Effects of Serving High-Sugar Cereals on Children's Breakfast-Eating Behavior

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KEY WORDS
obesity, children, food marketing, cereal, breakfast, nutrition

ABBREVIATION
RTE—ready-to-eat

www.pediatrics.org/cgi/doi/10.1542/peds.2010-0864

doi:10.1542/peds.2010-0864

Accepted for publication Sep 14, 2010

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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

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FINANCIAL DISCLOSURE: *The authors have indicated they have no financial relationships relevant to this article to disclose.*

WHAT'S KNOWN ON THIS SUBJECT: There are positive health benefits for children who consume ready-to-eat cereals for breakfast; however, cereal companies market their high-sugar products extensively to children, which causes concern that eating these products contributes to unhealthy levels of added sugar in children's diets.

WHAT THIS STUDY ADDS: Results demonstrate the potential negative effects of serving high-sugar cereal to children and how it affects their consumption of cereal, added sugar, and fruit during breakfast. In addition, they demonstrate that children like and will eat low-sugar cereals as an alternative.

abstract

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OBJECTIVES: To test (1) whether children will consume low-sugar ready-to-eat (RTE) cereals and (2) the effects of serving high- versus low-sugar cereals on the consumption of cereal, refined sugar, fresh fruit, and milk.

PARTICIPANTS AND METHODS: Using an experimental design, we randomly assigned children ($n = 91$) who were attending summer day camp to receive a breakfast that included either the choice of 1 of 3 high-sugar cereals (high-sugar condition) or low-sugar cereals (low-sugar condition), as well as low-fat milk, orange juice, bananas, strawberries, and sugar packets. Participants served themselves and completed a background questionnaire after eating. Researchers measured the amount and calories consumed of each food.

RESULTS: In both conditions, children reported "liking" or "loving" the cereal they chose. Children in the low-sugar cereal condition consumed, on average, slightly more than 1 serving of cereal (35 g), whereas children in the high-sugar condition consumed significantly more (61 g) and almost twice the amount of refined sugar in total (24.4 vs 12.5 g). Milk and total calories consumed did not differ significantly between conditions, but children in the low-sugar condition were more likely to put fruit on their cereal (54% vs 8%) and consumed a greater portion of total calories from fresh fruit (20% vs 13%).

CONCLUSIONS: Compared with serving low-sugar cereals, high-sugar cereals increase children's total sugar consumption and reduce the overall nutritional quality of their breakfast. Children will consume low-sugar cereals when offered, and they provide a superior breakfast option. *Pediatrics* 2011;127:71–76

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There is a consensus that children should eat breakfast every morning. Children who eat breakfast have healthier overall nutrition and lower BMI, and breakfast consumption may enhance academic achievement.[1–3] One common breakfast choice for children is ready-to-eat (RTE) cereal. Studies have consistently found that higher consumption of RTE cereals is associated with improved micronutrient intake, which supports the recommendation to promote RTE cereals to youth.[4,5] However, calories from added sugars exceed the total recommended discretionary calories for most people, which has led to increased attention to all sources of added sugar in children's diets, including highly sweetened cereals.[6,7] Breakfast cereals contribute 8% to 9% of added sweeteners in children's diets,[6] and cereals marketed directly to children contain significantly more added sugar than those marketed to adults and total 32% to 43% of cereal content by weight.[8,9] Children also may consume considerably more than the recommended 27- to 30-g serving for these cereals.[10]

Accordingly, some health professionals have suggested that parents not serve high-sugar children's cereals for breakfast and recommend only those low in sugar and sodium and high in fiber.[8,9] A debate has emerged in response.[11] Proponents of recommending all RTE cereals (ie, even those highly presweetened) make several important points. First, there is a critical need to promote breakfast to children, and a sugar-sweetened cereal is better than no breakfast at all.[12] This point is directly addressed in the *2005 Dietary Guidelines for Americans*,[13] which states that "sugars can improve the palatability of foods and beverages that otherwise might not be consumed." Second, RTE cereals are designed to be served as 1 component of a breakfast meal; therefore, they also promote the consumption of other encouraged foods, such as milk.[11,14] Finally, fortified RTE cereals provide important micronutrients for children, including iron, folic acid, vitamin D, and calcium.[2,11,12]

The aim of the present study was to compare children's consumption behavior during a breakfast meal when they are served high- versus low-sugar RTE cereals. We tested 3 hypotheses: (1) children will consume low-sugar cereals for breakfast when that is the only option provided; (2) children will consume more cereal and more sugar overall when served high-sugar cereals, even when they are allowed to add table sugar to their cereal; and (3) children are more likely to put fruit on low-sugar cereals, thus increasing the consumption of this encouraged food group.

PARTICIPANTS AND METHODS

Ninety-one children, aged 5 to 12 years, were recruited from 3 summer camps in a small, racially diverse New England city to participate in the study. Informed consent and all research procedures were approved by the Yale University Human Subjects Committee. Table 1 provides characteristics of study participants.

TABLE 1 Characteristics of 91 5- to 12-Year-Old Children

Characteristic	Value
Age, mean (SD), y	8.4 (2.0)
Male, %	52
Race/ethnicity, %	
White only	5
Black only	33
Hispanic only	39
Other/mixed	22
Spanish speaking, %	59
Consumed breakfast before arriving, %	39
Presence of television in bedroom, %	74
Eat plain cereal at home, %	81
Usually put sugar on plain cereal (of those who eat it)	62
Eat sugared cereal at home, %	96
Usually put sugar on sugared cereal (of those who eat it), %	28

Parents were asked to bring their children to camp to eat breakfast on the morning of the study. After all children arrived, researchers randomly assigned them to either the high-sugar or low-sugar cereal condition. The 2 types of breakfast were served in separate areas of the camp to minimize children's awareness of the other types of cereals served. Each place-setting contained an 8-oz carton of 1% low-fat milk (245 g), a small container of orange juice (182–197 g), and bowls of precut strawberries (140 g) and bananas (111 g). A bowl of sugar packets and additional orange juice and milk cartons were placed in the middle of each table.

The children were asked to eat breakfast as they usually would at home and to eat as much or as little as they liked. They also were told that they could not share food; however, they could help themselves to the items in the middle of the table and request more of any item. Researchers then asked the children to choose 1 of 3 cereal options and gave them their own cereal box (326 g) to pour. In the high-sugar condition ($n = 46$), the 3 cereals offered (Froot Loops [Kellogg's, Battle Creek, MI], Cocoa Pebbles [Post Foods, LLC, St Louis, MO], and Frosted Flakes [Kellogg's]) contained 11 or 12 g of sugar per serving. In the low-sugar condition ($n = 45$), the 3 cereal options (regular Cheerios [General Mills, Inc, Minneapolis, MN], Rice Krispies [Kellogg's], and Corn Flakes [Kellogg's]) contained 1 to 4 g of sugar per serving. Serving sizes, indicated by the manufacturer for each cereal, ranged from 28 to 33 g.

Children ate for 15 minutes and were notified 5 minutes before the end of the meal. Researchers observed and recorded the combination of food items chosen and consumed during the meal. After the children finished breakfast, researchers used a strainer to

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separate the cereal and milk remaining in the bowl and weighed all remaining food items separately. They recorded the amount consumed of each item, as well as the amount of cereal remaining in the box to assess how much cereal children poured into their bowls. All sugar poured from packets was recorded as consumed, because the remaining sugar could not be separated from other food items.

After breakfast, all children completed a questionnaire that assessed demographic variables (age, gender, and race/ethnicity), whether they had eaten breakfast before arriving at the study, and whether they liked the cereal they were served. Liking the cereal was assessed by using a smiley-face scale from 1 (loved it) to 5 (hated it), and an option to indicate "never heard of it" or "didn't eat it" was given. This scale has been used to assess taste preferences in previous research with both preschoolers and elementary school–aged children.[15,16] Researchers obtained answers verbally from the younger children who could not read. Those children with the ability to answer the survey independently also indicated availability of media in their bedrooms (television, VCR or DVD players, computer, or video game console), how much they liked all the cereals included in the study (using the smiley-face scale), and whether they typically put sugar on their cereals. Researchers then debriefed the children about the purpose of the study.

Sugar and calorie content were obtained from the nutrition-facts panels for cereals and the US Department of Agriculture National Nutrient Database for Standard References[17] for other breakfast items. The amount consumed of each breakfast item and the following additional variables were computed: (1) total refined sugar consumed from sugar packets and cereals combined (because none of the cereals contained fruit or other ingredients with sugar, all cereal sugar content was categorized as refined sugar); (2) cereal ingredients other than sugar content, calculated by subtracting the grams of sugar contained in the amount of cereal consumed from the total grams of cereal consumed; (3) total fresh fruit consumed from strawberries and bananas combined; (4) total calories consumed for each breakfast item; and (5) percentage of total calories consumed from each breakfast item, calculated by dividing calories for individual items consumed by total calories consumed, which enabled calorie comparisons after controlling for individual differences in total caloric consumption. Because the liking scale was reverse-coded, scale responses were inverted so that higher numbers indicated greater liking.

Five children were excluded from the final analyses: 1 participant became ill and could not complete the study, and researchers were unable to obtain accurate consumption data for 4 participants who spilled or mixed food items together.

Multivariate analyses of variance were used to assess differences according to condition for all consumption variables. Results of initial analyses indicated significant differences in consumption according to age; older children (aged 8–12 years) consumed larger portions of fresh fruit, cereal, and milk than younger children (aged 5–7 years) (all $P < .03$). Therefore, age group was included as a separate factor in all consumption analyses. By using t tests and χ^2 analyses, we assessed differences between conditions for individual child variables.

RESULTS

As predicted, children in both the high-sugar and low-sugar conditions consumed the cereals offered: all participants agreed to take and subsequently consumed 1 of either the low-sugar or high-sugar cereals. Participants in the 2 conditions did not report significant differences in how much they liked the cereal they consumed ($t_{87} = .37$; $P = .71$). Children indicated that they "liked" or "loved" both the high- and low-sugar cereals (mean: 4.5 of 5 in the low-sugar condition and 4.6 in the high-sugar condition). In addition to stating that they liked the cereal they consumed, children in the low-sugar condition consumed slightly more than 1 serving of cereal. In contrast, children in the high-sugar condition consumed ~2 servings of cereal, significantly more than children in the low-sugar condition ($F_{1,82} = 15.1$; $P < .001$). Table 2 lists consumption information according to condition and age group for all breakfast items.

Children in the low-sugar condition did add significantly more sugar to their cereal compared with children in the high-sugar condition ($F_{1,82} = 20.4$; $P < .001$). However, children consumed on average 5.7 tsp of refined sugar from the cereal alone in the high-sugar condition compared with 0.7 tsp of refined sugar from the low-sugar cereals. Including added table sugar, children who ate high-sugar cereals consumed almost twice as much refined sugar in total compared with children who ate low-sugar cereals ($F_{1,82} = 15.6$; $P < .001$). After subtracting the sugar content of the cereal consumed, the amount of other cereal content (ie, not sugar) consumed did not differ according to condition ($F_{1,82} = 2.3$; $P = .13$). Although children in the high-sugar condition consumed significantly more cereal overall, most of that difference consisted of added sugar (see Table 2 and Fig 1).

There was a main effect of cereal consumption according to age: older children consumed ~30% more cereal

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TABLE 2 Consumption of Individual Breakfast Items and Total Calories According to Condition and Age Group

Breakfast Item	Condition			Age Group			Interaction, *P*
	High-Sugar, Mean (SD)	Low-Sugar, Mean (SD)	Main Effect, *P*	5–7 y, Mean (SD)	8–12 y, Mean (SD)	Main Effect, *P*	
Cereal total, g	61.3 (39.1)	34.6 (24.3)	<.001	40.2 (30.4)	52.8 (37.1)	.03	.59
Sugar content	22.9 (14.4)	2.9 (2.6)	<.001	11.6 (12.1)	13.7 (15.7)	.05	.17
Other content	38.4 (24.7)	31.7 (22.4)	.13	28.6 (20.8)	39.1 (24.7)	.03	.89
Sugar from packets, g	1.4 (2.8)	9.6 (10.7)	<.001	4.9 (7.7)	5.9 (9.4)	.97	.70
Refined sugar total, g	24.4 (15.1)	12.5 (11.7)	<.001	16.5 (12.3)	19.6 (16.0)	.13	.42
Milk, g	160.4 (117.2)	160.9 (98.2)	.67	128.9 (82.3)	180.4 (117.0)	.03	.41
Fresh fruit, g	81.2 (54.5)	109.7 (78.2)	.13	66.2 (50.7)	113.7 (72.3)	<.01	.72
Orange juice, g	82.2 (92.4)	102.6 (105.6)	.19	78.6 (113.7)	100.9 (89.1)	.42	.05
Total calories consumed	384 (197)	345 (159)	.21	294 (155)	408 (181)	<.01	.62

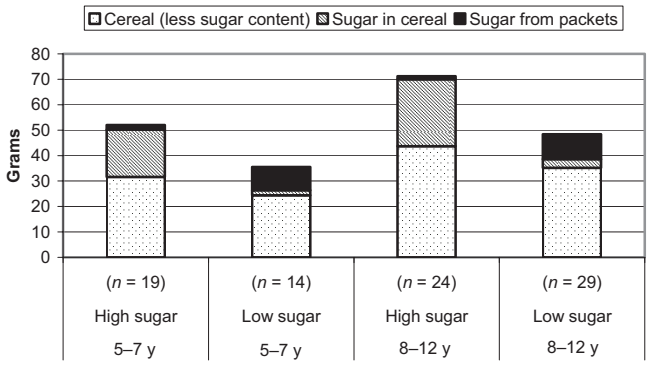

FIGURE 1
Grams consumed of cereal, sugar within the cereal, and table sugar according to age group and condition.

in total than did younger children ($F_{1,82} = 5.0$; $P = .03$). Additional sugar poured from packets did not differ according to age, and there were no significant interactions between age and condition.

Effects on Consumption of Other Breakfast Foods

Children in both conditions ate their cereal in the context of a breakfast meal that included milk, bananas, strawberries, and orange juice. Serving high-sugar cereals affected consumption of some other breakfast items but not all of them. Milk consumption did not differ between the 2 conditions; children drank, on average, two-thirds of a cup of milk in both conditions. Children in the low-sugar condition were significantly more likely to put fresh fruit on their cereal (54%) compared with children in the high-sugar condition (8%) (χ^2_1 [$n = 81$] $= 20.2$; $P < .001$). Children tended to consume more fresh fruit in total in the low-sugar condition; however, the difference did not reach conventional significance ($F_{1,82} = 2.35$; $P = .13$). There was no difference according to condition in orange juice consumption, but there was an interaction between age and condition ($F_{1,82} = 4.1$; $P = .05$). Younger children in the low-sugar condition consumed more orange juice compared with younger children in the high-sugar condition, but older children consumed similar amounts in both conditions.

Older children consumed 39% more calories in total than did younger children ($F_{1,82} = 9.7$; $P < .01$), but total calories consumed did not differ by condition ($F_{1,82} = 1.6$; $P = .210$). However, the composition of these calories (ie, calories consumed for individual breakfast items divided by total calories consumed) differed significantly according to condition (see Fig 2). Approximately one-quarter of all calories in the high-sugar condition consisted of refined sugar, 94 calories on average, compared with only 14% of calories in the low-sugar condition ($F_{1,82} =$

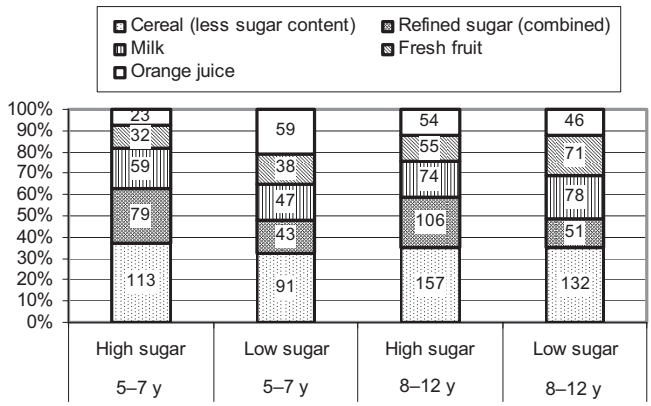

FIGURE 2
Calories consumed and the percentage of total calories for each breakfast component according to each age group and condition.

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18.6; $P < .001$). In addition, 18% to 20% of calories in the low-sugar condition consisted of fresh fruit, significantly more than the 12% to 13% of calories from fresh fruit in the high-sugar condition ($F_{1,82} = 5.1$; $P = .03$). There were no significant differences according to condition in the percentage of calories from milk (19% on average), orange juice (13%), or cereal (33% excluding calories from sugar), or differences according to age group (all $P > .33$).

Additional Findings

Most children reported familiarity with all cereals in the study (86% had heard of Corn Flakes, and 95% had heard of Frosted Flakes). When asked how much they liked the 6 cereals in the study, children indicated that they liked the 3 high-sugar cereals significantly more on average (mean: 4.2) than the low-sugar cereals (mean: 2.7) ($t_{65} = 9.5$; $P < .001$); however, as discussed earlier, children reported liking the cereal that they chose equally in both conditions. Confirming the random assignment, there were no significant differences according to condition for children who had consumed breakfast before arriving, gender, age, race, or ethnicity; presence of media in the bedroom; or children who usually eat plain or sugared cereals (all $P > .20$).

DISCUSSION

With this experimental study we examined how the level of added sugar in an RTE cereal affected children's consumption of cereal as well as other foods and beverages served at the meal. The results indicate that high-sugar cereals likely promote larger portion sizes, because children ate ~1 serving of low-sugar cereal and 2 servings of high-sugar cereals. The findings also support the position that children will eat and like the cereals that are served, even if they are low in sugar. Children do report liking the taste of high-sugar cereals more; however, when given the choice of 3 different low-sugar cereals, 90% of children found a cereal that they liked or loved. In addition, the children consumed a full serving of low-sugar cereal as specified on the cereals' nutrition-facts panel.

The usefulness of adding table sugar to increase the palatability of a low-sugar cereal was tested, and the findings suggest that children will add sugar to a low-sugar cereal. However, with no limits on the amount of sugar they could add, children did not add more sugar to the low-sugar cereals than was already contained within the high-sugar cereals. In addition, these numbers overstate actual sugar consumption in the low-sugar condition, because we assumed that all sugar poured from packets was consumed. Therefore, the results support the hypothesis that children will consume more refined sugar when served high-sugar cereals, even when they are allowed to add sugar to low-sugar cereals. This result suggests that a parent who is concerned that a child will not eat enough of a low-sugar cereal in the morning could provide a small amount of table sugar (eg, 1 tsp) as well as fresh fruit for the child to add to the cereal. This strategy would be preferable to purchasing a presweetened high-sugar cereal that typically contains 2½ or 3 teaspoons of sugar per serving. It would also provide parents with an opportunity to teach their children healthy strategies for increasing the appeal of low-sugar foods. Future research is needed to test whether children will eat as much low-sugar cereal if they are not permitted to add table sugar or if the amount of sugar they can add is limited.

The findings also demonstrate that serving low-sugar cereals can increase the overall nutritional quality of children's breakfasts. Although children consumed a similar number of total calories in both conditions, children in the low-sugar condition consumed more of their calories in the form of fresh fruit, whereas added sugar comprised a higher proportion of calories in the high-sugar condition. As a result, the overall nutritional quality of the low-sugar cereal meal was superior. Future work is needed to test whether the same pattern of caloric consumption would be observed if the orange juice option were removed and only fresh fruit, milk, and water were available. It is possible that the lower satiety associated with juice compared with whole fruit contributed to greater caloric consumption for the younger children.

The higher volume of high-sugar cereal consumed did contribute additional vitamins and minerals contained in the cereal; however, they came at the expense of higher sugar and lower fruit intake. In addition, children in the low-sugar condition consumed ~1 serving of cereal; therefore, they also received the micronutrients contained in 1 serving of RTE cereal. It is interesting to note that greater cereal consumption in the high-sugar condition did not lead to greater consumption of milk. Although we cannot determine how much of the milk children consumed with their cereal versus drinking directly from the container, it seems likely that children in the low-sugar condition poured less milk on their cereal but drank more directly from the container. Therefore, consuming more cereal cannot be assumed to increase milk consumption during a meal, and these data suggest that a serving of milk can be obtained as easily from eating 1 serving of cereal as 2.

These results likely underestimate the long-term consequences of regularly feeding high-sugar cereals to children. Children's taste preferences develop

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over time through continued experiences with different foods.[18] When children regularly consume a food with added sugar, they learn to prefer sweeter versions of that food compared with children who regularly consume a plain version of the same food. As a result, regularly feeding high-sugar cereals to children may increase their preferences and consumption of sweeter cereals over time and potentially increase their preferences for highly sweetened foods overall.

The study does have some limitations. The experimental design demonstrates a potential direct causal effect of serving high-sugar cereals on breakfast nutrition; however, we examined consumption during 1 meal on 1 day and included a limited number of food options. As with any controlled experiment, the results may not generalize to a broader context. Additional research is needed to determine if children make similar choices in their own home with a potentially wider range of food choices, and whether these consumption patterns continue in the long-term. In addition, the study sample consisted primarily of black and Hispanic children from lower socioeconomic status neighborhoods. Additional research is needed to examine whether these results are moderated by individual child characteristics not measured in this study, including BMI, socioeconomic status, and habitual sugar consumption.

CONCLUSIONS

The American Heart Association recommends that people of all ages reduce their intake of added sugars.[7] Because of the prevalent marketing of high-sugar cereals to children, many parents feel that they are faced with a choice between purchasing high-sugar children's cereal versus having their child eat no breakfast at all. Our results suggest that children will eat low-sugar varieties, and parents can make these options more appealing by adding a small amount of table sugar and/or fresh fruit to the bowl. This strategy could help reduce the amount of added sugar in children's diets while also promoting a balanced first meal of the day.

ACKNOWLEDGMENTS

This study was supported by grants from the Robert Wood Johnson Foundation and the Rudd Foundation to Yale University.

We thank our colleagues at the Rudd Center for their assistance in data collection.

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Pediatrics; originally published online December 13, 2010;
DOI: 10.1542/peds.2010-0864

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