

Child-targeted fast-food television advertising exposure is linked with fast-food intake among pre-school children

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Abstract

Objective: To determine whether exposure to child-targeted fast-food (FF) television (TV) advertising is associated with children's FF intake in a non-experimental setting.

Design: Cross-sectional survey conducted April–December 2013. Parents reported their pre-school child's TV viewing time, channels watched and past-week FF consumption. Responses were combined with a list of FF commercials (ads) aired on children's TV channels during the same period to calculate children's exposure to child-targeted TV ads for the following chain FF restaurants: McDonald's, Subway and Wendy's (MSW).

Setting: Paediatric and Women, Infants, and Children (WIC) clinics in New Hampshire, USA.

Subjects: Parents (*n* 548) with a child of pre-school age.

Results: Children's mean age was 4.4 years; 43.2% ate MSW in the past week. Among the 40.8% exposed to MSW ads, 23.3% had low, 34.2% moderate and 42.5% high exposure. McDonald's accounted for over 70% of children's MSW ad exposure and consumption. Children's MSW consumption was significantly associated with their ad exposure, but not overall TV viewing time. After adjusting for demographics, socio-economic status and other screen time, moderate MSW ad exposure was associated with a 31% (95% CI 1.12, 1.53) increase and high MSW ad exposure with a 26% (95% CI 1.13, 1.41) increase in the likelihood of consuming MSW in the past week. Further adjustment for parent FF consumption did not change the findings substantially.

Conclusions: Exposure to child-targeted FF TV advertising is positively associated with FF consumption among children of pre-school age, highlighting the vulnerability of young children to persuasive advertising and supporting recommendations to limit child-directed FF marketing.

Keywords
Fast-food advertising
Television
Children
Fast-food consumption

Over one in five US children of pre-school age is overweight or obese^(1,2). Although obesity determinants are multiple and complex, widespread marketing and consumption of energy-dense, nutrient-poor foods contribute substantially to the obesity epidemic^(3,4). Fast-food (FF) restaurants account for the greatest food advertising exposure among children aged 2–11 years^(5–9). In 2009, the FF industry spent \$US 583 million on child-directed marketing⁽⁹⁾. Children's consumption of FF is associated with increased intakes of total energy, fat and sugar,

making FF consumption an important risk factor for obesity^(3,10,11).

Television (TV) is the predominant medium through which young children are exposed to FF advertising^(8,9,12). Of the top ten FF restaurants (also known as quick-service restaurants in the food industry because of their fast food preparation and lack of table service), data obtained from Kantar Media indicated that three advertised on children's TV channels in 2013: McDonald's, Subway and Wendy's. A recent study showed that McDonald's accounted for 70%

of televised FF commercials (ads) aimed at young children, far exceeding Subway and Wendy's advertising⁽¹³⁾. McDonald's also surpasses Subway and Wendy's in terms of sales. In 2013, McDonald's US sales revenue topped \$US 35 billion, compared with approximately \$US 12.7 billion for Subway and \$US 8.6 billion for Wendy's⁽¹⁴⁾.

Young children do not have the cognitive ability to understand or recognize the persuasive intent of advertising and thus may be highly susceptible to food industry marketing tactics^(15–19). Experimental studies demonstrate that food marketing directly influences young children's food and taste preferences^(20–24), their requests to purchase advertised foods⁽²⁵⁾ and their short-term consumption of advertised foods^(26–29). Many studies have demonstrated an association between TV viewing and adiposity or less healthy dietary choices among children^(28,30–34). In these studies, TV viewing time is often used as a proxy measure for exposure to food advertising, presumably because of the difficulty of assessing children's exposure to TV advertising outside a laboratory setting⁽³⁵⁾. However, this type of approach makes it difficult to isolate the effects of food advertising from other risk factors associated with TV viewing, such as snacking. In a longitudinal study, Zimmerman and Bell found that commercial TV viewing by children under 6 years of age predicted higher BMI, whereas non-commercial TV viewing did not⁽³⁶⁾. Additionally, a study of 4- to 12-year-old children in the Netherlands found TV advertising exposure was positively associated with consumption of advertised food brands among low-income children⁽³⁷⁾. Despite extensive research documenting the content of TV food advertising in the USA^(7,9,38–40) and high levels of concern about children's exposure to this advertising, there is a surprising lack of empirical data examining the impact of food advertising on children's dietary intake in non-experimental, real-world settings⁽⁴¹⁾.

In the present analysis, we used data from a larger study of electronic media use and diet in children of pre-school age to determine whether exposure to child-targeted FF TV advertising is associated with young children's FF intake.

Methods

Study design

Between April 2013 and March 2014, trained research assistants were stationed in the waiting rooms of paediatric outpatient and Women, Infants, and Children (WIC) clinics located in Manchester and Nashua, New Hampshire, USA. Research assistants recruited participants by inviting parents to complete a survey about 'children's media use and food choices'. Surveys were pre-tested with a demographically comparable sample for comprehension, face validity and completion time. Eligibility for study participation included children's age (3–5 years) and parents' ability to complete a written survey in English or Spanish. If parents had multiple age-eligible children, we selected the child present for an

appointment. Computer-generated random number lists were used to randomly recruit one child when multiple age-eligible siblings were present for an appointment. Parents received a \$US 10 gift card and children received a toy for participating.

Of the 1349 parents approached, 516 were not eligible, 241 declined and 592 enrolled. The primary reason for not participating was insufficient time (44% of refusals). For the present analysis, we included data from 548 parents who completed the 136-item survey between April and December 2013, which corresponded to our advertising data time period. The analysis focused on three FF restaurants – McDonald's, Subway and Wendy's (MSW) – that met the following criteria: ranked in the top ten quick-service restaurants based on annual sales⁽¹⁴⁾; at least one outlet located in each recruitment area; and advertised on children's TV channels during the last three quarters of 2013.

Measures

Fast-food consumption

Consistent with measures used in prior population-based studies^(42–44), we asked parents: 'In the past 7 days, did your child have something to eat or drink from (McDonald's; Subway; Wendy's)?' (responses: yes/no/don't know for each). For MSW consumption, responses were combined into a dichotomous outcome indicating whether a child had eaten at any of the three FF restaurants during the past 7 d. We also examined children's consumption of McDonald's food and beverages separately, using parent responses to this question, because of its prominence in sales and child-targeted advertising.

Fast-food television advertising exposure

Children's exposure to child-targeted MSW TV ads was based on parental report of children's viewing time and channels watched. First, we asked: 'On average, how many days a week does your child do the following activities: watch TV (regular, cable or satellite)? (0, 1–2, 3–4, 5–6, 7 days)'. We then asked: 'On days when your child does the following activities, about how much time does your child spend: watching TV (regular, cable or satellite)? (0 to 6+ hours with 30 minute segments)'. For channels, we asked: 'In the past 7 d, has your child watched any of the following TV channels? (Boomerang; Cartoon Network; The Disney Channel; Disney Junior; Disney XD; The Hub (now called Discovery Family); Nickelodeon; Nick Jr.; Nicktoons; PBS Kids; Sprout)'. For each child, we calculated weekly TV viewing time by multiplying the number of days per week by the number of hours per day the child watched TV. We then estimated each child's weekly exposure to specific TV channels by dividing weekly viewing time by the number of children's channels the child watched in the past 7 d. This exposure measure was based on previously validated measures developed to examine children's exposure to tobacco use in electronic media^(45–47).

Lists of child-targeted FF advertising by channel for April–December 2013 were obtained from Kantar Media™, a company that tracks TV ads on an hourly basis. For each day, we calculated channel-specific averages of the number of MSW or McDonald's ads aired per hour between 06.00 and 23.00 hours or during child programming. For example, we did not include ads aired during Nick-at-Nite, which begins as early as 20.00 hours and shares channel space with Nickelodeon, because its programming is aimed at older audiences. We then multiplied each child's channel-specific weekly exposure time by the average number of MSW or McDonald's ads aired per hour on that channel during the 7 d prior to each survey. The resulting advertising exposure scores approximate the mean number of child-targeted MSW or McDonald's ads each child was exposed to during the week prior to the survey. Based on the distribution of the data, we categorized the scores to provide roughly comparable groups in terms of sample size as follows: none (0), low (<1), moderate (1–3) and high (>3).

Covariates

In the parent survey, we assessed demographics (child gender, race and age) and socio-economic status (parent education and household income). We assessed children's other screen time (DVD/videos, streaming, apps, Internet use and electronic games) using the TV viewing question format. To assess parent FF intake we asked: 'How often do you have something to eat or drink from a fast food restaurant? (never to 5 or more times a week)'.

Statistical analysis

We tabulated MSW/McDonald's ad exposure and covariates and compared the likelihood of MSW/McDonald's consumption among different subgroups using χ^2 tests. We used Poisson regression with robust variance estimates to estimate the risk ratios of eating at MSW or McDonald's in the past 7 d for each level of MSW/McDonald's ad exposure^(48,49). The fully adjusted models included all measured covariates. To maximize the sample size, we used multiple imputation by chained equations⁽⁵⁰⁾ to impute values for all variables in the multivariate models with missing data (0.2–5.8% per variable). All analyses were conducted in the statistical software package Stata version 12.

Results

Sample characteristics

Children's mean age was 4.4 (SD 0.8) years and 51.6% were female. Seventy-two per cent were non-Hispanic white; the majority (59.4%) of the others were Latino. Most (86.7%) participating parents were mothers. Approximately half (52.7%) the parents reported an annual household income of \$US 50 000 or less; 48.5% reported 'high school or less' as their highest level of education.

The study sample was slightly more diverse and had a lower household income than the underlying populations of our recruitment cities (in Manchester and Nashua, respectively: 82% and 79% non-Hispanic white; median household incomes of \$US 54 320 and \$US 65 671).

Fast-food advertising

Overall, 17 311 MSW ads were identified for the current analysis. Only five of the eleven children's channels aired MSW ads during the study period (Fig. 1). Almost one-third (31.7%) of all MSW ads were aired on Nicktoons. Sixty-nine per cent of the ads were for McDonald's, 21.7% for Wendy's and 9.1% for Subway. Almost two-thirds of all McDonald's ads were aired on Nickelodeon and Nicktoons.

Children's television viewing

Children's overall screen time averaged 21.5 (SD 19.9) h/week. TV viewing (regular, cable or satellite) represented nearly half (47.7%) of their overall screen time and averaged 9.3 (SD 8.3) h/week. Eighty-nine per cent of children watched at least one children's TV channel during the week before the survey and these children viewed a mean of 3.6 (SD 2.0) children's channels. Children's channels aired between 0 and 1.2 MSW ads/h (Table 1).

Fast-food advertising exposure

More than half of the children watched only children's channels without MSW advertising. Based on children's TV viewing during the past 7 d, 59.2% were not exposed any to child-targeted MSW ads whereas 40.8% were exposed to at least one. Among the exposed, 23.3% had low exposure (mean 0.57 (SD 0.26) ads), 34.2% moderate (mean 1.92 (SD 0.58) ads) and 42.5% had high exposure (mean 6.71 (SD 3.83) ads). Among those exposed to McDonald's ads, 33.8% had low exposure (mean 0.54 (SD 0.29) ads), 34.2% moderate (mean 1.84 (SD 0.60) ads) and 32.0% had high (mean 5.36 (SD 2.59) ads). On average, McDonald's ads accounted for 73.6 (SD 23.5) % of children's overall exposure; Wendy's accounted for 17.4 (SD 20.7) %; and Subway

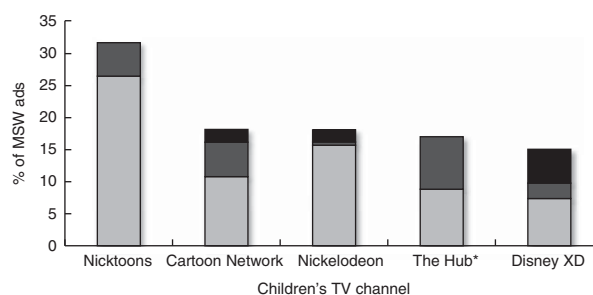


Fig. 1 Percentage of McDonald's (□), Subway (■) and Wendy's (▒) commercials (ads) out of the total number of McDonald's, Subway and Wendy's (MSW) ads aired on children's television (TV) channels between 06.00 and 23.00 hours or during child programming, USA, April–December 2013. *Currently known as Discovery Family

Table 1 Percentage of pre-school children who watched children's television (TV) channels and mean number of McDonald's, Subway and Wendy's (MSW) commercials (ads) aired per hour by channel during the 7 d preceding each survey, Manchester and Nashua, NH, USA, April–December 2013

Children's TV channel	Viewed in past 7 d (n 548, %)	MSW ads/h*		McDonald's ads/h	
		Mean	SD	Mean	SD
Disney Junior	58.0	0		0	
PBS Kids	53.3	0		0	
Nick Jr.	52.0	0		0	
The Disney Channel	46.2	0		0	
Sprout	33.9	0		0	
Nickelodeon	28.5	0.9	0.5	0.8	0.5
Cartoon Network	17.7	0.8	0.3	0.4	0.3
The Hub†	11.0	0.7	0.3	0.3	0.1
Disney XD	8.2	0.6	0.3	0.2	0.3
Nicktoons	7.3	1.2	0.5	1.0	0.4
Boomerang	2.9	0		0	

*Only ads aired between 06.00 and 23.00 hours or during child programming (for Nickelodeon and Cartoon Network) were included.

†Currently known as Discovery Family.

accounted for 9.0 (SD 14.6) %. Children's MSW ad exposure was positively associated with the following child characteristics: male gender ($P=0.03$), non-white race ($P<0.001$), hours of TV viewing ($P<0.001$) and hours of other screen time ($P=0.02$); inversely associated with household income ($P=0.002$) and parent education ($P<0.001$); and not significantly associated with child age and parent FF consumption. Children's McDonald's ad exposure showed similar associations and also was positively associated with child age ($P=0.02$).

Children's fast-food consumption

Forty-three per cent (n 228) of children ate at MSW in the past week: 34.4% ate at McDonald's, 9.9% at Wendy's and 5.1% at Subway. Most (88.2%) children ate at only one of these restaurants. Children's MSW consumption was significantly associated with their MSW ad exposure (Table 2). The association between McDonald's consumption and ad exposure was marginally significant. Children's MSW and McDonald's consumption were positively associated with parent FF consumption, but not significantly associated with overall hours of TV viewing, hours of other screen time or other sociodemographic characteristics.

Associations between children's fast-food consumption and exposure to advertising

After adjusting for demographics, socio-economic status and other screen time, children with moderate MSW ad exposure were 31% (95% CI 1.12, 1.53) more likely to have eaten at MSW in the past week compared with children with no MSW ad exposure (Table 3). Children with high MSW exposure were 26% (95% CI 1.13, 1.41) more likely to have eaten at MSW in the past week compared with children with no MSW ad exposure. Children with moderate and high levels of McDonald's ad exposure were 38% (95% CI 1.17, 1.62 and 95% CI 1.09, 1.76, respectively)

more likely to have eaten at McDonald's in the past week compared with children with no exposure. Low MSW or McDonald's ad exposure was not significantly associated with increases in consumption. In the adjusted models, none of the covariates were significantly associated with children's MSW or McDonald's consumption. Although parent FF consumption significantly predicted children's MSW and McDonald's consumption, adding it to the adjusted models did not change the findings substantially.

Discussion

The present study is the first to demonstrate a significant positive association between exposure to child-targeted FF TV advertising and FF consumption among children of pre-school age in a non-experimental setting. To some degree, this association is expected, especially considering FF industry expenditures on child-targeted advertising. However, demonstrating it empirically is challenging due to the broad nature of the exposure. Children's MSW and McDonald's consumption were significantly associated with their ad exposure, but not overall hours of TV viewing or other screen time. This supports the specificity of our measure and suggests our findings do not merely reflect differences among children who watch a lot of TV. Our results extend the findings of previous studies that have identified TV viewing as a risk factor for adiposity or unhealthy dietary choices^(28,30,32–34,36,51) by identifying advertising as a possible mechanism for this association. It also demonstrates that food marketing influences observed in highly controlled, experimental settings with children⁽²⁹⁾ are consistent with associations observed in uncontrolled, non-experimental settings with greater external validity, and that this is the case even for pre-school children. Empirical evidence of the association between children's exposure to food marketing and their intake of advertised products, such

Table 2 Pre-school children's consumption of McDonald's, Subway, and Wendy's (MSW) in the past 7 d by child and parent characteristics, Manchester and Nashua, NH, USA, April–December 2013

	<i>n</i>	MSW in past 7 d (%)	<i>P</i> value	McDonald's in past 7 d (%)	<i>P</i> value
Child advertising exposures					
MSW ad exposure					
None	318	37.6	0.03	29.8	0.08
Low	51	49.0		36.7	
Moderate	75	51.4		43.2	
High	93	51.1		40.2	
McDonald's ad exposure					
None	318	37.6	0.02	29.8	0.05
Low	74	45.1		35.2	
Moderate	75	54.7		42.7	
High	70	52.2		43.5	
Child characteristics					
Gender					
Female	283	41.0	0.30	33.8	0.79
Male	265	45.5		34.9	
Age					
3 years	193	41.3	0.73	34.2	0.97
4 years	208	42.9		34.0	
5 years	146	45.7		35.3	
Race					
Non-Hispanic white	380	41.1	0.18	33.2	0.52
Other	144	47.8		36.2	
Television watching (h/week)					
≤1	55	32.1	0.20	26.4	0.23
1.1–5	126	42.5		33.6	
5.1–10	130	46.8		37.9	
10.1–14	139	40.3		30.2	
>14	83	51.3		42.5	
Other screen time (h/week)					
≤1	41	52.5	0.07	43.6	0.21
1.1–5	164	37.3		30.4	
5.1–10	133	40.2		30.7	
10.1–14	56	57.4		44.4	
>14	133	44.0		35.6	
Parent characteristics					
Annual household income (\$US)					
≤25 000	150	43.5	0.94	36.3	0.661
25 001–50 000	122	41.7		30.0	
50 001–100 000	156	43.9		36.5	
>100 000	88	40.2		33.3	
Parent education					
High school or less	257	44.6	0.70	36.6	0.57
Associates or technical degree	111	44.0		33.0	
Bachelor's or graduate degree	162	40.4		31.6	
Parent fast-food consumption					
Never	51	16.7	<0.001	10.4	<0.001
Less than once per month	170	32.7		23.2	
Less than once per week	147	44.4		38.0	
Once per week or more	167	61.3		49.7	
Total	548	43.2		34.4	

as that noted in the present study, is critical to supporting and strengthening the recommendations of numerous public health authorities to limit marketing of low-nutrient foods to children^(3,4,28,52).

Much of the prior literature examining food marketing to children has focused on school-age children^(29,35). The results of the current study further illustrate that the influence of food marketing may begin as young as 3 years of age. Many have raised substantial concern about marketing that targets young children due to their cognitive inability to

discern the persuasive intent of marketing^(16–18). However, major food companies claim that their advertising is not intended for children under 6 years of age as they do not advertise on TV channels directed primarily to pre-schoolers (i.e. Nick Jr., Disney Junior)⁽⁵³⁾. Although the pre-school channels offer commercial-free programming choices for young children, these are not the only children's channels children are watching. Our results suggest that a substantial minority (40.8%) of 3–5-year-olds are nevertheless being exposed to child-targeted ads via TV channels widely viewed

Table 3 Risk ratios (RR) for pre-school children's consumption of McDonald's, Subway or Wendy's (MSW) in past 7 d, Manchester and Nashua, NH, USA, April–December 2013

	Unadjusted RR	95 % CI	Adjusted* RR	95 % CI	Adjusted† RR	95 % CI
MSW consumption by level of child-targeted MSW commercial (ad) exposure						
MSW ad exposure						
None	Ref.		Ref.		Ref.	
Low	1.28	0.89, 1.84	1.25	0.89, 1.78	1.19	0.83, 1.70
Moderate	1.34	1.15, 1.57	1.31	1.12, 1.53	1.25	1.15, 1.36
High	1.31	1.21, 1.43	1.26	1.13, 1.41	1.19	1.07, 1.32
McDonald's consumption by level of child-targeted McDonald's ad exposure						
McDonald's ad exposure						
None	Ref.		Ref.		Ref.	
Low	1.16	0.84, 1.60	1.16	0.84, 1.60	1.09	0.79, 1.50
Moderate	1.40	1.18, 1.67	1.38	1.17, 1.62	1.28	1.05, 1.56
High	1.43	1.16, 1.76	1.38	1.09, 1.76	1.33	1.06, 1.67

Ref., reference category.

Significant results are indicated in bold font.

*Adjusted for child gender, age, race, other screen time, household income and parent education.

†Adjusted for child gender, age, race, other screen time, household income and parent education plus parent fast-food consumption.

by both younger and older children (e.g. Nickelodeon, Cartoon Network) and that this exposure is associated with their intake of the advertised foods.

In the USA, child-directed food marketing is self-regulated by a voluntary body of the Council of Better Business Bureaus, called the Children's Food and Beverage Advertising Initiative (CFBAI). Food and beverage companies who voluntarily join the CFBAI must agree to only include products that meet CFBAI's own uniform nutrition criteria in their child-targeted advertising⁽⁵⁴⁾. Additionally, many CFBAI members commit not to target their advertising to young children at all. Subway and Wendy's are not members of the CFBAI. McDonald's is a member, but is the only signatory company that has failed to pledge not to directly advertise to children under 6 years of age⁽⁵⁵⁾. A recent analysis suggests that over 90% of FF products approved by the CFBAI as being appropriate for advertising on children's TV programming exceed governmental standards for recommended nutrients to limit⁽⁵⁶⁾. In 2013 when our data were collected, McDonald's committed to improving the quality of its kids' meals and related advertising in cooperation with the Alliance for a Healthier Generation and the Clinton Global Initiative⁽⁵⁷⁾. Prior research demonstrated that most of McDonald's child-targeted advertising emphasized the Happy Meal brand, rather than specific food components⁽¹³⁾. A more current content analysis of McDonald's Happy Meal ad content is necessary to determine whether this emphasis has changed since its commitment went into effect.

Forty-three per cent of the pre-school children in the current study consumed food from at least one of the three FF restaurants during the past week. Among these, most (79.4%) ate at McDonald's. McDonald's also predominated children's FF ad exposure, accounting for seven of every ten MSW ads viewed. McDonald's ads use child-appealing marketing strategies focusing primarily on toys and utilizing links with licensed cartoon characters^(13,34,41,54,55). Thus, in addition to the frequency of exposure, the enticing content of McDonald's ads may have contributed to the higher

prevalence of McDonald's consumption among children exposed to ads. Although we did not examine pester power as a mediator in this analysis, online survey research with a national US sample indicates that 15% of pre-school children ask their parents to go to McDonald's every day⁽⁵⁶⁾. Wendy's and Subway accounted for only one-fifth of MSW consumption and one-quarter of MSW ad exposure. Thus, our sample was too small to examine these restaurants separately. Of the two restaurants, only Subway used child-appealing strategies in its ads in 2013, such as tie-ins with popular children's movies⁽⁵⁷⁾. Additional research is needed to determine if the observed associations extend to FF restaurants other than McDonald's.

On average, parents reported that their children spent 1.3 h daily watching TV (regular, cable or satellite) and about 3 h daily on overall screen time. Over half (54.8%) of children in the present study averaged more than the daily 2 h of screen time recommended by the American Academy of Pediatrics⁽⁵⁸⁾. Notwithstanding, our estimates of TV viewing time are lower than estimates using Nielsen (a US-based company that tracks TV viewing patterns) data^(59,60). Although parents likely have a better sense of children's electronic media use during the pre-school years compared with when children are older, it is possible that parents underestimated children's screen time. Our estimate, however, is consistent with other research using parental report of children's screen time^(61–63). Almost 60% of the children viewed only channels that did not air MSW ads during child programming times (Boomerang, Disney Junior, Nick Jr., PBS Kids, Sprout and The Disney Channel). We do not know whether parents intentionally limited children's TV viewing to commercial-free channels, or whether parents and/or children preferred these channels because they have programming for children of pre-school age. Of the five channels with MSW ads, Nickelodeon was the most frequently viewed.

For children of pre-school age, parents are the primary gatekeepers for their exposure to food marketing and

access to FF. Although the current study included parental consumption of FF as a covariate, we did not examine the potential influence of parents' attitudes or beliefs about food marketing. This may be a particularly important direction for future work, given existing research indicating that parents' favourable social norms regarding FF consumption mediate the relationship between exposure to food marketing and consumption of FF in children⁽⁶⁴⁾. Further, parents of pre-school children could reduce their child's exposure to FF ads by ensuring that their child only watches age-appropriate programming, rather than programming aimed at older children. Paediatricians, WIC educators and others with the opportunity to promote children's healthy media use and diet are in an ideal position to make these recommendations.

Our analysis included about half (51.4%) of all FF advertising on children's channels because we excluded ads shown between 23.00 and 06.00 hours or outside child programming, and we focused on only three of the top ten national chain FF restaurants with locations in our catchment area. Due to these analytic restrictions, our estimate of children's MSW ad exposure is notably lower than estimates of overall FF ad exposure using Nielsen data^(5-7,38,39). Child-targeted ads account for only one-quarter to one-half of children's overall FF TV ad exposure^(7,38). Thus, examining the impact of children's exposure to FF ads on general audience channels is important for future work.

Our findings are also notable because we assessed and controlled for parental covariates, including parent FF consumption, that could have confounded the observed associations. In all instances, adding parent FF consumption to the model attenuated the adjusted risk ratios by less than 10%. This indicates the associations between children's ad exposure and consumption of MSW or McDonald's were not substantially confounded by the frequency of parent FF consumption. Surveying parents about children's TV viewing and matching their responses with advertising data enabled us to develop an advertising exposure measure that was independent of parent or child recall of specific ads; thus, eliminating bias based on participants' receptivity to MSW. Our sample was socio-economically diverse, although our results show that socio-economic status was not associated with children's FF intake.

Our study also had several limitations. Most obviously, the cross-sectional study design limits our ability to draw causal inferences. To the extent that children's TV viewing in the past week reflects their overall TV viewing patterns, our results likely suggest that children's ad exposure prompts MSW and McDonald's consumption. However, these results require replication using longitudinal methods that can establish causality. Because we did not collect data on what children actually consumed at MSW, we do not know whether MSW ad exposure was associated with less healthy food choices. Our regional sample was limited in racial/ethnic diversity. In light of research suggesting that black and Hispanic children view more FF advertising than white children, this research should be replicated in more urban

settings with greater racial/ethnic representation⁽⁶⁾. Finally, because we did not ask parents to report children's viewing time by channel, we assumed children's overall weekly viewing was equally distributed across channels watched. Future research using even more precise estimates of children's viewing time of individual children's TV channels will be important.

Conclusions

The current study demonstrates a positive association between children's exposure to child-targeted MSW TV ads and consumption from these restaurants. McDonald's accounted for almost three-quarters of TV advertising exposure and an even greater proportion of children's MSW consumption. These results are particularly sobering given that participating children were less than 6 years old and therefore are cognitively unable to defend against advertising^(17,18). Our findings highlight the vulnerability of young children to persuasive advertising and support the recommendations of numerous others to limit child-directed FF marketing^(3,4,28,52).

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References

1. Ogden CL, Carroll MD, Kit BK *et al.* (2014) Prevalence of childhood and adult obesity in the United States, 2011–2012. *JAMA* **311**, 806–814.
2. Skinner AC & Skelton JA (2014) Prevalence and trends in obesity and severe obesity among children in the United States, 1999–2012. *JAMA Pediatr* **168**, 561–566.
3. White House Task Force on Childhood Obesity (2010) Solving the Problem of Childhood Obesity within a Generation. <http://www.letsmove.gov/white-house-task-force-childhood-obesity-report-president> (accessed June 2016).
4. World Health Organization (2010) *Set of Recommendations on the Marketing of Foods and Non-Alcoholic Beverages to Children*. Geneva: WHO; available at <http://www.who.int/dietphysicalactivity/publications/recsmarketing/en/>

5. Powell LM, Szczypka G & Chaloupka FJ (2010) Trends in exposure to television food advertisements among children and adolescents in the United States. *Arch Pediatr Adolesc Med* **164**, 794–802.
6. Fleming-Milici F, Harris JL, Sarda V *et al.* (2013) Amount of Hispanic youth exposure to food and beverage advertising on Spanish- and English-language television. *JAMA Pediatr* **167**, 723–730.
7. Harris JL, Sarda V, Schwartz MB *et al.* (2013) Redefining 'child-directed advertising' to reduce unhealthy television food advertising. *Am J Prev Med* **44**, 358–364.
8. Federal Trade Commission (2008) Marketing food to children and adolescents. A review of industry expenditures, activities, and self-regulation. A report to Congress. <https://www.ftc.gov/reports/marketing-food-children-adolescents-review-industry-expenditures-activities-self-regulation> (accessed May 2016).
9. Federal Trade Commission (2012) A review of food marketing to children and adolescents. Follow up report. <https://www.ftc.gov/sites/default/files/documents/reports/review-food-marketing-children-and-adolescents-follow-report/121221-foodmarketingreport.pdf> (accessed May 2016).
10. Bowman SA, Gortmaker SL, Ebbeling CB *et al.* (2004) Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. *Pediatrics* **113**, 112–118.
11. Powell LM & Nguyen BT (2013) Fast-food and full-service restaurant consumption among children and adolescents: effect on energy, beverage, and nutrient intake. *JAMA Pediatr* **167**, 14–20.
12. Kelly B, Halford JCG, Boyland EJ *et al.* (2010) Television food advertising to children: a global perspective. *Am J Public Health* **100**, 1730–1736.
13. Bernhardt AM, Wilking C, Adachi-Mejia AM *et al.* (2013) How television fast food marketing aimed at children compares with adult advertisements. *PLoS One* **8**, e72479.
14. *QSR Magazine* (2015) The QSR 50. <https://www.qsrmagazine.com/reports/qsr50-2014-top-50-chart> (accessed June 2016).
15. Carter OBJ, Patterson LJ, Donovan RJ *et al.* (2011) Children's understanding of the selling versus persuasive intent of junk food advertising: implications for regulation. *Soc Sci Med* **72**, 962–968.
16. Harris JL, Brownell KD & Bargh JA (2009) The food marketing defense model: integrating psychological research to protect youth and inform public policy. *Soc Issues Policy Rev* **3**, 211–271.
17. Harris JL & Graff SK (2012) Protecting young people from junk food advertising: implications of psychological research for First Amendment law. *Am J Public Health* **102**, 214–222.
18. Calvert SL (2008) Children as consumers: advertising and marketing. *Future Child* **18**, 205–234.
19. Strasburger VC, Wilson BJ & Jordan AB (2009) *Children, Adolescents, and the Media*. Thousand Oaks, CA: SAGE Publications, Inc.
20. Borzekowski DL & Robinson TN (2001) The 30-second effect: an experiment revealing the impact of television commercials on food preferences of preschoolers. *J Am Diet Assoc* **101**, 42–46.
21. Chernin A (2008) The effects of food marketing on children's preferences: testing the moderating roles of age and gender. *Ann Am Acad Polit Soc Sci* **615**, 101–118.
22. de Droog SM, Valkenburg PM & Buijzen M (2011) Using brand characters to promote young children's liking of and purchase requests for fruit. *J Health Commun* **16**, 79–89.
23. Letona P, Chacon V, Roberto C *et al.* (2014) Effects of licensed characters on children's taste and snack preferences in Guatemala, a low/middle income country. *Int J Obes (Lond)* **38**, 1466–1469.
24. Robinson TN, Borzekowski DLG, Matheson DM *et al.* (2007) Effects of fast food branding on young children's taste preferences. *Arch Pediatr Adolesc Med* **161**, 792–727.
25. Stoneman Z & Brody G (1981) The indirect impact of child-oriented advertisements: on mother-child interactions. *J Appl Dev Psychol* **2**, 369–376.
26. Kotler JA, Schiffman JM & Hanson KG (2012) The influence of media characters on children's food choices. *J Health Commun* **17**, 886–898.
27. Roberto CA, Baik J, Harris JL *et al.* (2010) Influence of licensed characters on children's taste and snack preferences. *Pediatrics* **126**, 88–93.
28. Institute of Medicine (2006) *Food Marketing to Children and Youth: Threat or Opportunity?* Washington, DC: The National Academies Press.
29. Boyland EJ, Nolan S, Kelly B *et al.* (2016) 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* **103**, 519–533.
30. Andreyeva T, Kelly IR & Harris JL (2011) Exposure to food advertising on television: associations with children's fast food and soft drink consumption and obesity. *Econ Hum Biol* **9**, 221–233.
31. Jackson DM, Djafarian K, Stewart J *et al.* (2009) Increased television viewing is associated with elevated body fatness but not with lower total energy expenditure in children. *Am J Clin Nutr* **89**, 1031–1036.
32. Singh GK, Kogan MD, Van Dyck PC *et al.* (2008) Racial/ethnic, socioeconomic, and behavioral determinants of childhood and adolescent obesity in the United States: analyzing independent and joint associations. *Ann Epidemiol* **18**, 682–695.
33. Leech RM, McNaughton SA & Timperio A (2015) Clustering of diet, physical activity and sedentary behaviour among Australian children: cross-sectional and longitudinal associations with overweight and obesity. *Int J Obes (Lond)* **39**, 1079–1085.
34. Boyland EJ & Halford JCG (2013) Television advertising and branding. Effects on eating behaviour and food preferences in children. *Appetite* **62**, 236–241.
35. Lee B, Kim H, Lee S-K *et al.* (2014) Effects of exposure to television advertising for energy-dense/nutrient-poor food on children's food intake and obesity in South Korea. *Appetite* **81**, 305–311.
36. Zimmerman FJ & Bell JF (2010) Associations of television content type and obesity in children. *Am J Public Health* **100**, 334–340.
37. Buijzen M, Schuurman J & Bomhof E (2008) Associations between children's television advertising exposure and their food consumption patterns: a household diary-survey study. *Appetite* **50**, 231–239.
38. Powell LM, Schermbeck RM & Chaloupka FJ (2013) Nutritional content of food and beverage products in television advertisements seen on children's programming. *Child Obes* **9**, 524–531.
39. Powell LM, Schermbeck RM, Szczypka G *et al.* (2011) Trends in the nutritional content of television food advertisements seen by children in the United States: analyses by age, food categories, and companies. *Arch Pediatr Adolesc Med* **165**, 1078–1086.
40. Speers SE, Harris JL & Schwartz MB (2011) Child and adolescent exposure to food and beverage brand appearances during prime-time television programming. *Am J Prev Med* **41**, 291–296.
41. Kraak VI & Story M (2015) 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* **16**, 107–126.

42. Longacre M, Drake K, MacKenzie T *et al.* (2012) Fast-food environments and family fast-food intake in nonmetropolitan areas. *Am J Prev Med* **42**, 579–587.
43. Richardson AS, Boone-Heinonen J, Popkin BM *et al.* (2011) Neighborhood fast food restaurants and fast food consumption: a national study. *BMC Public Health* **11**, 543.
44. Centers for Disease Control and Prevention (2013) Methodology of the Youth Risk Behavior Surveillance System – 2013. *MMWR Recomm Rep* **62**, 1–20.
45. Sargent JD, Beach ML, Dalton MA *et al.* (2001) Effect of seeing tobacco use in films on trying smoking among adolescents: cross sectional study. *BMJ* **323**, 1394–1397.
46. Dalton M, Sargent J, Beach M *et al.* (2003) Effect of viewing smoking in movies on adolescent smoking initiative: a cohort study. *Lancet* **362**, 281–285.
47. Sargent JD, Worth KA, Beach M *et al.* (2008) Population-based assessment of exposure to risk behaviors in motion pictures. *Commun Methods Meas* **2**, 134–151.
48. Huber P (1967) *The Behavior of Maximum Likelihood Estimates Under Nonstandard Conditions*. Berkeley, CA: University of California Press.
49. Zou G (2004) A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol* **159**, 702–706.
50. Azur MJ, Stuart EA, Frangakis C *et al.* (2011) Multiple imputation by chained equations: what is it and how does it work? *Int J Methods Psychiatr Res* **20**, 40–49.
51. Emond JA, Bernhardt AM, Gilbert-Diamond D *et al.* (2015) Commercial television exposure, fast food toy collecting, and family visits to fast food restaurants among families living in rural communities. *J Pediatr* **168**, 158–163.
52. Healthy Eating Research (2015) *Recommendations for Responsible Food Marketing to Children*. Minneapolis, MN: Healthy Eating Research; available at <http://healthyeatingresearch.org/research/recommendations-for-responsible-food-marketing-to-children/>
53. Kolish ED, Enright M & Oberdorff B (2015) *The Children's Food and Beverage Advertising Initiative in Action: A Report on Compliance and Progress During 2014*. Arlington, VA: Council of Better Business Bureaus.
54. Longacre MR, Drake KM, Titus LJ *et al.* (2016) A toy story: association between young children's knowledge of fast food toy premiums and their fast food consumption. *Appetite* **96**, 473–480.
55. Jenkin G, Madhvani N, Signal L *et al.* (2014) A systematic review of persuasive marketing techniques to promote food to children on television. *Obes Rev* **15**, 281–293.
56. Rudd Center for Food Policy and Obesity (2010) Fast Food FACTS: Evaluating fast food nutrition and marketing to youth. http://fastfoodmarketing.org/media/FastFoodFACTS_Report_2010.pdf (accessed May 2016).
57. Rudd Center for Food Policy and Obesity (2013) Fast Food FACTS: Measuring progress in nutrition and marketing to youth. http://fastfoodmarketing.org/media/FastFoodFACTS_Report.pdf (accessed May 2016).
58. American Academy of Pediatrics (2013) Children, adolescents, and the media. *Pediatrics* **132**, 958–961.
59. The Nielsen Company (US), LLC (2015) *Kids' Audience Behavior Across Platforms*. New York: Nielson; available at <http://www.nielsen.com/us/en/insights/reports/2015/kids-audience-behavior-across-platforms.html>
60. The Nielsen Company (US), LLC (2009) *TV Viewing Among Kids at an Eight-Year High*. New York: Nielson; available at <http://www.nielsen.com/us/en/insights/news/2009/tv-viewing-among-kids-at-an-eight-year-high.html>
61. Common Sense Media (2011) *Zero to Eight: Children's Media Use in America*. San Francisco, CA: Common Sense Media.
62. Common Sense Media (2013) *Zero to Eight: Children's Media Use in America 2013*. San Francisco, CA: Common Sense Media.
63. Loprinzi PD & Davis RE (2015) Secular trends in parent-reported television viewing among children in the United States, 2001–2012. *Child Care Health Dev* **42**, 288–291.
64. Grier S, Mensinger J, Huang S *et al.* (2007) Fast-food marketing and children's fast-food consumption: exploring parents' influences in an ethnically diverse sample. *J Public Policy Mark* **26**, 221–235.