and 44% consumed other breakfasts.

Table 1. Percentage ± SE of the percentage of US African American adolescents 13-18 years of age in breakfast consumption group by age and gender, NHANES 1999-2002.

	n	Breakfast Skippers	RTEC Breakfast	Other Breakfast
Both Genders	988	36.8±2.0	19.4±1.5	43.8±1.9
Males	511	36.8±2.9	22.2±2.4	41.0±2.4
Females	477	36.8±2.5	16.5±1.7	46.8±2.6

Mean Daily Energy, Protein, Carbohydrate, Fat, Cholesterol, and Fiber Intake

RTEC breakfast and other breakfast consumers had higher mean energy (kcal) intakes than breakfast skippers ($p \leq 0.05$) (Table 2). There were no differences in the mean percentage of energy from protein among the breakfast consumption groups. However, RTEC breakfast consumers had the highest percentage of energy from carbohydrate and the lowest percentage of energy from total fat, when compared to breakfast skippers and other breakfast consumers. RTEC breakfast consumers had a higher mean daily intake of total sugars (g) than other breakfast consumers ($p \leq 0.05$). Skippers had higher mean daily intakes of added sugars (g) than other breakfast consumers ($p \leq 0.05$), but added sugars (g) intakes in RTEC breakfast consumers did not differ from other breakfast consumers.

RTEC breakfast consumers had lower intakes of total fat (g), monounsaturated fatty acids (MUFA) (g), and polyunsaturated fatty acids (g) than breakfast skippers and other breakfast consumers. Both breakfast skippers and RTEC breakfast consumers had lower mean intakes of cholesterol than other breakfast consumers. RTEC breakfast consumers had higher mean intakes of total dietary fiber (g) than breakfast skippers, and no differences were shown for other breakfast consumers ($p \leq 0.05$).

When milk added to RTEC was excluded from the analyses, RTEC consumers had significantly higher intakes of carbohydrates (g) and total dietary fiber (g) and significantly lower intakes of total fat (g), saturated fatty acids (g), and MUFA (g) than the other two breakfast consumption groups ($p \leq 0.05$) (data not shown).

Table 2. Total daily intakes (mean ± SEM)[1] of energy, protein, carbohydrate, fat, cholesterol and dietary fiber in U.S. African American adolescents 13-18 years of age by breakfast consumption group, NHANES 1999-2002.

	Breakfast Skippers (n = 359)	RTEC Breakfast (n = 193)	Other Breakfast (n = 436)
Total Energy (Kcal)[2]	1954±46 [a]	2518±66 [b]	2413±53 [b]
Protein (g)[3]	73.0±1.2 [a]	75.0±1.9 [ab]	76.2±1.0 [b]
Protein (% energy)[4]	13.1±0.3	13.3±0.2	13.4±0.2
Carbohydrate (g)[3]	302±5 [a]	324±5 [b]	298±4 [a]
Carbohydrate (% energy)[4]	53.7±1.1 [a]	57.2±0.7 [b]	53.3±0.6 [a]
Total Sugars (g)[3]	164.8±6.5 [ab]	175.2±5.9 [a]	159.1±2.6 [b]
Total Sugars (% energy)[4]	29.5±1.3	30.4±0.9	28.7±0.4
Added Sugars (g)[3]	132.3±5.4 [a]	124.8±6.6 [ab]	118.6±2.7 [ab]
Added Sugars (% energy)[4]	23.8±1.0 [a]	21.7±0.9 [ab]	21.2±0.4 [b]
Total Fat (g)[3]	86.1±1.7 [a]	77.0±1.6 [b]	86.7±1.5 [a]
Total Fat (% energy)[4]	33.7±0.8 [a]	30.6±0.6 [b]	33.9±0.6 [a]
Saturated Fatty Acids (g)[3]	29.1±0.6	27.4±0.6	28.7±0.8
Saturated Fatty Acids (% energy)[4]	11.2±0.3	10.8±0.2	11.2±0.3
Monounsaturated Fatty Acids (g)[3]	34.4±0.8 [a]	29. 0±0.8 [b]	33.8±0.7 [a]
Monounsaturated Fatty Acids (% energy)[4]	13.4±0.4 [a]	11.5±0.3 [b]	13.3±0.3 [a]
Polyunsaturated Fatty Acids (g)[3]	16.2±0.4 [a]	14.4±0.6 [b]	17.4±0.3 [a]
Polyunsaturated Fatty Acids (% energy)[4]	6.4±0.2 [a]	5.8±0.2 [b]	6.7±0.1 [a]
Cholesterol (mg)[3]	229±9 [a]	230±9 [a]	300±9 [b]
Total Dietary Fiber (g)[3]	11.4±0.3 [a]	13.2±0.4 [b]	12.1±0.4 [ab]

[1]Means not sharing an alphabetic character differ significantly ($p \leq 0.05$); breakfast skippers vs. RTEC breakfast consumers, breakfast skippers vs. other breakfast consumers, RTEC breakfast consumers vs. other breakfast consumers. This table represents data analysis with milk—when milk added to RTEC was excluded from the analyses, RTEC consumers had higher total carbohydrate and total fiber consumption, and lower consumption of total fat, saturated fatty

(Table Continued)

acids, and MUFA than breakfast skippers or other breakfast consumers. [2] Unadjusted [3] Adjusted for gender, and energy intake. [4] Adjusted for gender only.

Mean Adequacy Ratio and Mean Micronutrient Intake

RTEC breakfast consumers had the highest MAR, followed by other breakfast consumers; skippers had the lowest MAR ($p \leq 0.05$) (Table 3). RTEC breakfast consumers had higher intakes of vitamins A, B-6, B-12; thiamin; riboflavin; niacin; folate; calcium, phosphorus, magnesium, iron, zinc, and potassium compared to skippers and other breakfast consumers. Except for phosphorus, there were no differences in intakes of these micronutrients between breakfast skippers and other breakfast consumers; phosphorus intake was lower in skippers than other breakfast consumers. There were no differences in intakes of vitamins E, C, and K; and sodium between the breakfast consumption groups.

Analysis that excluded nutrient intake from milk combined with RTEC at breakfast showed that RTEC consumers had higher intakes of vitamins A, B-6, B-12; thiamin; riboflavin; niacin; folate; iron; and zinc than either of the other breakfast consumption groups ($p \leq 0.05$). There were no differences among the groups for intake of calcium, potassium, and magnesium (data not shown).

Table 3. Total daily intake of selected nutrients (mean ± SEM) [1] in US African American adolescents 13-18 years of age by breakfast consumption group, NHANES 1999-2002.

	Breakfast Skippers (n = 359)	RTEC Breakfast (n = 193)	Other Breakfast (n = 436)
MAR[2] (%)	73.6±1.3 [a]	92.1±0.4 [b]	83.7±0.7 [c]
Vitamin A (μg RAE)	382±19 [a]	745±32 [b]	437±37 [a]
Vitamin E (mg)	6.2±0.2	6.1±0.3	6.6±0.1
Vitamin C (mg)	93.6±7.7	118.5±8.1	113.1±5.1
Thiamin (mg)	1.46±0.05 [a]	2.17±0.09 [b]	1.50±0.04 [a]
Riboflavin (mg)	1.69±0.04 [a]	2.82±0.08 [b]	1.69±0.03 [a]
Niacin (mg)	20.6±0.5 [a]	28.7±0.8 [b]	20.4±0.3 [a]
Vitamin B-6 (mg)	1.47±0.06 [a]	2.54±0.07 [b]	1.46±0.03 [a]

(Table Continued)

Folate (µg DFE)	454±17 [a]	882±36 [b]	460±14 [a]
Vitamin B-12 (µg)	4.0±0.2 [a]	6.3±0.3 [b]	4.0±0.3 [a]
Calcium (mg)	747±27 [a]	1002±41 [b]	721±19 [a]
Phosphorus (mg)	1101±20 [a]	1291±37 [b]	1172±17 [c]
Magnesium (mg)	208±4 [a]	242±7 [b]	219±4 [a]
Iron (mg)	13.3±0.4 a	21.4±0.7 b	13.6±0.3 a
Zinc (mg)	10.4±0.3 a	14.0±0.4 b	10.5±0.2 a
Sodium (mg)	3416±80	3402±107	3615±66
Potassium (mg)	2073±56 a	2435±82 b	2187±35 a
Vitamin K (µg)	60.7±5.0	56.1±4.5	71.7±6.0

[1]Means not sharing an alphabetic character differ significantly ($p \leq 0.05$); breakfast skippers vs. RTEC breakfast consumers, breakfast skippers vs. other breakfast consumers, RTEC breakfast consumers vs. other breakfast consumers. This table represents data analysis with milk—when milk added to RTEC was excluded from the analyses, RTEC consumers had higher consumption of vitamins A, B-6, B12, thiamin, riboflavin, niacin, folate, iron, and zinc than breakfast skippers or other breakfast consumers; however, there was no difference in intake of calcium, potassium, or magnesium.
[2] MAR = Mean Adequacy Ratio. The MAR was the average intake of 13 nutrients (vitamins A, E, C, B1, B2, B6, B12; niacin; folate; phosphorus; magnesium; iron; and zinc) expressed as a percentage (%) of the EAR and capped at 100% prior to averaging.

Mean Body Weight Measures

RTEC breakfast consumers had lower mean WC and BMI ($p \leq 0.05$) than breakfast skippers (Table 4). However, the percentage of adolescents who were overweight did not differ among the breakfast consumption groups and there were no differences in mean z-scores of weight-for-age and BMI-for-age; or mean percentiles of weight-for-age and BMI-for-age.

Table 4. Weight measures (mean ± SEM) by breakfast consumption group in AA adolescents 13-18 years of age, NHANES 1999-2002.

	Breakfast Skippers (n=354)	RTEC Breakfast (n=192)	Other Breakfast (n=430)
Overweight (%)	23.8±2.7	17.8±3.4	22.9±1.6
Mean Waist Circumference (cm)	81.2±1.0 [a]	77.2±1.1 [b]	80.6±0.7 [ab]
Mean Body Mass Index (kg/m^2)	24.7±0.4 [a]	23.2±0.4 [b]	24.5±0.3 [ab]
Mean z-score of Weight-for-Age	0.76±0.07	0.65±0.08	0.73±0.05
Mean Percentile of Weight-for-Age	68.8±1.6	65.9±2.0	67. 8±1.2
Mean z-score of BMI for age	0.68±0.07	0.54±0.08	0.65±0.04
Mean Percentile of BMI for age	67. 3±1.6	63.9±1.9	66.4±1.1

(Table Continued)

Means not sharing an alphabetic character differ significantly ($p \leq 0.05$); breakfast skippers vs. RTEC breakfast consumers, breakfast skippers vs. other breakfast consumers, RTEC breakfast consumers vs. other breakfast consumers.

Discussion

In this study, more than one third of AA adolescents skipped breakfast. This prevalence is much higher than seen in AA children 1-5 years of age (7.4%) or 6-12 years of age (16.9%)[30], suggesting that older children and adolescents are more likely to skip breakfast than younger children. Breakfast skippers consumed less total energy than those consuming a RTEC breakfast and other breakfast consumers. Paradoxically, some studies have shown that overweight is more common among adolescents who skipped breakfast than in those who consumed it[30, 105]. This study showed that mean BMI and WC were lower in those consuming a RTEC cereal when compared with those skipping breakfast, but that these weight measures were not different between RTEC consumers and those consuming other breakfasts. Some studies have shown that adolescents, particularly adolescent girls, may skip breakfast in order to lose weight[25]; however, other studies have not shown this relationship[26]. Other reasons for skipping breakfast include lack of monetary resources[73], or lack of time needed for caretakers to prepare and provide breakfast to their children; poor health and nutrition knowledge among older children[76]; lack of time or hunger to eat and prepare breakfast[77]. Our data clearly show that skipping breakfast is not associated with a lower weight than consuming a RTEC breakfast.

That more than one third of AA adolescents skipped breakfast; this is of concern since it affects total nutrient intake and points to a potential avenue for an intervention to improve the diet of adolescents. Our finding of the high prevalence of breakfast skippers is consistent with other cross sectional[25, 35] and longitudinal studies[19, 48]. The number of adolescents in these studies who reported skipping breakfast varied from 19%[35] to 42%[25]. Differences may reflect the population studied or methodological differences. For example, our study used a single 24-hour recall to determine breakfast consumption, whereas Zullig *et al*., 2006[25] asked whether adolescents had consumed breakfast within the past 5 days.

In general, skipping breakfast in adolescence is associated with a higher prevalence of health-compromising behaviors including smoking[25] and physical inactivity[25, 41] than is seen in those consuming breakfast. Lower levels of physical activity may be the reason that breakfast skippers had higher BMIs than breakfast consumers. A study of ninth-grade students showed that the percentage of total daily energy intake from fats was higher, and energy from carbohydrates was lower for adolescents who skipped breakfast, compared with adolescents who consumed breakfast[35]. This study showed that adolescents consuming breakfast, and more specifically a breakfast including RTEC, had better nutrient intakes than those skipping breakfast or consuming other breakfasts. Total and saturated- and monounsaturated fatty acid intakes were lower in those consuming RTEC than in breakfast skippers or those consuming other breakfasts, whereas carbohydrate intake was higher.

Adolescents who skipped breakfast do not compensate for vitamins and minerals at other meals during the day[106]. Improved nutrient intake with RTEC consumption is consistent with other research and is likely due to the vitamin and mineral fortification of RTEC[21, 45].

Those consuming RTEC had the highest intake of four of the shortfall nutrients in children: calcium, magnesium, potassium, and fiber when compared with the other breakfast consumption groups. That milk is a rich source of calcium, magnesium, and potassium and is usually consumed with RTEC may also account for the increased nutrient intake observed. Our study showed that when milk added to RTEC consumed at breakfast was excluded from daily intakes, there were no differences in calcium or potassium intake among the breakfast consumption groups, whereas all other micronutrients that had been significantly increased in RTEC breakfast consumers remained increased after modeling the exclusion of milk. This suggests that consuming RTEC for breakfast may encourage dairy intake in AA adolescents, as it does in other populations[47]. This is important since AA adolescents did not meet the recommendations for dairy foods or calcium and intake of dairy foods and calcium is lower than in non-AA counterparts[16]. Real or perceived lactose maldigestion may be responsible for reduced dairy food consumption and calcium intake by AA populations; culturally determined food preferences and dietary practices learned early in life may also play a role[16]. Meeting the calcium requirements without adequate dairy foods in the diet is difficult and finding ways to increase dairy intake in AA adolescents is desirable.

Among AA adolescents, those who consumed RTEC at breakfast had a higher mean intake of fiber than breakfast skippers. Ready-to-eat cereals provide 7-13% of the daily recommended amounts of dietary fiber[107]. Fiber promotes a feeling of fullness, which is important in weight control; it may also help reduce risk of cardiovascular disease and type 2 diabetes mellitus. Since AAs are disproportionately affected by these health problems, it is important to help AA adolescents to improve diet early in life. Inclusion of RTEC into the diet is a convenient and inexpensive way to include fiber in the diet.

The percent of overweight AA adolescents (12 to 19 years of age) in the US is 21.1%[53]. This percentage is much higher than EA adolescents (13.5%) and a little lower than Mexican American adolescents (22.5%). RTEC consumers had a lower mean WC and lower mean BMI than breakfast skippers; however, no other differences in weight measures were seen. These results are supported by several previous cross-sectional studies that have shown a beneficial role of breakfast consumption on weight[18, 25] but are not supported by other literature that has shown that RTEC consumption is associated with lower weight[18]. One possible reason is that the classification of RTEC consumers was made on a single 24 hour recall and this may not reflect usual intake. The 2005 Dietary Guidelines committee suggested that other studies are needed to fully characterize the relationship between RTEC consumption and weight in adolescents.

Limitations

This study had several limitations. NHANES is a cross-sectional study, thus, causal inferences cannot be drawn. Participants relied on their memory to self-report dietary intakes and, therefore, data were subject to non-sampling errors, such as underreporting of energy and examiner effects. Further, 24-hour dietary recalls may not accurately reflect the usual dietary patterns of participants. Overall, however, with large samples, such as those used in NHANES, 24-hour recalls produce reasonably accurate group estimates of nutrient intake. Physical activity was not considered in the analyses of the weight measures; physical activity is an important contributor to weight status. RTEC breakfast consumers were considered as a homogeneous group; although the total and added sugars intakes of each participant may have varied according to the total and added sugars content of the specific RTEC reported in the 24-hour recall dietary interview, those who ate pre-sweetened RTEC at breakfast were not separated from breakfast consumers who ate non-sweetened RTEC at breakfast in this study. Analysis did not consider that RTEC consumed at other meals or as snacks may have made an additional positive contribution to nutrient intake and account for an association of body weight with any breakfast consumption group. Finally, foods other than RTEC and milk that were consumed by individuals in the RTEC breakfast group may have influenced nutrient intake.

Conclusions

In this study, improved nutrient intake was associated with RTEC consumption at breakfast. Lower BMI and WC were seen in AA adolescents consuming RTEC for breakfast when compared with those skipping breakfast, but not when compared with those consuming other breakfasts. Consuming a breakfast meal, especially a RTEC breakfast, should be encouraged in adolescents.

CHAPTER 5

SUMMARY

These two studies have shown the importance of breakfast, particularly RTEC as part of this meal. Weight status, nutrient adequacy, and dietary adequacy were improved in AA children and adolescents who consumed RTEC at breakfast. Consuming a breakfast meal, especially a RTEC breakfast, should be encouraged in children and adolescents.

African Americans 13-18 y were more likely to skip than children 1-12 y. In both studies, AA who skipped breakfast consumed less total energy than those who consumed RTEC or other foods at breakfast. However, mean BMI and WC were lower in those who consumed RTEC.

The majority of children in the US are not meeting nutrient recommendations[9]. In children and adolescents, overweight and failure to meet recommendations for essential vitamins and minerals needed for proper growth and development jeopardizes their health status[108-111]. If a group has a high prevalence of inadequate dietary intake of a nutrient, that nutrient is called a shortfall nutrient. Calcium and potassium were identified by the 2005 DGAC as two of the shortfall nutrients of particular concern in the diets of children 9 years of age or older; vitamin E, potassium, and fiber are shortfall nutrients regardless of age[13]. Adolescents that consumed RTEC had the highest mean intake of four of the shortfall nutrients in children: calcium, magnesium, potassium, and fiber when compared with the other breakfast consumption groups.

Skipping breakfast was associated with poor nutrient intake in AA children and adolescents. In both studies, breakfast skippers had lower intakes of most micronutrients when compared with RTEC breakfast consumers and other breakfast consumers. Further, children and adolescents who skipped breakfast did not appear to obtain these nutrients at other meals. In children and adolescents, breakfast consumption may be associated with healthier lifestyle factors that are beyond the scope of these two studies.

No differences in mean fiber intake among breakfast consumption groups in children were observed. However, among AA adolescents those who consumed RTEC at breakfast had a higher mean intake of fiber than breakfast skippers. Healthy People 2010 is a statement of national health objectives designed to identify the most significant preventable threats to health and to establish national goals to reduce these threats[54]. A goal of the Dietary Guidelines for Americans and one objective of Healthy People 2010 is to increase the proportion of persons 2 years of age and older who consume at least 6 daily servings of grain products, with at least half as whole grains[54]. National dietary survey data indicate that few are meeting this objective[54]. Ready-to-eat cereals were found to be a major food source of whole grains accounting for 30.9% of whole grain intake among those 2 to18 y[112]. Total grain intake is adequate for many, and intervention strategies could aim to aid children and adolescents in substituting non whole-grain foods with their whole grain counterpart[112]. African American children and adolescents could be encouraged to substitute whole-grain ready-to-eat cereals for whole-grain ready-to-eat cereals[112].

Both studies had similar limitations. Data from cross-sectional studies cannot be used to draw casual inferences. Further, 24-hour dietary recalls may not accurately reflect the usual dietary patterns of participants. Dietary intakes were self-reported and relied on memory of participants or their parent or guardian, and, therefore, data were subject to non-sampling errors, such as underreporting of energy and examiner effects[86, 96, 97, 99]. In children, self-reported portion size estimates may result in sizable errors in quantitative estimates of food and energy, but are appropriate for ranking children's relative intakes. Further, parents or guardians, who reported or assisted children with the recalls, may not have known the foods that children in daycare or school consumed the previous day. Overall, however, with large samples, such as those used in NHANES, 24-hour recalls produce reasonably accurate group estimates of nutrient intake[113]. Physical activity is an important contributor to weight status[62], but physical activity was not considered in analyses of weight measures. RTECs were grouped together; and although the majority are fortified, those consumed may have varied considerably in energy, carbohydrate, fiber, total and added sugars content[42]; whether RTEC were pre-sweetened was also not considered in this study. It was also not considered that RTEC consumed at other meals may make an additional positive contribution to nutrient intake and weight of all the breakfast consumption groups. Finally, foods other than RTEC and milk that were consumed by individuals in the RTEC breakfast group may have influenced nutrient intake. A study to determine the effects of other foods consumed with RTEC is necessary to determine contributions to nutrient intake.

There is a lack of peer review literature on the relationship of weight status, nutrient intake, and diet adequacy to breakfast and RTEC breakfast consumption in AA children and adolescents. The two articles presented here have contributed to the literature.

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APPENDIX

COPYRIGHT RELEASE

----- Original Message -----
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Subject: RE: Copyright Release
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-----Inline Message Follows-----
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Brandy M Williams, Carol E O'Neil, Debra R Keast, Susan Cho and Theresa A Nicklas
doi: 10.1017/S1368980008002760, Published online by Cambridge University Press 27 May 2008
Regards,

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