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Are breakfast consumption patterns associated with weight status and nutrient adequacy in African-American children?

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Abstract

Objective: The objective of the present study was to assess whether weight status, nutrient intake and dietary adequacy were associated with breakfast consumption patterns.

Design: A representative sample of the US population was used in a secondary analysis of nutrient intake/diet quality and weight status by breakfast consumption patterns.

Setting: The 1999–2002 National Health and Nutrition Examination Survey (NHANES).

Subjects: The study sample included African-American (AA) children aged 1–12 years (n 1389).

Results: Forty-five per cent of children aged 1–5 years and 38% of those aged 6–12 years consumed ready-to-eat cereal (RTEC) at breakfast; while 7·4% and 16·9% in those age groups skipped breakfast, respectively. The lowest mean BMI ($P \leq 0{\cdot}05$) and mean waist circumference ($P \leq 0{\cdot}05$) was found in children 1–12 years of age who consumed RTEC at breakfast compared with other consumption groups. RTEC breakfast consumers had the highest mean intakes of vitamins A, B_6 and B_{12}, thiamine, riboflavin, niacin, folate, Ca, Fe and Zn ($P \leq 0{\cdot}05$) and the highest Mean Adequacy Ratio ($P \leq 0{\cdot}05$). RTEC breakfast consumers also had the highest intake of carbohydrates and total sugars, and the lowest intakes of total fat ($P \leq 0{\cdot}05$).

Conclusions: Consuming RTEC at breakfast was associated with improved weight and nutrient adequacy in AA children. AA children in all breakfast categories still had mean intakes of most nutrients below recommended levels. 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.

Keywords
Breakfast
Ready-to-eat cereal
African-Americans
Children
Nutrient adequacy
Nutrient intake
Weight

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[1–4]. Over the 30-year period from 1971–1974 to 1999–2002, the prevalence of overweight increased approximately threefold (4% to 13%) among 6–11-year-old EA children but fivefold (4% to 20%) among AA children[2]. The prevalence of overweight in AA boys aged 6–11 years 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[5].

Overweight and obesity in childhood is associated with elevated blood pressure[6], dyslipidaemia[7], metabolic syndrome[8], type 2 diabetes mellitus[9] and reduced insulin sensitivity[10]. 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[11]. A longitudinal analysis showed that 84% of overweight AA girls and 82% of AA boys aged 5–14 years will be obese in early adulthood, compared with 65% and 71% of EA girls and boys, respectively[3]. Secular increases in childhood overweight are predicted to increase the burden of adult disease[2].

In addition to disparities in the prevalence of overweight, AA and EA children have dissimilar nutrient intakes[12,13]. AA males 1–10 years of age are more likely than EA males of the same age to have intakes of vitamin E,

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Ca and Zn two-thirds or less than the Recommended Dietary Allowance (RDA)[14], while AA girls are at risk for inadequate intakes of vitamins A and E, Ca, Fe and Zn[14]. Vitamin E, Ca, Mg, K and fibre have been identified as shortfall nutrients for all children by the 2005 Dietary Guidelines Advisory Committee (DGAC)[15].

Breakfast has been described as the most important meal of the day[16–20]. Compared with 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[16,21]. Skipping breakfast was associated with lower energy intakes, but higher BMI[19,22,23]. Skipping breakfast was also associated with infrequent exercise[24], suggesting that those who skipped breakfast had a less healthy lifestyle than those who did not. Compared with breakfast skippers, children who ate breakfast also had improved behaviour and school performance[17,25]. Although research has consistently shown that breakfast consumption improved diet quality and adequacy, it was the most commonly skipped meal[25,26].

In the USA, 92 % of ready-to-eat cereals (RTEC) are fortified with essential micronutrients[27] 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 Fe, folate, vitamin C and Zn, and with lower intakes of total fat and cholesterol[16,28–30]. Increased intakes of milk and Ca have also been observed in children who eat RTEC for breakfast[31]. Additionally, breakfasts that include RTEC have been associated with lower BMI[29,30]. Thus, RTEC breakfast may play a role in maintaining a healthy weight status and adequate nutrient intake in children[29,30].

The impact of breakfast consumption patterns on weight and dietary adequacy in AA children has been understudied. The aims of the present study were to determine the association between weight status, nutrient intake and dietary adequacy in AA children who skip breakfast, consume a breakfast that includes RTEC or consume a breakfast without RTEC.

Subjects and methods

Data collection

The National Health and Nutrition Examination Survey (NHANES) is a continuous programme 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[32]. 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 NHANES protocol manual[33].

A single, multiple-pass, 24 h dietary recall was conducted during the interview using computer-assisted software to record dietary intake data from participants[34]. 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[35]. Parents or caregivers reported dietary intakes for children less than 6 years of age, while subjects aged 6–11 years 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 to 2002 were used in a secondary analysis to compare weight measures and nutrient adequacy in AA children aged 1–12 years. Classification of race was self-reported and based on US census categories[36]. Children were categorized into one of three breakfast consumption groups: (i) breakfast skippers (those who did not eat breakfast or brunch); (ii) RTEC breakfast consumers (regardless of what else was consumed at the breakfast/brunch meal); and (iii) 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, the present study was exempted by the Institutional Review Boards of the Louisiana State University AgCenter and the Baylor College of Medicine.

Nutrient analysis

Nutrient analysis was accomplished using databases from the US Department of Agriculture (USDA) Agricultural Research Service (Beltsville, MD, USA). The USDA Food and Nutrient Database for Dietary Studies (FNDDS) version 1 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 available only in μg retinol equivalents, vitamin E intake data were available only in mg α-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 α-tocopherol (mg AT) and dietary folate equivalents (DFE), respectively[37,38]. We used the special database released by the USDA to determine vitamin A as mg RAE and vitamin E as mg AT (USDA Database of Vitamin A (mcg RAE) and Vitamin E (mg AT) for National Health and Nutrition Examination Survey 1999–2000). 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. 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 h recall after excluding any fluid milk other than soya 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 thirteen micronutrients: vitamins A, E, C, B_1, B_2, B_6 and B_{12}, niacin, folate, P, Mg, Fe and Zn[39,40]. A score of 90 and above was considered nutritionally adequate for MAR[39].

Statistical analyses

Sample-weighted data were used in all statistical analyses, and all analyses were performed using the SUDAAN software package release 9·0·1 (Research Triangle Institute, Research Triangle Park, NC, USA) to adjust the variance for the complex sample design. The sample-weighted percentages (and standard error 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 SAS [Statistical Analysis Software] Program for CDC Growth Charts (US Department of Health and Human Services, Hyattsville, MD, USA).

Sample-weighted LSMEANS and SE were estimated for micro- and macronutrients consumed. In comparing the three breakfast consumption groups, covariates were energy (kJ/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 *v.* RTEC breakfast consumers, breakfast skippers *v.* other breakfast consumers, RTEC breakfast consumers *v.* other breakfast consumers, the α value of $P \leq 0{\cdot}05$ 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[41].

Results

Percentage of African-American children in breakfast consumption groups by age and gender

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 6–12-year-old children who skipped breakfast. The percentage of children aged 1–5 years who consumed RTEC at breakfast was 45·0 %, compared with 38·0 % of children aged 6–12 years. 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.

Mean weight measures

AA children who consumed RTEC for breakfast had lower mean BMI ($P \leq 0{\cdot}05$) and waist circumference ($P \leq 0{\cdot}05$) than those who either skipped breakfast or consumed other types of breakfast (Table 2). There was a lower percentage of overweight children in the RTEC breakfast consumption group (13·1 %) compared with breakfast skippers (26·1 %), but there were no differences in the prevalence of overweight between the RTEC breakfast

Table 1 Percentages of US African-American children in breakfast consumption group by age and gender: National Health and Nutrition Examination Survey 1999–2002

		Breakfast skippers						RTEC breakfast						Other breakfast					
		Both genders		Males		Females		Both genders		Males		Females		Both genders		Males		Females	
Age (years)	*n*	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
1–5	521	7·4	1·7	8·0	2·4	6·6	1·8	45·0	3·0	46·2	4·1	43·9	3·3	47·6	3·4	45·8	4·6	49·5	3·5
6–12	868	16·9	1·0	14·4	1·2	19·4	1·7	38·0	1·9	40·5	2·4	35·4	2·3	45·2	1·8	45·1	2·3	45·3	2·9

RTEC, ready-to-eat cereal.

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Table 2 Weight measures in US African-American children by breakfast consumption group: National Health and Nutrition Examination Survey 1999–2002

	Breakfast skippers			RTEC breakfast			Other breakfast		
	n	Mean	SE	*n*	Mean	SE	*n*	Mean	SE
BMI (kg/m^2)									
2–12 years	180	19·8[a]	0·4	492	17·7[b]	0·2	565	18·5[c]	0·2
2–5 years	29	16·0	0·3	170	16·1	0·1	181	16·4	0·1
6–12 years	151	20·5[a]	0·4	322	18·5[b]	0·3	384	19·5[a,b]	0·2
Waist circumference (cm)									
1–12 years	179	65·5[a]	1·2	485	58·8[b]	0·6	560	61·2[c]	0·6
1–5 years	28	50·7	1·0	171	50·2	0·4	182	51·0	0·4
6–12 years	151	68·2[a]	1·1	324	63·0[b]	0·6	383	65·6[a]	0·7
Overweight (%)									
2–12 years	180	26·1[a]	2·9	492	13·1[b]	1·7	565	18·5[a,b]	1·5
2–5 years	29	12·3	3·7	170	7·1	2·3	181	10·2	2·1
6–12 years	151	28·8[a]	3·2	322	16·2[b]	2·1	384	22·1[a,b]	1·8
Percentile of weight-for-age									
2–12 years	180	68·0	3·1	493	63·9	1·5	566	67·2	1·1
2–5 years	29	55·7	5·7	171	61·3	1·7	182	63·0	1·9
6–12 years	151	70·4	3·0	322	65·2	2·1	384	69·1	1·2
Percentile of BMI-for-age									
2–12 years	180	65·4	3·2	492	59·7	1·7	565	63·6	1·3
2–5 years	29	48·5	6·1	170	55·1	2·7	181	57·9	1·9
6–12 years	151	68·7	3·1	322	62·1	1·9	384	66·1	1·4
Z score of BMI-for-age									
2–12 years	180	0·61	0·12	492	0·36	0·06	565	0·51	0·05
2–5 years	29	−0·02	0·23	170	0·20	0·10	181	0·28	0·07
6–12 years	151	0·73	0·11	322	0·44	0·07	384	0·61	0·06
Z score of weight-for-age									
2–12 years	180	0·75	0·12	493	0·51	0·06	566	0·68	0·04
2–5 years	29	0·24	0·21	171	0·42	0·07	182	0·51	0·06
6–12 years	151	0·85	0·12	322	0·56	0·08	384	0·76	0·05

RTEC, ready-to-eat cereal.
[a,b,c] Mean values within a row with unlike superscript letters were significantly different ($P \leq 0·05$); breakfast skippers *v.* RTEC breakfast consumers, breakfast skippers *v.* other breakfast consumers, RTEC breakfast consumers *v.* other breakfast consumers.

and the other breakfast consumption group. No differences in percentiles or *Z* scores of BMI-for-age or weight-for-age were observed between breakfast consumption groups in children.

Mean daily energy and micronutrient intakes

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 with 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 Fe ($P \leq 0·05$ for all). No differences were found in mean daily intakes of vitamin B_6, niacin, Ca and Zn between breakfast skippers and other breakfast consumers; however, RTEC breakfast consumers had higher intakes of these nutrients ($P \leq 0·05$) than the two other groups. RTEC breakfast consumers had a lower intake of vitamin E than breakfast skippers ($P \leq 0.05$). Comparisons of micronutrient intakes among breakfast consumption groups without milk on RTEC showed that Ca, P and K in RTEC breakfast consumers were lower than other breakfast consumers, but not significantly different from breakfast skippers (data not shown). AA children aged 1–12 years who ate RTEC at breakfast had a higher percentage MAR than breakfast skippers or those consuming other breakfasts ($P \leq 0·05$).

Protein, carbohydrate, fat, cholesterol and fibre intakes

Children who consumed RTEC for breakfast had the highest intakes from carbohydrate and total sugars and the lowest intake from total fat when compared with either breakfast skippers or other breakfast consumers ($P \leq 0·05$) (Table 4). RTEC breakfast consumers had lower SFA intake than breakfast skippers and lower cholesterol intake than other breakfast consumers ($P \leq 0·05$). Breakfast skippers and other breakfast consumers had higher intakes of MUFA and PUFA than RTEC breakfast consumers ($P \leq 0·05$). 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 SFA intake was lowest in RTEC breakfast consumers compared with both breakfast skippers and other breakfast consumers (data not shown). No differences were seen in total dietary fibre among breakfast consumption categories.

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Table 3 Mean daily intake of energy and selected nutrients in US African-American children 1–12 years of age by breakfast consumption with milk on ready-to-eat cereal (RTEC) eaten at the breakfast meal: National Health and Nutrition Examination Survey 1999–2002

	Breakfast skippers (*n* 188)		RTEC breakfast (*n* 560)		Other breakfast (*n* 641)	
Nutrient*	Mean	SE	Mean	SE	Mean	SE
Total energy (kJ)†	6958[a]	310	8034[b]	113	8122[b]	134
Total energy (kcal)†	1662[a]	74	1919[b]	27	1940[b]	32
MAR‡ (%)	84·3[a]	1·2	95·7[b]	0·2	93·2[c]	0·4
MAR‡ (%) w/o milk on RTEC eaten at breakfast meal	84·3[a]	1·2	94·3[b]	0·3	93·2[b]	0·4
Vitamin A (μg RAE)	357[a]	22	581[b]	18	443[c]	17
α-Tocopherol (mg)	6·1[a]	0·2	5·0[b]	0·2	5·4[b]	0·1
Vitamin C (mg)	95·9	5·9	105·7	4·0	99·3	3·9
Thiamin (mg)	1·19[a]	0·04	1·74[b]	0·03	1·36[c]	0·03
Riboflavin (mg)	1·49[a]	0·04	2·26[b]	0·04	1·71[c]	0·03
Niacin (mg)	16·8[a]	0·4	21·9[b]	0·4	17·2[a]	0·4
Vitamin B_6 (mg)	1·28[a]	0·03	1·91[b]	0·03	1·32[a]	0·02
Folate (μg DFE)	357[a]	15	675[b]	24	411[c]	11
Vitamin B_{12} (μg)	3·2[a]	0·1	4·9[b]	0·2	3·7[c]	0·1
Ca (mg)	719[a]	19	866[b]	17	741[a]	15
P (mg)	1002[a]	16	1084[b]	13	1076[b]	11
Mg (mg)	198[a,b]	4	205[a]	3	195[b]	2
Fe (mg)	11·0[a]	0·3	16·6[b]	0·3	12·6[c]	0·2
Zn (mg)	8·6[a]	0·3	11·4[b]	0·2	9·0[a]	0·2
Na (mg)	2930	74	3031	43	3129	35
K (mg)	2037	45	2111	29	2050	32
Vitamin K (μg)	57·6	12·0	50·8	4·7	66·4	10·5

MAR, Mean Adequacy Ratio; RAE, retinol activity equivalents; DFE, dietary folate equivalents.
[a,b,c] Mean values within a row with unlike superscript letters were significantly different ($P \leq 0{\cdot}05$); breakfast skippers *v.* RTEC breakfast consumers, breakfast skippers *v.* other breakfast consumers, RTEC breakfast consumers *v.* other breakfast consumers.
*Adjusted for age, gender and energy.
†Unadjusted.
‡MAR was the percentage of the Estimated Average Requirement for each of thirteen nutrients (vitamins A, E, C, B_1, B_2, B_6 and B_{12}, niacin, folate, P, Mg, Fe and Zn), but truncated at 100 % prior to averaging.

Discussion

Our data suggest that older children are more likely to skip breakfast. This finding is consistent with results from other studies[30,42]. Further research is needed to determine the reasons, but breakfast skipping may be partially attributable to environmental or behavioural changes that occur with increasing age, such as the changes in food choices available at school or changes in behaviour that are influenced by peers[26,42,43]. Investigation into why children aged 6–12 years skip breakfast more than those aged 1–5 years 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[24,44]. The lower mean BMI and waist circumference suggest that children who consume breakfast may have healthier lifestyles than those who skip breakfast. Under-reporting of energy intake may also have occurred in these children, since the BMI of the parent or child may affect reporting in a 24 h recall[45].

Children 1–12 years of age who skipped breakfast also had significantly lower intakes of most of the micronutrients 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 results with those conducted with other age and ethnic groups reveal similar findings[28,29,44,46]. In a representative sample of 4–12-year-old children, Albertson *et al.* found that the frequency of RTEC consumption over a 2-week period was positively correlated with micronutrient intake[29]. van den Boom *et al.* concluded that frequency of RTEC consumption was positively related to improved nutritional profiles in Spanish children[44]. Further, a representative sample of British children aged 4–18 years found that intakes of Fe and vitamins B and D were positively associated with daily percentage of energy obtained from RTEC[46]. 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[28]. Similarly, a study of AA children found that skipping breakfast resulted in substantial deficits in dietary intakes of nutrients[16]; more than a third of breakfast skippers consumed

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Table 4 Mean daily intake of protein, carbohydrate, fat, cholesterol and total dietary fibre in US African-American children 1–12 years of age by breakfast consumption group: National Health and Nutrition Examination Survey 1999–2002

	Breakfast skippers (*n* 188)		RTEC breakfast (*n* 560)		Other breakfast (*n* 641)	
Nutrient	Mean	SE	Mean	SE	Mean	SE
Protein* (g)	62·4[a,b]	1·2	61·9[a]	0·7	64·9[b]	0·9
Protein† (%)	13·2[a,b]	0·4	13·1[a]	0·2	13·8[b]	0·2
Carbohydrate* (g)	249[a]	3	266[b]	2	248[a]	2
Carbohydrate† (%)	53·2[a]	1·0	56·6[b]	0·4	52·7[a]	0·5
Total sugars* (g)	128·7[a]	3·2	139·7[b]	1·9	127·0[a]	3·0
Total sugars† (%)	28·0[a,b]	0·8	29·7[a]	0·3	27·3[b]	0·6
Added sugars* (g)	85·9[a,b]	3·5	89·6[a]	1·5	80·1[b]	2·5
Added sugars† (%)	18·2[a,b]	0·7	18·8[a]	0·3	16·8[b]	0·5
Total fat* (g)	74·7[a]	1·1	67·1[b]	0·9	73·5[a]	0·8
Total fat† (%)	34·8[a]	0·7	31·5[b]	0·4	34·5[a]	0·4
SFA* (g)	25·8[a]	0·4	24·2[b]	0·4	25·1[a,b]	0·3
SFA† (%)	11·9	0·3	11·4	0·2	11·8	0·1
MUFA* (g)	29·6[a]	0·6	25·4[b]	0·4	28·7[a]	0·4
MUFA† (%)	13·9[a]	0·3	11·9[b]	0·2	13·4[a]	0·2
PUFA* (g)	13·8[a]	0·5	12·2[b]	0·4	13·8[a]	0·3
PUFA† (%)	6·4[a]	0·2	5·7[b]	0·1	6·5[a]	0·1
Cholesterol* (mg)	186[a]	7	180[a]	4	267[b]	8
Total dietary fibre* (g)	11·4	0·4	11·3	0·2	11·1	0·3

RTEC, ready-to-eat cereal.
[a,b,c] Mean values within a row with unlike superscript letters were significantly different ($P \leq 0{\cdot}05$); breakfast skippers *v.* RTEC breakfast consumers, breakfast skippers *v.* other breakfast consumers, RTEC breakfast consumers *v.* other breakfast consumers.
*Least-square mean and standard error nutrient intakes were adjusted for age, gender and energy intake.
†Least-square mean and standard error percentage energy from nutrients were adjusted for age and gender only.

less than 50 % of the RDA for vitamins A, E, B_6 and folate, and nearly a quarter consumed less than 50 % of the RDA for energy, vitamin C, Ca and Fe[16].

Mean Ca intake was higher for RTEC breakfast consumers than for breakfast skippers and other breakfast consumers. Consumption of milk, which is high in Ca and K and is commonly consumed with cereal, may explain this finding as it is consistent with other research[31]. Ca and K were identified by the 2005 DGAC as two of the shortfall nutrients in the diets of children 9 years of age or older[15]. AA males aged 1–10 years were more likely than same-age EA males to have Ca intakes two-thirds or less than the RDA[14], while AA girls were at risk for inadequate intake of Ca[14]. Consumption of milk with RTEC could improve Ca intake in this group.

Although our study did not show differences in fibre intake among breakfast consumption groups, others have shown RTEC as a significant source of fibre for children[30,47,48]. Children in our study may have consumed low-fibre cereals, which would suggest the need to promote increased intake of RTEC with higher fibre content or the need to supplement RTEC with additional fibre[47].

The present 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 the participants or their parent or guardian; therefore data were subject to non-sampling errors, such as under-reporting of energy and examiner effects[36]. Parents or guardians who reported or assisted children with the recalls may not know all foods that children in day care or school consumed the previous day. Further, 24 h dietary recalls may not accurately reflect the usual dietary patterns of participants[49,50]; however, the collection of group data from 24 h recalls with mean reporting, as used by the NHANES, is an appropriate use of 24 h diet recalls[51]. Children's self-reported portion size estimates are appropriate for ranking children's relative intakes, but may result in sizeable errors in quantitative estimates of food and energy intakes[52].

Another limitation was that physical activity, an important contributor to weight status[53], was not used as a covariate since physical activity information was not collected using a standardized method across the age groups. Further, RTEC were grouped together and although the majority were fortified, those consumed may have varied considerably in energy, carbohydrate, fibre, total and added sugar content[27]; whether RTEC were pre-sweetened was also not considered in our 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 the present study, improved weight measures and nutrient adequacy were associated with eating RTEC for

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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.

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