American Journal of
Preventive Medicine

RESEARCH ARTICLE

Exposure to Child-Directed TV Advertising and Preschoolers' Intake of Advertised Cereals

Jennifer A. Emond, PhD,[1,2,3,4] Meghan R. Longacre, PhD,[1,3,4,5] Keith M. Drake, PhD,[5,6] Linda J. Titus, PhD,[2,3,4,5] Kristy Hendricks, RD,[4] Todd MacKenzie, PhD,[1,5] Jennifer L. Harris, PhD,[7] Jennifer E. Carroll, MPH,[1] Lauren P. Cleveland, MS, MPH,[8] Gail Langeloh, MS,[1] Madeline A. Dalton, PhD[1,3,4,5]

Introduction: Child-directed TV advertising is believed to influence children's diets, yet prospective studies in naturalistic settings are absent. This study examined if child-directed TV advertisement exposure for ten brands of high-sugar breakfast cereals was associated with children's intake of those brands prospectively.

Methods: Observational study of 624 preschool-age children and their parents conducted in New Hampshire, 2014–2015. Over 1 year, parents completed a baseline and six online follow-up surveys, one every 8 weeks. Children's exposure to high-sugar breakfast cereal TV advertisements was based on the network-specific TV programs children watched in the 7 days prior to each follow-up assessment, and parents reported children's intake of each advertised high-sugar breakfast cereal brand during that same 7-day period. Data were analyzed in 2017–2018.

Results: In the fully adjusted Poisson regression model accounting for repeated measures and brand-specific effects, children with high-sugar breakfast cereal advertisement exposure in the past 7 days (i.e., recent exposure; RR=1.34, 95% CI=1.04, 1.72), at any assessment in the past (RR=1.23, 95% CI=1.06, 1.42), or recent and past exposure (RR=1.37, 95% CI=1.15, 1.63) combined had an increased risk of brand-specific high-sugar breakfast cereal intake. Absolute risk difference of children's high-sugar breakfast cereal intake because of high-sugar breakfast cereal TV advertisement exposure varied by brand.

Conclusions: This naturalistic study demonstrates that child-directed high-sugar breakfast cereal TV advertising was prospectively associated with brand-specific high-sugar breakfast cereal intake among preschoolers. Findings indicate that child-directed advertising influences begin earlier and last longer than previously demonstrated, highlighting limitations of current industry guidelines regarding the marketing of high-sugar foods to children under age 6 years.

Am J Prev Med 2018;000(000):1–9.

From the [1]Department of Biomedical Data Sciences, Geisel School of Medicine, Dartmouth College, Hanover, New Hampshire; [2]Department of Epidemiology, Geisel School of Medicine, Dartmouth College, Hanover, New Hampshire; [3]Norris Cotton Cancer Center, Geisel School of Medicine, Dartmouth College, Hanover, New Hampshire; [4]Department of Pediatrics, Geisel School of Medicine, Dartmouth College, Hanover, New Hampshire; [5]The Dartmouth Institute for Health Policy and Clinical Practice, Geisel School of Medicine, Dartmouth College, Hanover, New Hampshire; [6]Greylock McKinnon Associates, Cambridge, Massachusetts; [7]Rudd Center for Food Policy and Obesity, University of Connecticut, Storrs, Connecticut; and [8]Division of Chronic Disease Research Across the Lifecourse, Department of Population Medicine, Harvard Pilgrim Health Care Institute, Harvard School of Medicine, Boston, Massachusetts

Address correspondence to: Jennifer A. Emond, PhD, Department of Biomedical Data Science, Geisel School of Medicine at Dartmouth, Hinman Box 7920, One Medical Center Drive, Lebanon NH 03756. E-mail: jennifer.a.emond@dartmouth.edu.

0749-3797/$36.00
https://doi.org/10.1016/j.amepre.2018.09.015

INTRODUCTION

Ready-to-eat, high-sugar breakfast cereals (SBCs) are heavily advertised on children's TV.[1–3] More than $102 million is spent annually marketing SBCs to children on TV.[1] Despite manufacturers' claims that the nutritional quality of foods advertised to children on TV is high,[4] the most frequently advertised SBCs exceed recommended sugar limits and thus fail to meet accepted nutrient standards.[2,3]

Child-directed TV advertisements are designed to attract children's attention with animation, brand mascots, licensed media characters, and themes of fun.[5–8] Preschoolers are especially vulnerable because they cannot recognize the persuasive intent of advertising.[9,10] Importantly, young children's requests influence parental purchases,[1,11] and manufacturers craft child-directed TV food advertisements to promote child pestering for the advertised products.[1] Experimental studies demonstrate that food advertising exposure affects children's food preferences and requests.[1] TV food advertisement exposure also cues immediate consumption of food,[12,13] and cross-sectional studies indicate significant associations between children's advertisement exposure and intake of advertised foods.[14] However, little is known about the prospective influence of food advertising on preschoolers' dietary intake in natural settings.

This study examines preschool-age children's exposure to TV advertisements for specific SBC brands and intake of those brands prospectively over 1 year. Study results may have implications for current policies governing the marketing of high-sugar foods to preschool-aged children.

METHODS

Study Sample

Participants were recruited (March 2014–October 2015) from community-based sites in two cities in New Hampshire, U.S., including pediatric outpatient clinics, federal assistance clinics, child care centers, and community and recreational events. Facebook and participant referrals were also used for recruitment.

Eligibility criteria included children aged 3–5 years, no condition significantly impacting food intake, and living with parent ≥3 days/week or every other week; parent literacy (English); and residence ≤1 hour drive from recruitment site and no plan to relocate within 12 months. If parents had multiple age-eligible children, the child at the recruitment site was selected; if two or more children were present, one was randomly selected.[14] Parents who completed all study components received $150 in gift cards; children received two toys. Parents provided signed informed consent. The Dartmouth College Committee for the Protection of Human Subjects approved the study.

Among the 667 parent–child dyads screened for eligibility, 93.6% (n=624) enrolled. Enrolled parents completed a baseline and six follow-up surveys accessible online every 8 weeks. The final follow-up survey was completed, on average, 46.6 (SD=2.8) weeks after baseline. Surveys were pre-tested with a demographically comparable sample for comprehension, face validity, and completion time.

Measures

Ten child-directed SBC brands were included: Cinnamon Toast Crunch, Cocoa Pebbles, Cocoa Puffs, Froot Loops, Frosted Flakes, Fruity Pebbles, Honey-Nut Cheerios, Lucky Charms, Reese's Puffs, and Trix. These brands were top-ranked in terms of child-directed advertising, with a sugar content of 9–12 g of added sugar per ≅1-ounce (28.3-g) serving.[2,15] By contrast, the Interagency Working Group, a group of four U.S. government agencies charged with examining food marketed to children, recommended <8 g of sugar per 30-g serving for child-directed cereals.[16] At baseline, parents indicated cereals their children usually ate from a list of 30 brands that included these ten SBCs. At each follow-up survey, parents reported their children's recent intake for each of the ten SBCs (zero, one, two, three, four, five or more times in the past 7 days). The primary outcome was any versus no intake in the past 7 days; frequency of intake was the secondary outcome.

At each follow-up, parents indicated first the networks that their children watched in the past 7 days from 11 national children's networks, six of which were advertisement-supported: Boomerang, Cartoon Network, Disney XD, Discovery Family Channel (previously The Hub), Nickelodeon, and NickToons. Parents then indicated the programs their children watched on each selected network in the past 7 days using a network-specific list of currently aired programs. Network-specific program lists were updated prior to each survey using TV listings from Zap2it.[17] SBC advertisements aired during those programs were identified using a database from Kantar Media.[18] SBC advertisements were limited to those placed in children's programming aired between 6:00AM and 10:59PM during the 7 days prior to each follow-up assessment. Thus, recent SBC advertisement exposure and SBC intake cover the same 7-day period.

For the baseline visit, parents indicated which TV networks their children usually watched from the same list of 11 national children's networks; shows were not included. Children were considered to have had exposure to SBC advertisements at baseline if the networks they usually watched aired SBC advertisements during the 2 weeks prior to the baseline survey. For 17% of children, 2 weeks after the baseline survey was used because pre-baseline advertisement data were unavailable.

Parents reported their children's usual TV (regular, cable, satellite) viewing and other screen time (DVDs/VHS, streaming, apps, Internet use, electronic games) at baseline as the number of days/week and hours/day spent on each activity; responses were multiplied to compute hours/week.[14,19] Past 7-day TV viewing time was also collected at follow-up surveys; missing data were imputed using the method of last observation carried forward.[20] Additional covariates collected at screening or baseline included child date of birth (to compute age), sex, race/ethnicity, and participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC); and for parents: parent age, education level, employment status, living with spouse/partner, and annual household income.

Statistical Analysis

Baseline characteristics were summarized overall. Mixed effects Poisson regression with a random intercept at the child level, to account for the repeated measures, and robust SEs were used to compute unadjusted RRs between baseline characteristics and SBC intake prospectively. Chi-square tests were used to compare any SBC intake by SBC advertisement exposure at each follow-up survey.

The primary analysis compared exposure to advertisements for each SBC brand and intake of that brand prospectively. An econometric modeling method[21] was used in preliminary analyses to examine the relationship between cumulative advertisement exposure, accounting for a diminishing effect over time, and SBC intake. Results did not support a dose–response relationship. However, there was a consistent, elevated risk of intake for any level of advertisement exposure compared with no exposure. Thus, advertisement exposure for each brand was operationalized as no exposure, recent exposure only, past exposure only, or recent and past exposure combined to assess short- and long-term advertising effects separately. Recent exposure reflected exposure in the 7 days prior to each assessment, and past exposure reflected exposure at any other previous assessment including baseline. Mixed effects Poisson regression was also used to compute the RR of brand-specific SBC intake by brand-specific advertisement exposure; crossed random effects at the child and brand levels were included to account for the repeated measures and effects nested within brand. The fully adjusted model included covariates selected a priori (i.e., child's age, sex, race/ethnicity, WIC participation, TV and other screen time, and usual intake of each SBC brand at baseline), and parent education, which was associated with SBC intake in unadjusted and adjusted models. To demonstrate that the effect of brand-specific advertisement exposure was evident regardless of baseline SBC intake, the model was repeated separately for children who did and did not consume any of the advertised SBCs at baseline. Adjusted Poisson regression was also used to compare children's brand-specific advertisement exposure to brand-specific frequency of intake (i.e., a count) in the past 7 days.

To visually illustrate brand-specific effects, adjusted RRs for brand-specific intake were plotted by brand-specific advertisement exposure for each of the ten brands. To enable a simple interpretation of those effects, advertisement exposure was operationalized as one composite measure of any recent and past exposure to advertisements for each SBC brand (yes/no).

As a sensitivity check of the brand-specific findings, children's exposure to any SBC advertisements was compared to any intake of SBCs in a non–brand-specific, pooled analysis. SBC advertisement exposure was also modeled on recent (i.e., past 7-day) intake of Dunkin' Donuts, a brand that does not directly advertise to children, to assess the specificity of results. Parent report for child intake of Dunkin' Donuts was comparable to that for SBC intake, responses were similarly dichotomized, and a repeated measures Poisson regression model was used. Analyses were completed with the R Language for Statistical Computing, version 3.4.2. Data were analyzed in 2017–2018.

RESULTS

Mean age of children was 4.3 (SD=0.8) years, 44.7% were male, and 85.3% were white, non-Hispanic. Nearly all (98.4%) participants enrolled at baseline completed one of the six follow-up surveys; 579 (92.8%) completed the final survey. At baseline, 60.4% of children consumed at least one of the ten advertised SBCs. In unadjusted Poisson models (Table 1), any SBC intake over the study was more likely among racial/ethnic minorities and children attending child care/school, and intake was positively associated with children's TV and non-TV screen time, usual viewing of an advertisement-supported children's TV network, and usual intake of any advertised SBC at baseline. Any SBC intake was also inversely associated with parent education and annual household income.

At any follow-up, ≅20% of children were exposed to SBC advertisements and between 43.7% and 47.3% of children consumed at least one advertised SBC (Table 2). Of those who consumed an SBC, half (51.2%) ate an SBC once in the past 7 days. SBC intake was significantly greater among children who were exposed to advertisements compared with those who were not (all $p \leq 0.01$) at each follow-up assessment (Table 2). When averaging advertisement exposure across all ten brands, 57.8% of children had no advertising exposure, 2.3% had recent only, 26.9% had past only, and 13.0% had recent and past exposure combined at the final survey.

In brand-specific regression models (Table 3), any intake of an SBC was positively associated with advertisement exposure for that brand. In the unadjusted model (Table 3; Model 1), recent exposure to SBC advertisements without past advertisement exposure was associated with a 38% increased risk of brand-specific intake, and past advertisement exposure without recent exposure was associated with a 43% increased risk of intake; the risk was greatest for children with both recent and past exposure combined (RR=1.67, 95% CI=1.39, 2.01). Effects remained statistically significant after adjustment for child and parent characteristics (Table 3; Model 2) and when further adjustment was made for children's usual intake of SBC brands at baseline (Table 3; Model 3). Brand-specific advertisement effects were significant among children who did (n=377) or did not (n=247) consume at least one advertised SBC at baseline; for example, adjusted RRs for recent and past advertisement exposure combined were 1.20 (95% CI=1.01, 1.43, p=0.04) among consumers of any SBCs at baseline (after adjusting for baseline brand-specific SBC intake) and 1.77 (95% CI=1.11, 2.82, p=0.02) among nonconsumers of SBCs at baseline.

When modeling brand-specific SBC intake frequency (i.e., count) as the outcome (Appendix Table 1), the fully adjusted incident rate ratios were >1.0 for the advertisement exposure categories of recent only, past only, and recent and past exposure combined; however, only

Table 1. Sample Characteristics and Associations With Children's SBC Intake Over the Study Period[a]

Characteristics	*n* (%)	SBC intake,[b] RR (95% CI)[c]
Child		
Age, years, M (SD), *n*=624	4.3 (0.8)	1.03 (0.95, 1.13)
Age, years		
3	248 (39.7)	ref
4	237 (38.0)	0.95 (0.80, 1.11)
5	139 (22.3)	1.09 (0.91, 1.30)
Male	279 (44.7)	1.12 (0.97, 1.29)
Racial or ethnic minority	92 (14.7)	**1.23 (1.03, 1.48)***
WIC participation	77 (12.3)	1.15 (0.96, 1.39)
In any child care or school	505 (80.9)	**1.23 (1.01, 1.49)***
Screen time, hours per week, M (SD), *n*=624		
TV (regular, cable, or satellite)	8.2 (7.7)	**1.01 (1.00, 1.02)***
Other screen time	10.1 (12.2)	**1.01 (1.00, 1.01)***
Usually watches an advertisement-supported children's network[d]	188 (30.1)	**1.43 (1.24, 1.64)****
Usual intake of an advertised SBC brand at baseline	377 (60.4)	**3.04 (2.56, 3.61)****
Parent		
Relationship to child		
Mother	578 (92.6)	ref
Father	34 (5.4)	1.00 (0.74, 1.35)
Other	12 (1.9)	1.30 (0.90, 1.88)
Age, years		
20–29	129 (20.7)	ref
30–39	396 (63.5)	**0.77 (0.66, 0.90)***
40–49	92 (14.7)	**0.65 (0.50, 0.84)****
≥50	7 (1.1)	1.23 (0.84, 1.79)
Educational attainment		
High school or less	151 (24.2)	ref
Associate's or technical degree	113 (18.1)	0.88 (0.73, 1.06)
Bachelor's degree	199 (31.9)	0.71 (0.60, 0.84)**
Graduate degree	161 (25.8)	0.64 (0.52, 0.78)**
Employment status		
Not employed	193 (30.9)	ref
Employed part-time	126 (20.2)	0.97 (0.78, 1.21)
Employed full-time	305 (48.9)	**1.20 (1.02, 1.41)***
Lives with spouse or partner	529 (84.8)	**0.82 (0.69, 0.97)***
Annual household income		
≤$25,000	80 (12.8)	Ref
$25,001–$75,000	210 (33.7)	0.82 (0.68, 0.99)
$75,001–$125,000	225 (36.1)	**0.67 (0.55, 0.82)****
>$125,000	109 (17.5)	**0.66 (0.52, 0.85)****

Note: Boldface indicates statistical significance (*$p<0.05$; **$p<0.01$).
[a]Among 624 children enrolled in a prospective study.
[b]SBC intake defined as any intake in the 7 days prior to each follow-up assessment.
[c]Relative risks (RRs) were computed with Poisson models with a random intercept for child; time was the only covariate included. Robust SEs were computed. All SBC brands were pooled together. RRs presented reflect the average increased risk of SBC intake over the course of the study.
[d]Advertisement-supported children's networks include Boomerang, Discovery Family Channel, Disney XD, Nickelodeon, Nicktoons, and Cartoon Network.
SBC, high-sugar breakfast cereal; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

recent and past advertisement exposure combined was associated with a significantly greater mean intake of SBCs (incident rate ratio=1.21, 95% CI=1.03, 1.43).

When considering any (recent and past) versus no advertisement exposure (Figure 1), any brand-specific SBC advertisement exposure was associated with a 39%

Table 2. SBC Advertisement Exposure and SBC Intake at Each Follow-up Assessment[a]

Follow-up assessment	*n*	Exposure to SBC ads,[b] %	SBC intake[b] (%)			*p*-value[c]
			Overall	Among children with SBC ad exposure	Among children without SBC ad exposure	
1	588	17.2	43.7	55.5	41.3	**0.01**
2	572	19.2	45.3	61.8	41.3	**<0.001**
3	571	18.2	44.8	62.5	40.9	**<0.001**
4	566	18.9	47.0	69.2	41.8	**<0.001**
5	560	19.6	47.3	62.7	43.6	**<0.001**
6	579	26.1	46.8	63.6	40.9	**<0.001**

Note: Boldface indicates statistical significance ($p<0.05$).
[a]Among 624 children enrolled in a prospective study.
[b]Advertisement exposure and SBC intake refers to exposure or intake in the 7 days prior to each follow-up assessment.
[c]*P*-values from χ^2 tests.
SBC, high-sugar breakfast cereal.

increased risk of brand-specific SBC intake (RR=1.39, 95% CI=1.13, 1.70). Increased risks were evident for seven brands when considered separately. The excess absolute risk of SBC intake varied by brand based on differences in RRs and intake among unexposed children. For example, on average, 7.2% of children who were not exposed to Cinnamon Toast Crunch advertisements consumed this SBC brand during the study, compared with 11.4% of children exposed to Cinnamon Toast Crunch advertisements (7.2% intake among unexposed * RR of 1.59=11.4%), for an excess risk of 4.2% (11.4% −7.2%=4.2%).

In the sensitivity analysis pooling all brands of SBC together, there were positive associations between recent only and past only advertisement exposure on the risk of any SBC intake, although only the category of recent and past advertisement exposure combined (RR=1.28, 95% CI=1.10, 1.48) met the threshold for statistical significance. In the specificity analyses, children's SBC advertisement exposure was not associated with Dunkin' Donuts intake.

DISCUSSION

In this observational study of 624 preschool-age children, exposure to child-directed TV advertisements for specific SBC brands was associated with the intake of those brands prospectively over 1 year, independent of sociodemographic and child characteristics. Children with the most sustained advertise-

Table 3. Associations Between Exposure to Advertisements for Specific SBC Brands and Children's Intake of Those SBC Brands[a]

Independent variable	Outcome: Any recent SBC intake (yes versus no)[b]		
	Model 1 Unadjusted, RR (95% CI)	Model 2 Adjusted for covariates, RR (95% CI)	Model 3 Adjusted for covariates and baseline SBC intake, RR (95% CI)
SBC advertisement exposure, brand-specific			
No exposure	1.0 (ref)	1.0 (ref)	1.0 (ref)
Recent (i.e., past 7-day) exposure only	**1.38 (1.07, 1.77)***	**1.32 (1.03, 1.70)***	**1.34 (1.04, 1.72)***
Past exposure only[c]	**1.43 (1.23, 1.67)****	**1.31 (1.12, 1.53)****	**1.23 (1.06, 1.42)***
Recent (i.e., past 7-day) and past exposure	**1.67 (1.39, 2.01)****	**1.52 (1.26, 1.83)****	**1.37 (1.15, 1.63)****
Usual intake of SBC brand at baseline	—	—	**4.32 (3.92, 4.77)****

Note: Boldface indicates statistical significance (*$p<0.05$; **$p<0.001$).
[a]Among 624 children enrolled in a prospective study.
[b]SBC intake measured over the past 7 days. Each Poisson model included crossed random effects for child and SBC brand to account for the repeated measures and effects nested within brand, respectively. Each model was adjusted for time (i.e., follow-up assessment, continuous) and included both advertising exposures listed in the table. Model 2 is further adjusted for child age, sex, race/ethnicity, and WIC recipient status; parent education; children's other screen time (hours per week) at baseline and TV time (hours per week) at each study survey. Model 3 includes those same covariates plus usual intake of each advertised SBC brand at baseline.
[c]Past advertisement exposure based on any exposure at a previous follow-up assessment including baseline.
RR, relative risk; SBC, sweetened, high-sugar breakfast cereal; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children.

ment exposure (i.e., recent [within the past week] and past [prior to the past week] combined) were at the greatest risk of any intake and also had a greater mean frequency of intake of advertised SBCs. Findings support the framework[22] that child-directed advertising, and in particular child-directed advertising for SBCs, has both a short-term and longer-term effect on children's dietary intake, and support that these associations are likely brand specific. This study further documents that the effects of advertising exposure on children's intake of advertised products starts younger than previously demonstrated.

Laboratory-based studies[12,13,22,23] have demonstrated that food advertising exposure shapes children's immediate food preferences and requests[22] and cues immediate eating in children as young as age 3–5 years.[12,13] The current study extends those findings and prior cross-sectional work[14] by demonstrating a prospective advertising effect on diet in a population-based study of preschool-age children. A previous longitudinal ecologic

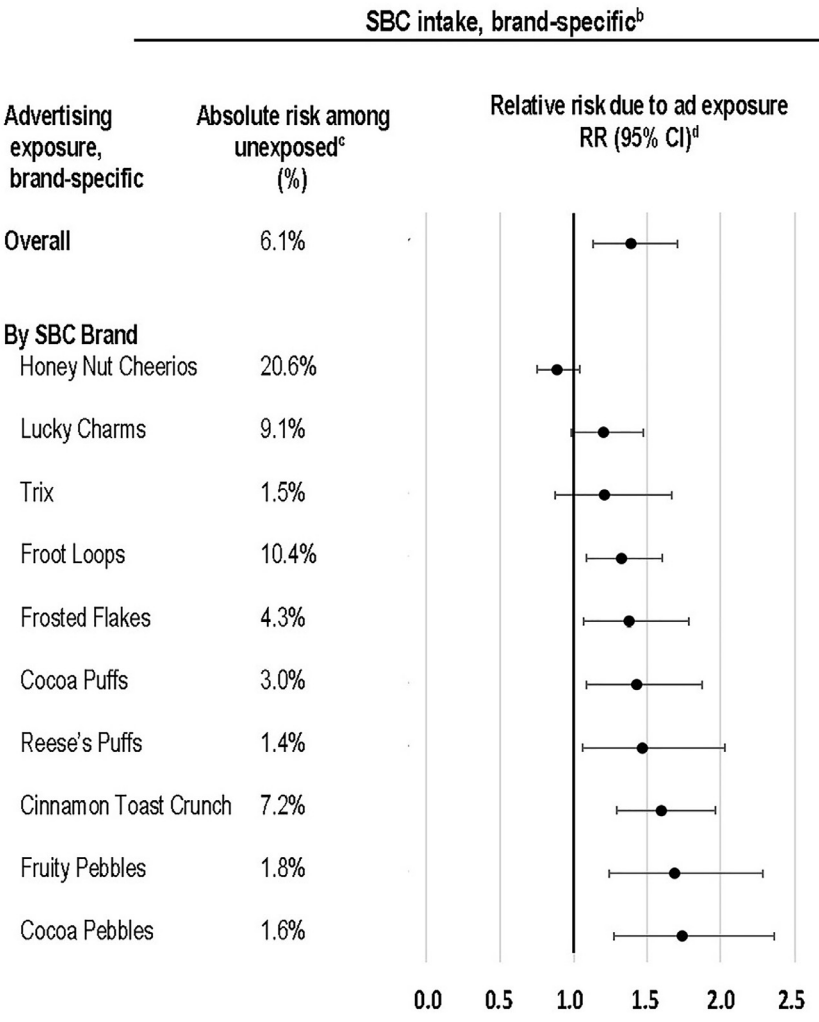

Figure 1. Adjusted associations between SBC advertising exposure and SBC intake by brand.[a]

[a]Among 624 children enrolled in a prospective study.

[b]The outcome was recent (i.e., within the past 7 days) intake of each advertised SBC brand.

[c]Percentage of children with recent (i.e., in the past 7 days) SBC intake by brand among children with no exposure to advertisements for that SBC brand. Percentages are marginal probabilities from the adjusted regression model.

[d]RR (95% CI): Risk ratios with 95% CIs. RRs estimated from a single Poisson model with crossed random effects at the child and SBC brand level to account for the repeated measures and effects nested within brand, respectively. SBC advertisement was exposure operationalized as any recent or past exposure combined (yes versus no). The model was adjusted for time (i.e., follow-up assessment, continuous), baseline intake of each SBC brand, child age, sex, race/ethnicity, and WIC recipient status; parent education; children's other screen time (hours per week) at baseline, and TV time (hours per week) at each follow-up assessment.

SBC, high-sugar breakfast cereal.

study[24] documented prospective associations between soft drink and fast-food TV advertisement exposure and a greater intake of those products over 3 years among fifth-graders; however, advertisement exposure was not measured at the individual level. Thus, the current study provides the strongest evidence to date of an advertising influence on intake in a naturalistic setting.

Preschool-aged children do not purchase foods on their own, but instead influence parent purchases with requests,[11] and manufacturers are aware of such "pester power."[1] Thus, although not examined in the current study, it is likely that children's requests mediated the association between children's SBC advertisement exposure and SBC intake. Study findings are particularly novel as they indicate that advertisement exposure may have long-term effects on children's requests and brand preferences as measured over this 1-year follow-up. Because child-directed advertisements are crafted to capture preschoolers' attention,[5–8] perhaps only a brief exposure is needed to raise children's awareness of an advertised SBC brand, and in turn, increase future cued-recall and requests for that brand. It is possible that once purchased, children may develop a preference for the brand, leading to repeated purchases. The observed association between past advertisement exposure and intake might also be an artifact because of continued access to an SBC in the home after an initial purchase. Although the underlying mechanisms need examination, findings clearly show that advertising exposure shapes preschoolers' dietary intake prospectively.

In this study, intake of an advertised SBC at baseline was the strongest predictor of children's SBC intake during follow-up. Baseline intake may reflect past advertisement exposure or another household member's cereal preference. However, the effects of advertisement exposure on intake was independent of usual SBC intake at baseline, further emphasizing the potential effectiveness of advertisement exposure in shaping children's diets independent of household routines. For example, advertisement exposure related to an increased risk of SBC intake by study end among nonconsumers of SBCs at baseline, as well as continued intake of advertised SBCs among baseline consumers. When considering brand-specific effects, significant, positive effects for seven of the ten SBC brands were evident when analyzed separately. There are likely several factors (e.g., advertisement content,[7] parental perception of product) that contribute to the observed variations in brand-specific effects. Additional studies are needed to better understand such effect modification, as well as potential cross-branding advertising effects.

Child-directed food marketing in the U.S. is self-regulated through the Children's Food and Beverage Advertising Initiative (CFBAI).[25,26] SBC manufacturers included in this study participate in the CFBAI, and all ten SBC brands met CFBAI uniform nutritional criteria[27,28] as foods appropriate for child-directed (i.e., age less than 12 years) advertising. Yet the SBCs included in this study contained 9–12 g of sugar per serving or 31%–41% sugar by weight[15] and thus are considered nutritionally poor according to the Nutritional Profiling Index.[15] By contrast, WIC-eligible cereals must have 6 g or less of sugar/ounce.[29] U.S. preschoolers exceed recommended intakes of added sugar,[30] and SBC consumption is related to greater intakes of added sugars.[31,32] High added sugar intake contributes added calories, and is associated with dental caries[33] and risk factors for poor cardiovascular health.[30,34,35] The CFBAI should adopt stricter criteria regarding the added sugar content for cereals marketed to children, such as the current WIC criteria, to help reduce children's added sugar intake.

Findings also highlight gaps in current voluntary pledges from SBC manufacturers related to marketing food to preschoolers in the U.S.[25,36] Specifically, in spite of company pledges to not direct any advertising to children under the age of 6 years,[37] defined as when 35% or more of the audience is under the age of 6 years,[4,28] preschool-aged children in this study were nevertheless exposed to SBC advertisements from these manufacturers on popular children's TV networks. Current criteria are thus insufficient to guarantee that children under the age of 6 years are not exposed to TV advertisements for SBCs.

Limitations

Strengths of this study include the prospective design in a natural setting, repeated measures, brand-specific advertisement exposure defined by TV programs viewed by children, a socioeconomically diverse sample, and a high survey completion rate. Analyses only considered child-directed TV advertising and did not include advertisement exposure on general audience networks; on other media (e.g., online); exposure to promotional tie-ins; or point-of-purchase exposure.[2] The combined effects of all SBC marketing could have an even greater impact on children's SBC intake. Most of the TV advertisements for SBCs are targeted to children.[7,38] However, parents' exposure to SBC advertisements was not collected, and it is unclear to what extent that may have confounded study findings. Finally, the sample was primarily non-Hispanic white with lower than average rates of TV viewing.[39] Black children are disproportionally exposed to food advertising because of higher TV viewing[40,41]; thus, TV advertisement effects may be even greater in more diverse samples.

CONCLUSIONS

This study extends previous research by documenting significant, prospective effects of brand-specific SBC TV advertisement exposure on children's SBC intake in a natural setting. Findings provide support for the recommendations of WHO[42] and others to restrict child-directed marketing of high-sugar foods, and indicate that stronger restrictions are needed to limit exposure to advertisements for SBCs specifically among children under the age of 6 years.

ACKNOWLEDGMENTS

This study was supported by NIH, grant number R01HD071021.

NIH had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.

Drs. Longacre, Titus, Hendricks, MacKenzie, and Dalton contributed to the conception and design of the study. Drs. Longacre, Titus, Hendricks, Carroll, Cleveland, Langeloh, and Dalton acquired the data. Drs. Emond, Drake, and MacKenzie analyzed the data, and all authors made a substantial contribution to the interpretation of data analyses. Drs. Emond and Longacre wrote the article, and Drs. Drake, Titus, Hendricks, MacKenzie, and Dalton revised for important intellectual content. All authors read and approved the final version of the submitted manuscript.

No financial disclosures were reported by the authors of this paper.

SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at https://doi.org/10.1016/j.amepre.2018.09.015.

REFERENCES

1. Botha S, Fentonmiller K, Jennings C, et al. *A Review of Food Marketing to Children and Adolescents.* Washington, DC: Federal Trade Commission, 2012:356.
2. Harris JL, Schwartz MB, Brownell KD, et al. *Cereal FACTS 2012: limited progress in the nutritional quality and marketing of children's cereals.* Yale Rudd Center for Food Policy & Obesity. www.cerealfacts.org/media/Cereal_FACTS_Report_2012_7.12.pdf. Published June 2012. Accessed August 12, 2014.
3. Powell LM, Schermbeck RM, Chaloupka FJ. Nutritional content of food and beverage products in television advertisements seen on children's programming. *Child Obes.* 2013;9(6):524–531. https://doi.org/10.1089/chi.2013.0072.
4. Better Business Bureau. *Food companies remain committed to advertising healthier foods to children.* The Children's Food and Beverage Advertising Initiative (CFBAI). www.bbb.org/council/news-events/news-releases/2016/12/food-companies-remain-committed-to-advertising-healthier-foods-to-children/. Published December 12, 2016. Accessed November 28, 2017.
5. Kraak VI, Story M. An accountability evaluation for the industry's responsible use of brand mascots and licensed media characters to market a healthy diet to American children. *Obes Rev.* 2015;16(6):433–453. https://doi.org/10.1111/obr.12279.
6. Kraak VI, Story M. Influence of food companies' brand mascots and entertainment companies' cartoon media characters on children's diet and health: a systematic review and research needs. *Obes Rev.* 2015;16(2):107–126. https://doi.org/10.1111/obr.12237.
7. Emond JA, Smith ME, Mathur SJ, Sargent JD, Gilbert-Diamond D. Children's food and beverage promotion on television to parents. *Pediatrics.* 2015;136(6):1095–1102. https://doi.org/10.1542/peds.2015-2853.
8. Connor SM. Food-related advertising on preschool television: building brand recognition in young viewers. *Pediatrics.* 2006;118(4):1478–1485. https://doi.org/10.1542/peds.2005-2837.
9. Graff S, Kunkel D, Mermin SE. Government can regulate food advertising to children because cognitive research shows that it is inherently misleading. *Health Aff (Millwood).* 2012;31(2):392–398. https://doi.org/10.1377/hlthaff.2011.0609.
10. Calvert SL. Children as consumers: advertising and marketing. *Future Child.* 2008;18(1):205–234.
11. Henry HKM, Borzekowski DLG. The Nag Factor. A mixed-methodology study in the U.S. of young children's requests for advertised products. *J Child Media.* 2011;5(3):298–317. https://doi.org/10.1080/17482798.2011.584380.
12. Boyland EJ, Nolan S, Kelly B, et al. Advertising as a cue to consume: a systematic review and meta-analysis of the effects of acute exposure to unhealthy food and nonalcoholic beverage advertising on intake in children and adults. *Am J Clin Nutr.* 2016;103(2):519–533. https://doi.org/10.3945/ajcn.115.120022.
13. Emond JA, Lansigan RK, Ramanujam A, Gilbert-Diamond D. Randomized exposure to food advertisements and eating in the absence of hunger among preschoolers. *Pediatrics.* 2016;138(6):e20162361. https://doi.org/10.1542/peds.2016-2361.
14. Longacre MR, Drake KM, Titus LJ, et al. Child-targeted TV advertising and preschoolers' consumption of high-sugar breakfast cereals. *Appetite.* 2017;108:295–302. https://doi.org/10.1016/j.appet.2016.10.014.
15. Harris JL, Schwartz MB, Brownell KD, et al. *Cereal FACTS 2012: Cereal Nutrition Scores.* Yale Rudd Center for Food Policy & Obesity. www.cerealfacts.org/cereal_nutrition_scores.aspx. Published June 2012. Accessed November 5, 2017.
16. Interagency Working Group on Food Marketed to Children. Preliminary proposed nutrition principles to guide industry self-regulatory efforts. Request for comments. www.ftc.gov/sites/default/files/documents/public_events/food-marketed-children-forum-interagency-working-group-proposal/110428foodmarketproposedguide.pdf. Accessed August 4, 2018.
17. zap2it. TV listing. http://tvlistings.zap2it.com. Accessed November 5, 2017.
18. Kantar Media. Advertising, monitoring & evaluation. www.kantarmedia.com/us/our-data/measurement. Accessed November 5, 2017.
19. Dalton MA, Longacre MR, Drake KM, et al. Child-targeted fast-food television advertising exposure is linked with fast-food intake among pre-school children. *Public Health Nutr.* 2017;20(9):1548–1556. https://doi.org/10.1017/S1368980017000520.
20. Molenberghs G, Kenward MG. *Missing Data in Clinical Studies.* Hoboken, NJ: Wiley; 2007. https://doi.org/10.1002/9780470510445.
21. Broadbent S. One way TV advertisements work. *J Market Res Soc.* 1979;21(3):139–166.
22. Institute of Medicine. *Food Marketing to Children and Youth: Threat or Opportunity?* Washington, DC: National Academies Press; 2006. https://doi.org/10.17226/11514.
23. WHO Regional Office for Europe. Marketing of foods high in fat, saltand sugar to children: update 2012-2013. www.euro.who.int/en/publications/abstracts/marketing-of-foods-high-in-fat,-salt-and-sugar-tochildren-update-20122013. Published 2013. Accessed December 7, 2015.

24. Andreyeva T, Kelly IR, Harris JL. Exposure to food advertising on television: associations with children's fast food and soft drink consumption and obesity. *Econ Hum Biol.* 2011;9(3):221–233. https://doi.org/10.1016/j.ehb.2011.02.004.
25. Harris JL, Frazier W, Romo-Palafox M, et al. *FACTS 2017. Food industry self-regulation after 10 years: progress and opportunities to improve food advertising to children*. UConn Rudd Center for Food Policy & Obesity. www.uconnruddcenter.org/files/Pdfs/FACTS-2017_Final.pdf. Published November 2017. Accessed January 4, 2018.
26. The Better Business Bureau. Children's Food & Beverage Advertising Initiative (CFBAI). www.bbb.org/council/the-national-partner-program/national-advertising-review-services/childrens-food-and-beverage-advertising-initiative/. Accessed December 17, 2017.
27. The Children's Food and Beverage Advertising Initiative. White paper on CFBAI's uniform nutrition criteria. www.bbb.org/us/storage/0/Shared%20Documents/White%20Paper%20on%20CFBAI%20Uniform%20Nutrition%20Criteria%20July%202011.pdf. Published July 2011. Accessed May 1, 2015.
28. Children's Food and Beverage Advertising Initiative. Council of Better Business Bureaus. Foods and beverages that meet the CFBAI category-specific uniform nutrition criteria that may be in child directed advertising. www.bbb.org/globalassets/shared/media/cfbai/cfbai-product-list-jan-2015.pdf. Published January 2015. Accessed April 26, 2015.
29. U.S. Department of Agriculture. Food and Nutrition Service. WIC Food Packages—Regulatory Requirements for WIC-Eligible Foods. www.fns.usda.gov/wic/wic-food-packages-regulatory-requirements-wic-eligible-foods#BREAKFASTCEREAL. Accessed December 12, 2017.
30. Vos MB, Kaar JL, Welsh JA, et al. Added sugars and cardiovascular disease risk in children: a scientific statement from the American Heart Association. *Circulation.* 2017;135(19):e1017–e1034. https://doi.org/10.1161/CIR.0000000000000439.
31. Priebe MG, McMonagle JR. Effects of ready-to-eat-cereals on key nutritional and health outcomes: a systematic review. *PLoS One.* 2016;11(10):e0164931. https://doi.org/10.1371/journal.pone.0164931.
32. Fayet-Moore F, McConnell A, Tuck K, Petocz P. Breakfast and breakfast cereal choice and its impact on nutrient and sugar intakes and anthropometric measures among a nationally representative sample of Australian children and adolescents. *Nutrients.* 2017;9(10):1045. https://doi.org/10.3390/nu9101045.
33. Touger-Decker R, van Loveren C. Sugars and dental caries. *Am J Clin Nutr.* 2003;78(4):881S–892S. https://doi.org/10.1093/ajcn/78.4.881S.
34. Johnson RK, Appel LJ, Brands M, et al. Dietary sugars intake and cardiovascular health: a scientific statement from the American Heart Association. *Circulation.* 2009;120(11):1011–1020. https://doi.org/10.1161/CIRCULATIONAHA.109.192627.
35. Kell KP, Cardel MI, Bohan Brown MM, Fernandez JR. Added sugars in the diet are positively associated with diastolic blood pressure and triglycerides in children. *Am J Clin Nutr.* 2014;100(1):46–52. https://doi.org/10.3945/ajcn.113.076505.
36. Harris JL, Sarda V, Schwartz MB, Brownell KD. Redefining "child-directed advertising" to reduce unhealthy television food advertising. *Am J Prev Med.* 2013;44(4):358–364. https://doi.org/10.1016/j.amepre.2012.11.039.
37. The Better Business Bureau. The Children's Food and Beverage Advertising Initiative (CFBAI). Participant pledges. https://bbbprograms.org/programs/CFBAI/cfbai-pledges. Accessed September 17, 2018.
38. The Yale Rudd Center for Food Policy and Obesity. Cereal FACTS 2012: limited progress in the nutrition quality and marketing of children's cereals. Cereal Facts. www.cerealfacts.org/media/Cereal_-FACTS_Report_2012_7.12.pdf. Accessed June 29, 2018.
39. The Nielsen Company. The Nielsen Total Audience Report. Q1 2017. www.nielsen.com/content/dam/corporate/us/en/reports-downloads/2017-reports/total-audience-report-q1-2017.pdf. Accessed September 26, 2017.
40. Fleming-Milici F, Harris JL. Television food advertising viewed by preschoolers, children and adolescents: contributors to differences in exposure for black and white youth in the United States. *Pediatr Obes.* 2018;13(2):103–110. https://doi.org/10.1111/ijpo.12203.
41. Grier SA, Kumanyika SK. The context for choice: health implications of targeted food and beverage marketing to African Americans. *Am J Public Health.* 2008;98(9):1616–1629. https://doi.org/10.2105/AJPH.2007.115626.
42. WHO. Global strategy on diet, physical activity and health. Marketingof foods and non-alcoholic beverages to children. www.who.int/dietphysicalactivity/marketing-food-to-children/en/. Published 2010. Accessed September 2015.