Economics and Human Biology xxx (2011) xxx–xxx

Contents lists available at ScienceDirect

Economics and Human Biology

journal homepage: http://www.elsevier.com/locate/ehb

Exposure to food advertising on television: Associations with children's fast food and soft drink consumption and obesity

Tatiana Andreyeva [a], Inas Rashad Kelly [b,*], Jennifer L. Harris [a]

[a] Yale University, Rudd Center for Food Policy & Obesity, 309 Edwards Street, New Haven, CT 06520-8369, United States
[b] Queens College, City University of New York, 65-30 Kissena Boulevard, Flushing, NY 11367, United States

ARTICLE INFO

Article history:
Received 23 July 2010
Received in revised form 14 February 2011
Accepted 24 February 2011
Available online xxx

Keywords:
Food advertising
BMI
Food consumption
Fast food
Soft drinks
USA

ABSTRACT

There is insufficient research on the direct effects of food advertising on children's diet and diet-related health, particularly in non-experimental settings. We employ a nationally-representative sample from the Early Childhood Longitudinal Survey–Kindergarten Cohort (ECLS-K) and the Nielsen Company data on spot television advertising of cereals, fast food restaurants and soft drinks to children across the top 55 designated-market areas to estimate the relation between exposure to food advertising on television and children's food consumption and body weight. Our results suggest that soft drink and fast food television advertising is associated with increased consumption of soft drinks and fast food among elementary school children (Grade 5). Exposure to 100 incremental TV ads for sugar-sweetened carbonated soft drinks during 2002–2004 was associated with a 9.4% rise in children's consumption of soft drinks in 2004. The same increase in exposure to fast food advertising was associated with a 1.1% rise in children's consumption of fast food. There was no detectable link between advertising exposure and average body weight, but fast food advertising was significantly associated with body mass index for overweight and obese children ($\geq$85th BMI percentile), revealing detectable effects for a vulnerable group of children. Exposure to advertising for calorie-dense nutrient-poor foods may increase overall consumption of unhealthy food categories.

1. Introduction

Public health experts increasingly call for substantial changes in the food environment to effectively address the epidemic of obesity and poor diet among young people (Frieden et al., 2010; Goldberg and Gunasti, 2007; Story et al., 2008). Many consider the volume of marketing for calorie-dense nutrient-poor foods targeted to children and adolescents to be one of the most pernicious environmental influences on food consumption by youth (Harris et al., 2009a; Swinburn et al., 2008). A recent White House Task Force on Childhood Obesity Report to the President highlights the need for additional research to establish the link between advertising and "food preferences and consumption by children and adolescents" (White House Task Force on Childhood Obesity, 2010). A substantial body of literature consistently demonstrates that food marketing increases children's preferences, requests to parents and choices of advertised brands; however, far fewer studies have examined effects of food marketing on consumption of food categories (Hastings et al., 2003; Institute of Medicine, 2006).

Recent research provides indirect evidence that food marketing can have a significant impact on unhealthy food consumption in children in the short-term (Epstein et al., 2008; Halford et al., 2004, 2007; Harris et al., 2009b). There is also evidence of long-term effects: television exposure in middle and high school predicts

* Corresponding author. Tel.: +1 718 997 5440; fax: +1 718 997 5466.
E-mail addresses: tatiana.andreyeva@yale.edu (T. Andreyeva), inas.kelly@qc.cuny.edu (I.R. Kelly), jennifer.harris@yale.edu (J.L. Harris).

1570-677X/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.ehb.2011.02.004

increased consumption of foods commonly advertised to youth five years later (Barr-Anderson et al., 2009). One study found that adiposity in children increased with exposure to fast food advertising and that banning those advertising practices could reduce the incidence of childhood overweight by 18% (Chou et al., 2008). This is true even though descriptive studies show that exposure to food advertising by children and adolescents has remained stable and may even slightly declined (Desrochers and Holt, 2007; Holt et al., 2007; Zywicki et al., 2004). Yet "Holt et al. (2007) do not directly address the postulated link between ad exposure and food consumption or other behaviors that may be related to obesity" (Desrochers and Holt, 2007, p. 198), which we explore in the current analysis. They also do not account for a host of other factors occurring simultaneously in the time period that may be affecting both changes in advertising and obesity.

As a whole, prior research suggests that food advertising likely has significant negative effects on young people's diet, body weight, and health. The 2006 Institute of Medicine (IOM) report concluded that there was substantial evidence that "food and beverage marketing influences the preferences and purchase requests of children, influences consumption at least in the short term, is a likely contributor to less healthful diets, and may contribute to negative diet-related health outcomes and risks" (p. 307). This evidence has motivated public health efforts to advocate for a significant reduction in child exposure to advertising for energy-dense nutrient-poor foods, including possible government regulation if current self-regulatory industry efforts do not substantially improve the marketing landscape. Important support for these efforts can be provided by further direct evidence that food advertising increases consumption of the unhealthy food categories most commonly promoted to youth. The IOM report goes on to say that "[n]ew research is needed on food and beverage marketing and its impact on diet and diet-related health and on improving measurement strategies for factors involved centrally in this research" (p. 309). Our study is designed to contribute to the evidence and test the hypothesis that children's exposure to television food advertising is associated with higher consumption of highly advertised food categories, namely fast food and soft drinks. In doing so, we draw from newer, more comprehensive data previously unexploited in this area. Using a nationally-representative sample from the Early Childhood Longitudinal Study-Kindergarten Cohort (ECLS-K) with food consumption data on 5th graders and The Nielsen Company (Nielsen) measures of children's exposure to food advertising, we estimate associations between exposure to TV advertising and children's food consumption and body weight. While we perform several robustness checks to address the potential endogeneity of advertising, data limitations render it difficult to attribute the effects found to causal mechanisms. We are therefore careful not to conclude that the associations provide definitive evidence of causality from advertising exposure to increased food consumption, but are suggestive of causal effects.

2. Methods

2.1. Participants

We used data from the ECLS-K, a nationally representative longitudinal study of kindergartners in 1998–1999 conducted by the National Center for Education Statistics. The children were followed from kindergarten entry in the fall of 1998 to the spring of the 8th grade (2007) with five intermediate assessments. The survey collected data from multiple sources, including children via questionnaires and direct assessment in school, their parents interviewed by phone, and teachers and school administrators surveyed through questionnaires. The ECLS-K participants were selected via a multistage probability sampling design and some racial/ethnic groups were oversampled. More details on the ECLS-K survey design are published elsewhere (Tourangeau et al., 2009).

The original fall-kindergarten sample included 19,684 participants, but due to sample attrition (non-response and children moving out of the original schools and not being selected for follow-up) the spring-fifth grade sample consisted of 12,029 eligible children and 11,820 of them participated (Tourangeau et al., 2009). We removed respondents missing data for any of the following measures: body weight or height ($N = 820$[1]), consumption of fast food and soft drinks ($N = 570$), residential location ($N = 830$), TV viewing ($N = 930$), socio-demographic characteristics of the child ($N = 820$), and the child's mother ($N = 1100$; children could be missing multiple measures). After these exclusions 9760 children (82.6% of the original sample) remained eligible for analysis. Children excluded due to missing data were less likely to be of Asian origin or live with a married mother and were more likely to live in the South.

Advertising data were merged using geocoded data from the ECLS-K in 2002 (3rd grade) and 2004 (5th grade). Advertising years 2002 and 2003 were merged with 2002 ECLS-K data, while advertising year 2004 was merged with 2004 ECLS-K data. In that sense, with the exception of the possibility that a child moved between 2002 and 2003, advertising exposure is captured in the designated market area of the child's residence.

2.2. Measures

2.2.1. Dependent variables

2.2.1.1. Food consumption. Children completed a food consumption questionnaire that assessed consumption of fast food, soft drinks (including fruit and sports drinks; referred throughout by "soft drinks"), milk, 100% fruit juice, fruit, and vegetables at any venue (home, school, restaurants). We used fast food and soft drinks due to their large share in children's diet and associations with poor nutrition and obesity (Collison et al., 2010).

For soft drinks, children were asked: "During the past 7 days, how many times did you drink soda pop

[1] All unweighted sample size numbers are rounded to the nearest ten according to our license agreement for the restricted-use ECLS-K data.

Please cite this article in press as: Andreyeva, T., et al., Exposure to food advertising on television: Associations with children's fast food and soft drink consumption and obesity. Econ. Hum. Biol. (2011), doi:10.1016/j.ehb.2011.02.004

(EXAMPLES Coke, Pepsi, Mountain Dew), sports drinks (EXAMPLE Gatorade), or fruit drinks that are not 100% fruit juice (EXAMPLES Kool-Aid, Hi-C, Fruitopia, Fruitworks)?'' There were seven answer choices ranging from ''I did not drink any during the past 7 days'' to ''4 or more times per day.'' We converted responses into a count of daily beverage servings; we used a mid-point for the range responses of ''1 to 3 times during the past 7 days'' and ''4 to 6 times during the past 7 days'' and capped responses to ''4 or more times per day'' at 4 (Powers and Xie, 2008).[2]

The fast food consumption question was: ''During the past 7 days, about how many times did you eat a meal or snack from a fast food restaurant such as McDonald's, Pizza Hut, Burger King, KFC (Kentucky Fried Chicken), Taco Bell, Wendy's and so on?'' with the same seven answer choices from no intake to ''4 or more times per day''. We converted the scale responses to construct a count of daily fast food meals/snacks consumed using the same approach as for soft drinks. To adjust for the skewed nature of the distribution of food consumption (Fig. 1), we took the natural logarithm of all consumption measures. A constant was added before taking the natural logarithm so that no observations were deleted and to allow skewness to be as close to zero as possible (using the *lnskew0* command in Stata 10).

2.2.1.2. Body weight. Trained examiners took height and weight measurements for the ECLS-K participants. We used these measures to construct body mass index (BMI) percentiles and *z*-scores according to the CDC growth charts for children's age and gender (Kuczmarski et al., 2000). BMI *z*-scores served as our primary measure of child's body weight status.

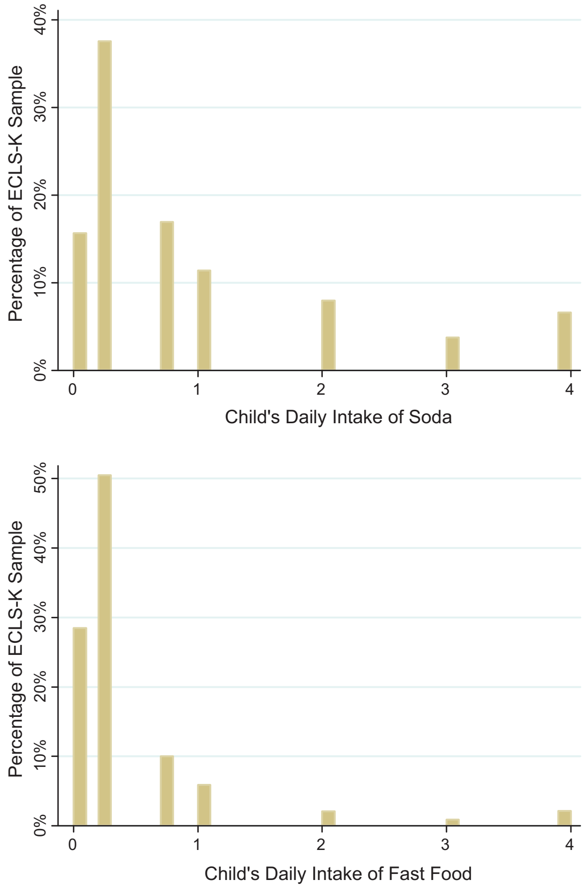

Fig. 1. Distributions of soft drink and fast food consumption, ECLS-K.

2.2.2. Independent variables

2.2.2.1. Children's exposure to food advertising on TV. We used Nielsen media data on annual gross rating points (GRPs) for spot market advertising to children ages 6–11, the best-matched available age group for our sample of fifth-graders. Specifically, we looked at category-level advertising of ready-to-eat cereal, regular and dietary carbonated soft drinks (CSDs), and quick service restaurants (i.e., fast food restaurants). These three categories are important contributors to children's diet and also most often marketed to children. Indeed, the average child ages 2–11 viewed more than 2000 television commercials for these categories combined in 2004, 40% of all food commercials viewed (Harris et al., 2010b). Fast food, CSDs and cereal also accounted for most of food industry spending on marketing to children ages 6–11 years in 2006, with 26% of that spending on cereal advertising alone (Federal Trade Commission, 2008).

We measure advertising in GRPs, which give the percentage of a specific target audience reached by advertising for the category of interest in a specific designated market area (DMA) during a certain time period. For example, an advertising campaign that reaches 80% of a demographic group during the year on average 100 times will have GRPs of $80 \times 100 = 8000$ for that year. Spot market GRPs measure exposure to commercials that occurred only in local television markets and contrast with national GRPs that measure exposure to network, cable and syndicated advertising aired across the country. Spot market data allow us to examine differences in outcomes for children who reside in different geographic areas. Children living in the same market are assumed to have the same advertising exposure, and our models adjust for individual TV viewing behavior. We used advertising data for the most densely populated 55 DMAs that covered on average 70.746% of the total U.S. population according to Nielsen.[3]

The Nielsen data provided annual GRP totals by DMA for the 2002, 2003 and 2004 calendar years.[4] During this time period, spot advertising as a proportion of children's

[2] We also run models where we cap the top response at 6 drinks per day, since multiplying the top response by 1.5 is standard in some settings (U.S. Census Bureau, 1993).

[3] Data on 56 DMAs are available, yet only 55 DMAs are available in all three years. These DMAs are listed in Table A1.

[4] Information on local allocation data, which identify how the national GRP is allocated to each DMA market, would provide more variation in the advertising exposure at the DMA level. However, we lack access to these data.

total food advertising exposure dropped from 13.0% in 2002 to 7.9% in 2004 and continued to decline in the following years. For packaged food products (excluding restaurants), spot advertising in 2004 represented only 4.5% of children's exposure, a reduction of 45% from the 2002 level. We chose to examine the period through 2004 as more recent years would not provide enough variance in spot market advertising. Our preferred estimation relies on the measures of cumulative exposure to TV food advertising combining 2002 through 2004 GRPs for each product. The GRP measures were deflated by 10,000 to ease interpretation of the regression coefficients.

2.2.3. Control variables

The ECLS-K offers rich data on a wide range of family, school, community, and child characteristics that affect child development and school performance. We use the following controls: child's age in months and its square, race/ethnicity (reported by parents), gender, mother's age in years and its square, mother's marital status, household socio-economic status (SES), daily number of hours the child spent watching TV, dichotomous variables for low (<2500 grams) and high ($\geq$4000 g) birth weight (included in BMI regressions only), and vectors indicating U.S. Census regions.[5] All control variables were assessed in 2004 parental interviews with the exception of the child's birth weight reported by parents at the kindergarten baseline.

2.3. Statistical analysis

We merged data from the ECLS-K and Nielsen using geographic identifiers in each dataset, including zip codes from the 2002 ECLS-K for the 2002–2003 advertising data and 2004 ECLS-K zip codes for the 2004 advertising data. From the original sample, 89% of children in 2002 and 93% of children in 2004 had valid zip code data. Children missing zip codes had on average higher BMI, were more likely to be of minority race, lower SES, live in the South, and have higher fast food intake. For children with available zip code data but living outside of the most populated 55 DMAs and missing advertising data (N = 4040), we added a dichotomous variable to indicate their lack of data and tested its significance across models. Compared to children residing in the top 55 DMAs, these participants were more likely to be from rural areas and of lower socio-economic status.

We estimated a series of ordinary least squares (OLS) regressions in which logarithmic scale food consumption measures for fifth-grade children were regressed on children's exposure to fast food, CSD and cereal television advertising in the year of the food assessment and two years prior to it. This postulated relation can be interpreted as the possible effect of increasing the child's exposure to TV advertising by 10,000 GRPs on the child's daily consumption of the advertised food category. Given that our advertising measure refers to three annual GRP totals and the outcome is measured on the log scale, the regression coefficient gives a percentage change in daily food consumption from exposure to an additional 100 food commercials during three years for the average child.

The set of food consumption models was the following: advertising of CSDs (regular and diet); advertising of fast food restaurants; advertising of cereal; and three advertising measures for cereal, CSDs and fast food restaurants in one model. We used cereal advertising as a test of the robustness of our specification: we would not expect cereal advertising to affect consumption of soft drinks or fast food. A set of similar models was estimated with BMI z-scores as an outcome.

The potential endogeneity of advertising may be of concern in this context. This may particularly be the case with local advertising measures, yet we are compelled to use local markets since national advertising provides no source of variation at a point in time. Companies may choose to place their advertisements in areas where demand is already high to capture market share from other companies perhaps rendering these types of companies somewhat predatory in nature. Alternatively, they may target areas where demand is low to capture demand maybe revealing their cooperative nature. At the same time, companies may be cooperative in areas where demand is high to further increase demand on the intensive margin. If the industry behavior is predatory, our OLS estimates are likely biased upward. In contrast, our estimates are conservative if the industry is cooperative. There is evidence that the soft drink industry might be more cooperative than predatory in nature, which would render them more likely to capture demand that does not exist rather than capture a competing company's demand (Gasmi et al., 1992).

In a similar context, Chou et al. (2008) address this potential endogeneity using instrumental variables, where the price of an advertisement and the number of households with a television in the DMA serve as instruments for fast food advertising. These instruments are found to be valid in that they jointly strongly predict advertising yet are legitimately excludable from the BMI equation. Hausman tests in this context revealed OLS estimates to be consistent, and that endogeneity was not problematic.

We rely on the Chou et al. (2008) study in addition to specification checks other than our cereal advertising falsification check to ensure that our OLS estimates are consistent. The inclusion of many covariates in our models should also somewhat mitigate this concern. Fixed effects for US Census regions capture any time-invariant regional characteristics associated with a company's decision to advertise in a particular region.

Our first check addresses possible omitted variables bias in exploring alternate outcomes that should not be influenced by any of our advertising measures. For example, we do not expect fruit and vegetable consumption or physical activity to change detectably as a result of children's exposure to soft drink or fast food commercials. These specification checks aid in attributing the effects we find to advertising and not to spurious correlation.

Our second specification check is to analyze the effect of advertising on consumption without additional controls.

[5] DMA fixed effects cannot be included in the regression model because the DMA-level advertising measures vary across DMAs but are constant within each DMA.

Table 1
Variable definitions and weighted sample means, ECLS-K.

Variable	Description	Mean (SD)
BMI *z*-score	Body Mass Index *z*-score in 5th grade	0.668 (1.113)
Soft Drink Consumption	Number of soft drinks, sports drinks or fruit drinks consumed daily	0.907 (1.1)
Fast Food Consumption	Number of fast food meals and/or snacks consumed daily	0.462 (0.75)
Fruit & Vegetable Consumption	Number of fruits and/or vegetables consumed daily	2.860 (2.631)
Milk Consumption	Glasses of milk consumed daily (including with cereal)	1.466 (1.330)
Vigorous Activity	Number of days a week child participated in vigorous physical activity continuously for at least 20 min	3.735 (1.922)
Regular Carbonated Soft Drink Advertising	Regular CSD spot TV GRPs for children aged 6–11, 2002–2004, from Nielsen (in 10,000 GRPs)	0.696 (0.824)
Diet Carbonated Soft Drink Advertising	Diet CSD spot TV GRPs for children aged 6–11, 2002–2004, from Nielsen (in 10,000 GRPs)	0.076 (0.088)
Cereal Advertising	Cereal spot TV GRPs for children aged 6–11, 2002–2004, from Nielsen (in 10,000 GRPs)	1.746 (1.907)
Fast Food Advertising	Fast food service restaurants spot TV GRPs for children aged 6–11, 2002–2004, from Nielsen (in 10,000 GRPs)	4.402 (4.844)
Male	Dichotomous variable that equals 1 if respondent is male	0.511 (0.500)
White Non-Hispanic	Dichotomous variable that equals 1 if respondent is white but not Hispanic	0.568 (0.495)
Black Non-Hispanic	Dichotomous variable that equals 1 if respondent is black but not Hispanic	0.159 (0.366)
Hispanic	Dichotomous variable that equals 1 if respondent is Hispanic	0.199 (0.400)
Asian	Dichotomous variable that equals 1 if respondent is Asian	0.030 (0.170)
Other Race	Dichotomous variable that equals 1 if respondent is of a race other than White, Black, Hispanic, or Asian	0.043 (0.204)
Age in Months	Age of respondent in months	134.782 (4.696)
Mother's Age in Yrs	Age of respondent's mother in years	38.682 (6.887)
Low SES	Low SES based on ECLS socioeconomic status variable created using family education, occupation, and family income (composite of 5 measures, each with mean = 0 and SD = 1)	0.206 (0.404)
Middle SES	Middle SES based on ECLS socioeconomic status variable created using family education, occupation, and family income (composite of 5 measures, each with mean=0 and SD = 1)	0.597 (0.491)
High SES	High SES based on ECLS socioeconomic status variable created using family education, occupation, and family income (composite of 5 measures, each with mean = 0 and SD = 1)	0.198 (0.398)
Married	Dichotomous variable that equals 1 if respondent's mother is married	0.676 (0.468)
Single	Dichotomous variable that equals 1 if respondent's mother is single	0.123 (0.328)
Divorced	Dichotomous variable that equals 1 if respondent's mother is divorced or separated	0.201 (0.401)
TV Viewing	Child TV average daily viewing in hours, 5th grade	2.362 (1.245)
Low Birth Weight	Dichotomous variable that equals 1 if child's birth weight is less than 2500 g	0.071 (0.257)
High Birth Weight	Dichotomous variable that equals 1 if child's birth weight is greater than 4000 g	0.098 (0.298)
Living outside top 56 DMAs (missing advertising data)	Dichotomous variable that equals 1 if respondent does not live in one of the top 56 DMAs and has no advertising data	0.446 (0.497)

Source: Authors' analysis.
Notes: Standard deviation is reported in parentheses. ECLS cross-sectional sample child-level weights are used in calculating the mean and standard deviation. Number of observations is 9760.

Should companies choose to locate advertisements where demand is high, we would expect models with no additional controls to yield significant effects that are high in magnitude. As we show, in no case are our estimates without controls significant, and in all cases the magnitude of the coefficients is lower than in the models with a full set of controls, indicating that our reported results may be conservative rather than inflated.[6]

Our third check is to use only 2004 advertising. To maximize our information on exposure, we combined advertising data from 2002 to 2004, especially due to the lingering effects of past advertising on current consumption. Bagwell (2007), however, cites studies showing that advertising effects depreciate within a year. While this may vary from industry to industry, it does suggest that the "goodwill effects" of past advertising strongly influencing current sales may not be the case. We run regressions using only 2004 advertising, as the ECLS-K children were interviewed in Spring 2004 and prior to being exposed to all 2004 advertisements. While this is not a perfect measure, since 2004 advertising is likely correlated with 2003 advertising, weaker estimates that are lower in magnitude would suggest that the potential endogeneity issue is mitigated. Indeed, this is our finding as shown in Table A3, particularly for fast food consumption.

[6] Results without controls are shown in Table A2, in addition to results for regular soft drink and fast food advertising with BMI as an outcome. Full results are available from the authors upon request.

Table 2
Association between TV advertising and soft drink consumption.

VARIABLES	Model 1 Advertising for Regular CSDs (Std. Dev) [Elasticity]	Model 2 Advertising for Diet CSDs (Std. Dev) [Elasticity]	Model 3 Advertising for Fast Food (Std. Dev) [Elasticity]	Model 4 Advertising for Cereal (Std. Dev) [Elasticity]	Model 5 Advertising for Cereal, Fast Food & CSDs (Std. Dev) [Elasticity]
Regular CSD Advertising	0.0938*** (0.026) [0.0653]				
Diet Soft drink Advertising		0.8454** (0.346) [0.0643]			
Fast Food Advertising			0.0157** (0.008) [0.0691]		0.0012 (0.011) [0.0053]
Cereal Advertising				0.0195 (0.014) [0.0340]	0.0044 (0.013) [0.0077]
Diet & Regular Soft Drink Advertising					0.0798* (0.041) [0.0616]
Male	0.1681*** (0.036)	0.1659*** (0.036)	0.1671*** (0.035)	0.1669*** (0.035)	0.1681*** (0.035)
Black Non-Hispanic	−0.0393 (0.092)	−0.0356 (0.091)	−0.0347 (0.091)	−0.0325 (0.092)	−0.0399 (0.092)
Hispanic	−0.0543 (0.042)	−0.0467 (0.044)	−0.0494 (0.042)	−0.0495 (0.043)	−0.0548 (0.042)
Asian	−0.3150*** (0.085)	−0.3107*** (0.085)	−0.3078*** (0.086)	−0.3128*** (0.086)	−0.3158*** (0.087)
Other Race	0.0166 (0.069)	0.0166 (0.069)	0.0192 (0.069)	0.0176 (0.068)	0.0158 (0.068)
Age in Months	−0.0872 (0.157)	−0.0945 (0.154)	−0.0927 (0.155)	−0.0834 (0.156)	−0.0870 (0.157)
Age in Months Sq	0.0004 (0.001)	0.0004 (0.001)	0.0004 (0.001)	0.0003 (0.001)	0.0004 (0.001)
Mother's Age	−0.0217 (0.021)	−0.0218 (0.021)	−0.0228 (0.022)	−0.0233 (0.022)	−0.0218 (0.021)
Mother's Age Sq	0.0002 (0.000)	0.0002 (0.000)	0.0002 (0.000)	0.0002 (0.000)	0.0002 (0.000)
Middle SES	0.0828 (0.054)	0.0837 (0.055)	0.0840 (0.054)	0.0838 (0.055)	0.0832 (0.054)
High SES	−0.0832 (0.067)	−0.0823 (0.067)	−0.0850 (0.066)	−0.0867 (0.066)	−0.0838 (0.067)
Single	−0.0689 (0.071)	−0.0668 (0.071)	−0.0671 (0.072)	−0.0690 (0.072)	−0.0679 (0.072)
Divorced	0.0487 (0.050)	0.0483 (0.050)	0.0493 (0.050)	0.0505 (0.049)	0.0497 (0.049)
TV Viewing	0.0271 (0.019)	0.0270 (0.019)	0.0268 (0.019)	0.0270 (0.019)	0.0270 (0.019)
Living outside top56 DMAs	0.0542 (0.055)	0.0535 (0.064)	0.0621 (0.074)	−0.0098 (0.052)	0.0710 (0.070)
Constant	4.9357 (10.433)	5.4434 (10.290)	5.3493 (10.324)	4.7160 (10.382)	4.9036 (10.452)
Observations	9760	9760	9760	9760	9760
R-squared	0.033	0.032	0.032	0.031	0.033
Advertising *p*-value					0.0110

Note: Dependent variable pertains to the natural log of children's soft drink consumption, adjusted for skewness. Robust standard errors are shown in parentheses. Controls for Census region are included in all regressions. Elasticities calculated at the advertising mean are reported in brackets. Advertising *p*-value refers to the joint significance of advertising variables in column (5). Regressions are weighted and clustered by designated market area.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

We corrected standard errors for clustering at the DMA-level of our advertising measures. Cross-sectional child-level weights for parental interview data were applied in all models. Table 1 defines all variables in the estimation and provides their descriptive statistics.

3. Results

Fifth-graders consumed a mean (SD) of 0.46 (0.75) fast food meals/snacks per day, with higher intake among low-SES children of 0.71 (1.1) and African-American children of 0.78 (1.1). Some children reported no consumption of fast food within the last 7 days (27%), but 12% of the respondents consumed fast food at least daily. Soft drink consumption was on average 0.91 (1.11) servings daily, with 15% of children not drinking them in the last 7 days and 19% reporting at least 2 daily servings. Children viewed about 2.4 (1.2) hours of television per day with only 9% children watching TV for less than 1 h. The average 6–11-year-old child in the top 56 DMAs viewed 297 fast food commercials on spot TV in 2002 (0.81 per day) and 238 (0.65 per day) in 2004 (29,748 and 23,772 GRPs, respectively). Local advertising exposure was less intense for CSDs, 0.17 ads per day in 2002 and 0.10 in 2004.

Table 2 presents results from estimations where child soft drink consumption is the outcome. As predicted, an increase in TV exposure to sugar-sweetened CSD advertising by 10,000 GRPs over the three-year period (the equivalent of exposure to 100 ads in total or about 33 ads per year) was associated with a 9.4% increase in children's consumption of soft drinks, significant at the 1% level (column 1). The elasticity at the mean value of regular CSD advertising (0.696) implies that a 100% increase in sugar-sweetened CSD advertising was associated with a 6.5% increase in children's consumption of soft drinks. The same increase in exposure to fast food advertising was associated with a smaller soft drink consumption rise of 1.6%, significant at the 5% level (column 3). This positive effect reveals the complementary nature of soft drinks and fast food. When all three advertising measures (CSDs, fast food, and cereal) were included, they were jointly significant ($p = 0.011$) (column 5).

Table 3 presents results from estimations where child fast food consumption is the outcome. An increase in TV exposure to fast food advertising by 10,000 GRPs over the three-year period was associated with a 1.1% increase in children's consumption of fast food, significant at the 10% level (column 3). A significant 7.4% increase is found for a

Table 3
Association between TV advertising and fast food consumption.

Variables	Model 1 Advertising for Regular CSDs (Std. Dev) [Elasticity]	Model 2 Advertising for Diet CSDs (Std. Dev) [Elasticity]	Model 3 Advertising for Fast Food (Std. Dev) [Elasticity]	Model 4 Advertising for Cereal (Std. Dev) [Elasticity]	Model 5 Advertising for Cereal, Fast Food & CSDs (Std. Dev) [Elasticity]
Regular CSD Advertising	0.0736** (0.025) [0.0512]				
Diet Soft drink Advertising		0.4593* (0.260) [0.0349]			
Fast Food Advertising			0.0109* (0.006) [0.0480]		0.0015 (0.009) [0.0066]
Cereal Advertising				−0.0014 (0.017) [0.0024]	−0.0152 (0.016) [−0.0265]
Diet & Regular Soft Drink Advertising					0.0706** (0.034) [0.0545]
Male	0.0530 (0.036)	0.0514 (0.036)	0.0522 (0.036)	0.0514 (0.036)	0.0524 (0.036)
Black Non-Hispanic	0.2261*** (0.064)	0.2309*** (0.063)	0.2304*** (0.064)	0.2357*** (0.062)	0.2290*** (0.063)
Hispanic	0.1234** (0.046)	0.1301*** (0.047)	0.1278*** (0.046)	0.1320** (0.050)	0.1273** (0.048)
Asian	−0.1427* (0.076)	−0.1383* (0.076)	−0.1369* (0.077)	−0.1354* (0.076)	−0.1380* (0.077)
Other Race	0.0267 (0.063)	0.0278 (0.063)	0.0289 (0.063)	0.0305 (0.062)	0.0290 (0.063)
Age in Months	−0.2162 (0.141)	−0.2206 (0.141)	−0.2202 (0.142)	−0.2179 (0.139)	−0.2213 (0.141)
Age in Months Sq	0.0008 (0.001)	0.0008 (0.001)	0.0008 (0.001)	0.0008 (0.001)	0.0008 (0.001)
Mother's Age	−0.0260 (0.032)	−0.0264 (0.033)	−0.0269 (0.033)	−0.0271 (0.033)	−0.0258 (0.032)
Mother's Age Sq	0.0003 (0.000)	0.0003 (0.000)	0.0003 (0.000)	0.0003 (0.000)	0.0003 (0.000)
Middle SES	−0.1715*** (0.047)	−0.1710*** (0.047)	−0.1707*** (0.047)	−0.1714*** (0.047)	−0.1719*** (0.047)
High SES	−0.3054*** (0.063)	−0.3052*** (0.064)	−0.3068*** (0.064)	−0.3062*** (0.064)	−0.3036*** (0.063)
Single	0.0552 (0.083)	0.0556 (0.083)	0.0561 (0.083)	0.0529 (0.084)	0.0539 (0.083)
Divorced	0.0843** (0.038)	0.0836** (0.038)	0.0845** (0.038)	0.0823** (0.037)	0.0816** (0.037)
TV Viewing 5th gr	0.0246 (0.023)	0.0246 (0.023)	0.0244 (0.023)	0.0247 (0.023)	0.0247 (0.023)
Living outside top 56 DMAs	0.0879** (0.042)	0.0579 (0.044)	0.0825* (0.047)	−0.0128 (0.059)	0.0610 (0.056)
Constant	13.8070 (9.501)	14.1381 (9.531)	14.1150 (9.593)	14.0195 (9.375)	14.1996 (9.489)
Observations	9760	9760	9760	9,760	9760
R-squared	0.040	0.040	0.040	0.039	0.040
Advertising *p*-value					0.0457

Note: Dependent variable pertains to the natural log of fast food consumption, adjusted for skewness. Robust standard errors are shown in parentheses. Controls for Census region are included in all regressions. Elasticities calculated at the advertising mean are reported in brackets. Advertising *p*-value refers to the joint significance of advertising variables in column (5). Regressions are weighted and clustered by designated market area.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

similar increase in regular CSD advertising, again revealing a strong complementary nature of the two goods. The elasticities are roughly the same at 0.05. When all three advertising measures (CSDs, fast food, and cereal) were included, they were jointly significant ($p = 0.046$) (column 5).

For both soft drink and fast food consumption, carbonated soft drink advertising emerges as a strong and significant predictor of consumption. Multicollinearity across the various measures of advertising for less healthy products may be an issue, causing the effects of soft drink advertising to dominate. Moreover, soft drink advertising is likely to be significant due to the possible nonlinear nature of advertising; since the mean of soft drink advertising is much lower than that of fast food advertising, the effect is greater at the mean.

As illustrated in Table 4, increments in TV food advertising exposure had no detectable effects on average body weight as measured by BMI *z*-scores with the exception of a marginally significant negative effect for cereal advertising ($\beta = -0.026$; $p < 0.10$) (column 4). However, the results changed when we isolated the upper tail of the BMI distribution to focus on children with BMIs at or above the 85th percentile, who were predicted to have significantly higher BMI *z*-scores with incremental exposure to TV fast food advertising. Specifically, a 10,000 GRP increase in fast food advertising was associated with a 0.01 unit increase in the BMI *z*-score ($p < 0.01$), an increase of 1.5% from a mean BMI *z*-score of 0.668 (column 3). The implied elasticity for the 85th percentile is 0.065.[7] Similar results for fast food advertising can be seen for the 75th and 95th percentiles of the BMI distribution, albeit less precisely measured ($p < 0.10$).

While fruit, vegetable, and milk consumption can be indirectly affected by advertising of less healthy foods due to displacement, we did not expect them to shift significantly as a result of fast food or soft drink advertising. Table 5 documents no significant association between our advertising measures and fruit and vegetable

[7] In their study, Chou et al. (2008) find implied BMI elasticities for fast-food restaurant advertising of 0.0157 for 3–11 year-olds, and 0.0263 for 12–18 year-olds.

Table 4
Association between TV advertising and body mass index z-score.

VARIABLES	Model 1 Advertising for Regular CSDs (Std. Dev) [Elasticity]	Model 2 Advertising for Diet CSDs (Std. Dev) [Elasticity]	Model 3 Advertising for Fast Food (Std. Dev) [Elasticity]	Model 4 Advertising for Cereal, Fast Food & CSDs (Std. Dev) [Elasticity]
Whole Sample				
Regular CSD Advertising	0.0123 (0.031) [0.0128]			
Diet CSD Advertising		0.1012 (0.318) [0.0115]		
Fast Food Advertising			0.0046 (0.006) [0.0303]	0.0108 (0.011)[0.0712]
Cereal Advertising				−0.0259* (0.015) [−0.0677]
Diet & Regular CSD Advertising				−0.0089 (0.050) [−0.0103]
Observations	9760	9760	9760	9760
R-squared	0.049	0.049	0.049	0.050
Advertising *p*-value				0.342
75th Percentile and above				
Regular CSD Advertising	0.0142 (0.027) [0.0148]			
Diet CSD Advertising		−0.0353 (0.213) [−0.0040]		
Fast Food Advertising			0.0083* (0.005) [0.0547]	0.0160** (0.008) [0.1054]
Cereal Advertising				−0.0065 (0.012) [−0.0170]
Diet & Regular CSD Advertising				−0.0374 (0.031) [−0.0432]
Observations	4838	4838	4838	4838
R-squared	0.036	0.036	0.037	0.038
Advertising *p*-value				0.220
85th Percentile and above				
Regular CSD Advertising	0.0277 (0.021) [0.0289]			
Diet CSD Advertising		0.0933 (0.204) [0.0106]		
Fast Food Advertising			0.0099*** (0.004) [0.0652]	0.0153** (0.006) [0.1008]
Cereal Advertising				−0.0116 (0.011) [−0.0303]
Diet & Regular CSD Advertising				−0.0199 (0.026) [−0.0230]
Observations	3808	3808	3808	3808
R-squared	0.049	0.049	0.052	0.053
Advertising *p*-value				0.041
95th Percentile and above				
Regular CSD Advertising	0.0098 (0.015) [0.0102]			
Diet CSD Advertising		0.0032 (0.125) [0.0004]		
Fast Food Advertising			0.0052* (0.003) [0.0343]	0.0107* (0.006) [0.0705]
Cereal Advertising				−0.0112* (0.006) [−0.0293]
Diet & Regular CSD Advertising				−0.0212 (0.020) [−0.0245]
Observations	2062	2062	2062	2062
R-squared	0.085	0.085	0.087	0.089
Advertising *p*-value				0.178

Source: Authors' analysis.
Notes: Dependent variable pertains to the BMI z-score. Robust standard errors are shown in parentheses. Controls for birth weight, gender, race/ethnicity, age, mother's age, socioeconomic status, mother's marital status, TV viewing, and Census region are included in all regressions. Elasticities calculated at the BMI z-score and advertising means are reported in brackets. Advertising *p*-value refers to the joint significance of advertising variables in column (5). Regressions are weighted and clustered by designated market area.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

consumption, and only cereal advertising predicted lower milk consumption. We found that advertising for fast food was marginally associated with lower children's vigorous physical activity, potentially reflecting the positive association of fast food advertising with BMI for heavier children and their lower engagement in physical activity.

Due to the skewed and categorical nature of our consumption measures, we perform several robustness

Table 5
Specification checks: associations between TV advertising and alternative outcomes.

VARIABLES	Model 1 Advertising for Regular CSDs (Std. Dev) [Elasticity]	Model 2 Advertising for Diet CSDs (Std. Dev) [Elasticity]	Model 3 Advertising for Fast Food (Std. Dev) [Elasticity]	Model 4 Advertising for Cereal, Fast Food & CSDs (Std. Dev) [Elasticity]
Dependent variable: Log of fruit and vegetable consumption				
Regular CSD Advertising	0.0172 (0.024) [0.0120]			
Diet CSD Advertising		0.2357 (0.220) [0.0179]		
Fast Food Advertising			0.0017 (0.005) [0.0075]	−0.0042 (0.008) [−0.0185]
Cereal Advertising				0.0086 (0.011) [0.0150]
Diet & Regular CSD Advertising				0.0255 (0.035) [0.0197]
Observations	9760	9760	9760	9760
R-squared	0.022	0.022	0.022	0.022
Advertising *p*-value				0.7706
Dependent variable: Log of milk consumption				
Regular CSD Advertising	0.0103 (0.025) [0.0072]			
Diet CSD Advertising		0.3238* (0.191) [0.0246]		
Fast Food Advertising			0.0001 (0.005) [0.0004]	0.0004 (0.006) [0.0018]
Cereal Advertising				−0.0289*** (0.009) [−0.0505]
Diet & Regular CSD Advertising				0.0281 (0.024) [0.0217]
Observations	9760	9760	9760	9760
R-squared	0.044	0.045	0.044	0.046
Advertising *p*-value				0.0109
Dependent variable: Vigorous physical activity				
Regular CSD Advertising	−0.0708 (0.049) [−0.0493]			
Diet CSD Advertising		−0.1479 (0.610) [−0.0112]		
Fast Food Advertising			−0.0240* (0.013) [−0.1056]	−0.0412* (0.023) [−0.1814]
Cereal Advertising				0.0529 (0.032) [0.0924]
Diet & Regular CSD Advertising				0.0450 (0.089) [0.0347]
Observations	9570	9570	9570	9570
R-squared	0.051	0.050	0.051	0.052
Advertising *p*-value				0.1385

Source: Authors' analysis.
Notes: Robust standard errors are shown in parentheses. Standard controls included in Tables 2–4 are included in all regressions. Elasticities calculated at the advertising mean are reported in brackets for fruit & vegetable consumption and milk consumption. Semi-elasticities calculated at the advertising mean are reported in brackets for vigorous physical activity. Regressions are weighted and clustered by designated market area.
* $p < 0.10$.
** $p < 0.05$
*** $p < 0.01$.

checks by employing alternative specifications. These results are presented in Table A4a (for soda consumption as an outcome) and Table A4b (for fast food consumption as an outcome). The first four rows show results from separate regressions, with the standard control variables included in each model.

The first column of Tables A4a and A4b reports results for 2002–2003 advertising (excluding 2004, the year in which our outcome variables are measured). These results are in general slightly stronger than the results in Tables 2 and 3, and thus remain consistent. Column 2 presents probit results where consumption = 1 if an individual consumed the product *daily* and 0 otherwise. (Marginal effects are reported.) The qualitative nature of the results remains the same. Columns 3 and 4 report results for negative binomial and ordered probit models, respectively, using the original food consumption categories provided in the questionnaire.[8] Results again remain robust to specification. The last column (Column 5) reports results from models using a slightly altered top category for consumption—6 rather than 4. These results are qualitatively similar to those reported in Tables 2 and 3.

4. Discussion

We observed higher consumption of soft drinks and fast food in children with increased exposure to TV advertising

[8] Results from Poisson models were very similar to negative binomial models. Negative binomial models are preferred since tests for equidispersion were rejected, suggesting that Poisson models were inappropriate.

for CSDs and fast food. These findings suggest that children's exposure to advertising for calorie-dense nutrient-poor foods is associated with increased overall consumption of the unhealthy food categories commonly advertised to children. This may contribute to poor diet in children in the short-term, with potential long-term effects on BMI and health, especially among the heaviest children.

Additionally, we found an association between CSD advertising and soft drink consumption regardless of whether we used advertising measures for sugar-sweetened or diet products or their combination. Recently, beverage companies have increased advertising of their diet products relative to sugar-sweetened products (Harris et al., 2010a), yet our results suggest it does not matter. Lack of association in models testing the specification (e.g., cereal advertising as a predictor of soft drink and fast food consumption) also helps rule out potential spurious correlation.

The association between exposure to TV food advertising and children's body weight is mainly confined to the upper tail of the BMI distribution. Increasing exposure to fast food advertising on TV is strongly associated with higher BMI z-scores among 5th graders in the upper tails of the BMI distribution starting at the 75th percentile. The opposite is true for exposure to cereal advertising, although the negative BMI association may be explained by breakfast eating behaviors. Cereal consumption predicts the probability that a child eats breakfast (Albertson et al., 2003; Nicklas et al., 1994), and consuming breakfast is associated with good health (Siega-Riz et al., 1998).

There have been recent public health initiatives to reduce children's exposure to advertising for energy-dense nutrient-poor foods, in particular CSDs and fast food. One such initiative is the 2006 Children's Food and Beverage Advertising Initiative (CFBAI) (Council of Better Business Bureaus, 2009). This initiative relies on industry self-regulation to improve the nutritional quality of foods marketed to children, although recent evaluations of food advertising to children highlight the limitations of this self-regulatory approach (Harris et al., 2010b; Kunkel et al., 2009). Since 2004, children's exposure to CSD advertising has declined by 67% (Harris et al., 2010b). Powell et al. (2010) also find a marked reduction in exposure to food advertising by children and adolescents after the CFBAI, reporting reductions in exposure to sweet and beverage ads between 2003 and 2007. However, they identify increases in exposure to fast food ads in the same time period. Most major beverage companies belong to the CFBAI, and they have taken dramatic steps to reduce their television advertising to children. In contrast, exposure to fast food advertising increased by 21% during the same period. Only two major fast food advertisers (McDonald's and Burger King) belong to the CFBAI; and these companies, along with non-participating fast food advertisers, have instead introduced a few more nutritious options to their children's meals, but have continued to advertise their products extensively to children. More research is needed on the effectiveness of the industry initiatives.

Our findings are subject to limitations. First, survey consumption measures are based on children's self-reports, which may underestimate actual intake. We have no details on actual food consumption and cannot distinguish between diet and regular soft drinks, types of foods consumed at fast food restaurants, or cereal consumption. Also, lack of association between advertising and children's body weight across the BMI distribution may be partly due to BMI being a stock variable and less stable for children than adults. While the BMI z-score adjusts for child's age and gender (by obtaining the z-score within each age/gender cell), growth patterns differ from child to child, and we do not capture long-run changes in body weight due to the short time period analyzed. As an example of concerns with using BMI as a measure of child's health, obesity was found to be a very poor gauge of high cholesterol in children (Lee et al., 2009). In adults, fat-free mass, or body composition, is likely a more accurate measure of adiposity than BMI (Burkhauser and Cawley, 2008; Wada and Tekin, 2010). The primary contribution of this paper therefore pertains to food consumption and not body mass index.

Although fruit and sports drinks were included in the consumption question for soft drinks, we do not include advertising for these drinks. Children between the ages of 6 and 11 were exposed to a similar number of ads for fruit drinks and soft drinks in 2003 (Powell et al., 2010). We are therefore underestimating the exposure to advertising by children.

Our results may be overestimates in the sense that the existence of the advertising does not equate to its exposure. Yet the results are underestimates in the sense that only spot advertising is analyzed and children are exposed to food advertising through multiple media channels. As stated above, soft drink advertising does not include fruit and sports drinks. While it has been found that exposure to television food advertising has not increased over the 1977–2004 period, children see about 50 percent of television food advertising on children's programming (Holt et al., 2007).

Another significant limitation is lack of advertising data for children living outside the top 55 DMAs (about 44% of our sample) or the possibility that a child moved between 2002 and 2003. Furthermore, while evaluating delayed effects of exposure to advertising in our study (throughout 2002–2004 and consumption in 2004) could be a concern, there is evidence that young children's exposure to commercial television in 1997 affected their BMI in 2002 (Zimmerman and Bell, 2010).

Most importantly, our study establishes associations rather than definitive causal mechanisms. Although our models carefully control for a host of confounding factors and include robustness checks to ensure that the effects found are not due to spurious correlation, causality from advertising to food consumption cannot be inferred using the current data and methods. Urgently-needed future research in this area should tackle the difficult identification problem of finding and exploiting exogenous variation in advertising exposure and linking it to consumption in nationally representative panel data.

In summary, our results provide evidence that children's exposure to soft drink and fast food advertising on television is associated with increased consumption of the

Please cite this article in press as: Andreyeva, T., et al., Exposure to food advertising on television: Associations with children's fast food and soft drink consumption and obesity. Econ. Hum. Biol. (2011), doi:10.1016/j.ehb.2011.02.004

advertised product categories. As the overwhelming majority of food commercials viewed by children are for energy-dense nutrient-poor foods, excessive intake of advertised foods may ultimately present risk for weight gain. In light of the epidemic of childhood obesity, continuing child exposure to advertising for nutritionally-poor foods is a serious public health concern.

Acknowledgements

This research was supported by grants from the Robert Wood Johnson Foundation and the Rudd Foundation. The authors thank Roy Wada, John Cawley, three anonymous referees, and participants at the 2009 Workshop on the Economics of Obesity at the Paris School of Economics, the 2009 FTC Forum on Sizing Up Food Marketing and Childhood Obesity, the 2nd Annual Meeting on the Economics of Risky Behavior, and the 2010 American Society of Health Economists conference for helpful comments. The authors alone are responsible for errors.

Appendix A

See Tables A1–A3 and Tables A4a and A4b.

Table A1
Top 55 designated market areas in 2002–2004 used in study.

DMA	DMA
ALBUQUERQUE-SANTA FE	MEMPHIS
ATLANTA	MIAMI-FT. LAUDERDALE
AUSTIN	MILWAUKEE
BALTIMORE	MINNEAPOLIS-ST. PAUL
BIRMINGHAM (ANN TUSC)	NASHVILLE
BOSTON (MANCHESTER)	NEW ORLEANS
BUFFALO	NEW YORK
CHARLOTTE	NORFOLK-PORTSMTH-NEWPT NWS
CHICAGO	OKLAHOMA CITY
CINCINNATI	ORLANDO-DAYTONA BCH-MELBRN
CLEVELAND-AKRON (CANTON)	PHILADELPHIA
COLUMBUS OH	PHOENIX (PRESCOTT)
DALLAS-FT. WORTH	PITTSBURGH
DENVER	PORTLAND OR
DETROIT	PROVIDENCE-NEW BEDFORD
GRAND RAPIDS-KALMZOO-B.CRK	RALEIGH-DURHAM (FAYETVLLE)
GREENSBORO-H.POINT-W.SALEM	SACRAMNTO-STKTON-MODESTO
GREENVLL-SPART-ASHEVLL-AND	SALT LAKE CITY
HARRISBURG-LNCSTR-LEB-YORK	SAN ANTONIO
HARTFORD & NEW HAVEN	SAN DIEGO
HOUSTON	SAN FRANCISCO-OAK-SAN JOSE
INDIANAPOLIS	SEATTLE-TACOMA
JACKSONVILLE	ST. LOUIS
KANSAS CITY	TAMPA-ST. PETE (SARASOTA)
LAS VEGAS	WASHINGTON DC (HAGRSTWN)
LITTLE ROCK-PINE BLUFF	WEST PALM BEACH-FT. PIERCE
LOS ANGELES	WILKES BARRE-SCRANTON
LOUISVILLE	

Table A2
Specification checks: Model 1 of Table 2 & Model 3 of Table 3 without controls.

Variables	Dependent Variable		
	Soft Drink Consumption	Fast Food Consumption	BMI
	Model 1 Advertising for Regular CSDs (Std. Dev)	Model 3 Advertising for Fast Food (Std. Dev)	
Regular CSD Advertising	0.0377 (0.035)		0.0131 (0.066)
Fast Food Advertising		0.0011 (0.005)	−0.0072 (0.011)
Observations	9760	9760	9760
R-squared	0.0009	0.0000	0.0005
Advertising p-value			0.2607

Source: Authors' analysis.
Notes: Robust standard errors are shown in parentheses. Regressions are weighted and clustered by designated market area. *$p < 0.10$. **$p < 0.05$. ***$p < 0.01$.

Table A3
Specification checks: Model 1 of Table 2 & Model 3 of Table 3 separately by advertising year.

Variables	Dependent Variable		
	Soft Drink Consumption	Fast Food Consumption	BMI
	Model 1 Advertising for Regular CSDs (Std. Dev)	Model 3 Advertising for Fast Food (Std. Dev)	
2002			
Regular CSD Advertising	0.3339*** (0.070)		0.089 (0.124)
Fast Food Advertising		0.043** (0.019)	−0.004 (0.028)
Observations	5791	5791	5791
R-squared	0.0411	0.0472	0.0625
2003			
Regular CSD Advertising	0.2977*** (0.100)		−0.222 (0.149)
Fast Food Advertising		0.0387** (0.019)	0.019 (0.030)
Observations	5734	5734	5734
R-squared	0.0396	0.0471	0.0653
2004			
Regular CSD Advertising	0.3039*** (0.097)		−0.2854** (0.139)
Fast Food Advertising		0.0391 (0.026)	0.052* (0.030)
Observations	6299	6299	6299
R-squared	0.0336	0.0410	0.0624

Source: Authors' analysis.
Notes: Robust standard errors are shown in parentheses. Standard controls included in Tables 2–5 are included in all regressions. Regressions are weighted and clustered by designated market area.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

Table A4a
Robustness of results to various specifications: soda consumption.

Variables	(1) 2002–2003 Advertising	(2) Probit	(3) Negative Binomial	(4) Ordered Probit	(5) Adjusted Consumption Measures
Regular CSD Advertising	0.1520*** (0.033)	0.0373*** (0.009)	0.6480*** (0.139)	0.0957*** (0.025)	0.1073*** (0.031)
Diet CSD Advertising	1.0195* (0.538)	0.3382** (0.143)	5.5908*** (1.964)	0.8526** (0.361)	0.9706** (0.409)
Fast Food Advertising	0.0237** (0.010)	0.0059** (0.003)	0.1062** (0.047)	0.0156** (0.008)	0.0178* (0.009)
Cereal Advertising	0.0286 (0.019)	0.0064 (0.008)	0.1116 (0.105)	0.0207 (0.014)	0.0215 (0.016)
Fast Food Advertising	−0.0026 (0.016)	−0.0003 (0.005)	−0.0036 (0.068)	−0.0002 (0.011)	0.0008 (0.013)
Cereal Advertising	0.0083 (0.018)	0.0005 (0.007)	0.0059 (0.086)	0.0060 (0.013)	0.0044 (0.015)
Diet & Regular CSD Advertising	0.1439** (0.061)	0.0352** (0.017)	0.6027*** (0.219)	0.0852** (0.040)	0.0935* (0.048)
Advertising *p*-value	0.00112	0.00042	0.0000	0.0033	0.01343
Observations	9760	9760	9760	9760	9760

* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

Table A4b
Robustness of results to various specifications: fast food consumption.

Variables	(1) 2002–2003 Advertising	(2) Probit	(3) Negative Binomial	(4) Ordered Probit	(5) Adjusted Consumption Measures
Regular CSD Advertising	0.1098*** (0.036)	0.0133** (0.005)	0.3245*** (0.087)	0.0766*** (0.023)	0.0798*** (0.028)
Diet CSD Advertising	0.5306 (0.459)	0.1550*** (0.057)	2.9934*** (0.896)	0.5424** (0.242)	0.4926* (0.292)
Fast Food Advertising	0.0157* (0.009)	0.0018 (0.001)	0.0488** (0.021)	0.0108* (0.006)	0.0120* (0.007)
Cereal Advertising	−0.0013 (0.020)	−0.0029 (0.005)	−0.0092 (0.068)	−0.0041 (0.017)	−0.0014 (0.018)
Fast Food Advertising	0.0004 (0.014)	−0.0002 (0.003)	0.0046 (0.037)	0.00001 (0.009)	0.0020 (0.010)
Cereal Advertising	−0.0197 (0.019)	−0.0059 (0.004)	−0.0774 (0.049)	−0.0183 (0.015)	0.0751* (0.038)
Diet & Regular CSD Advertising	0.1151** (0.054)	0.0163 (0.010)	0.3330** (0.152)	0.0805** (0.035)	−0.0165 (0.018)
Advertising *p*-value	0.03494	0.00872	0.0000	0.0100	0.05718
Observations	9760	9760	9760	9760	9760

Notes: Marginal effects evaluated at the mean are reported in columns (2) and (3). Coefficients are reported in remaining columns. Weekly consumption values are used in the negative binomial count models. Raw responses are used in ordered probit models. Robust standard errors are shown in parentheses. Standard controls included in Tables 2–5 are included in all regressions. Regressions are weighted and clustered by designated market area.
* $p < 0.10$.
** $p < 0.05$.
*** $p < 0.01$.

References

Albertson, A.M., Anderson, C.H., Crockett, S.J., Goebel, M.T., 2003. Ready-to-eat cereal consumption: Its relationship with BMI and nutrient intake of children aged 4 to 12 years. J. Am. Diet. Assoc. 103, 1613–1619.
Bagwell, K., 2007. The economic analysis of advertising. In: Armstrong, M., Porter, R. (Eds.), Handbook of Industrial Organization, vol. III. Elsevier, pp. 1701–1844.
Barr-Anderson, D.J., Larson, N.I., Nelson, M.C., Neumark-Sztainer, D., Story, M., 2009. Does television viewing predict dietary intake five years later in high school students and young adults? Int. J. Behav. Nutr. Phys. Act. 6, 7.
Burkhauser, R.V., Cawley, J., 2008. Beyond BMI: the value of more accurate measures of fatness and obesity in social science research. J. Health Econ. 27, 519–529.
Chou, S., Rashad, I., Grossman, M., 2008. Fast-food restaurant advertising on television and its influence on childhood obesity. J. Law Econ. 51, 599–618.
Collison, K.S., Zaidi, M.Z., Subhani, S.N., et al., 2010. Sugar-sweetened carbonated beverage consumption correlates with BMI, waist circumference, and poor dietary choices in school children. BMC Public Health 10, 234.
Council of Better Business Bureaus, 2009. Children's food and beverage advertising initiative; http://us.bbb.org/WWWRoot/SitePage.aspx?site=113&id=dba51fbb-9317-4f88-9bcb-3942d7336e87. Accessed Feb. 5, 2009.
Desrochers, D.M., Holt, D.J., 2007. Children's exposure to television advertising: implications for childhood obesity. Am. Market. Assoc. 26, 182–201.
Epstein, L.H., Roemmich, J.N., Robinson, J.L., et al., 2008. A randomized trial of the effects of reducing television viewing and computer use on body mass index in young children. Arch. Pediatr. Adolesc. Med. 162, 239–245.
Federal Trade Commission, 2008. Marketing Food to Children and Adolescents. A Review of Industry Expenditures, Activities, and Self-Regulation. A report to Congress; http://www.ftc.gov. Accessed Sept. 20, 2008.

Frieden, T.R., Dietz, W., Collins, J., 2010. Reducing childhood obesity through policy change: acting now to prevent obesity. Health Aff. 29, 357–363.

Gasmi, F., Laffont, J.J., Vuong, Q., 1992. Econometric analysis of collusive behavior in a soft-drink market. J. Econ. Management Strategy 1, 277–311.

Goldberg, M.E., Gunasti, K., 2007. Creating an environment in which youths are encouraged to eat a healthier diet. J. Public Policy Market. 26, 162–181.

Halford, J.C.G., Boyland, M.J., Hughes, G., Oliveira, L.P., Dovey, T.M., 2007. Beyond-brand effect of television (TV) food advertisement/commercials on caloric intake and food choice of 5-7-year-old children. Appetite 49, 263–267.

Halford, J.C.G., Gillespie, J., Brown, V., et al., 2004. Effect of television advertisements for foods on food consumption in children. Appetite 42, 221–225.

Harris, J.L., Bargh, J.A., Brownell, K., 2009a. The direct effects of television food advertising on eating behavior. Health Psychol. 28, 404–413.

Harris, J.L., Pomeranz, J.L., Lobstein, T., Brownell, K.D., 2009b. A crisis in the marketplace: how food marketing contributes to childhood obesity and what can be done. Annu. Rev. Public Health 30, 211–225.

Harris, J.L., Sarda, V., Schwartz, M.B., 2010a. Television advertising for sugar-sweetened beverages: evidence of targeting by age and race.

Harris, J.L., Weinberg, M.E., Schwartz, M.B., et al., 2010b. Trends in television food advertising: Progress in reducing unhealthy marketing to young people? http://www.yaleruddcenter.org/resources/upload/docs/what/reports/RuddReport_TVFoodAdvertising_2.10.pdf. Accessed March 1, 2010.

Hastings, G., Stead, M., McDermott, L., et al., 2003. Review of research on the effects of food promotion to children; http://www.foodstandards.gov.uk/multimedia/pdfs/foodpromotiontochildren1.pdf. Accessed February 20, 2006.

Holt, D.J., Ippolito, P.M., Desrochers, D.M., Kelley, C.R., 2007. Children's Exposure to TV Advertising in 1977 and 2004: Information for the Obesity Debate. FTC, Washington, DC.

Institute of Medicine, 2006. National Academy of Sciences, Committee on Food Marketing and the Diets of Children and Youth. Food Marketing to Children and Youth: Threat or Opportunity?

Kuczmarski, R.J., Ogden, C.L., Grummer-Strawn, L.M., et al., 2000. CDC growth charts: United States. Adv. Data 2000, 1–27.

Kunkel, D., McKinley, C., Wright, P., 2009. The impact of industry self-regulation on the nutritional quality of foods advertised on television to children; http://www.childrennow.org/uploads/documents/adstudy_2009.pdf.

Lee, J.M., Gebremariam, A., Card-Higginson, P., et al., 2009. Poor performance of body mass index as a marker for hypercholesterolemia in children and adolescents. Arch. Pediatr. Adolesc. Med. 163, 716–723.

Nicklas, T.A., Meyers, L., Berenson, G.S., 1994. Impact of ready-to-eat cereal consumption on total dietary intake of children: The Bogalusa Heart Study. J. Am. Diet. Assoc. 94, 316–318.

Powell, L.M., Szczypka, G., Chaloupka, F.J., 2010. Trends in exposure to television food advertisements among children and adolescents in the United States. Arch. Pediatr. Adolesc. Med. 164, 794–802.

Powers, D.A., Xie, Y., 2008. Statistical Methods for Categorical Data Analysis. Emerald Group Publishing Ltd., UK.

Siega-Riz, A.M., Popkin, B.M., Carson, T., 1998. Trends in breakfast consumption for children in the United States from 1965-1991. Am. J. Clin. Nutr. 67, 748S–756S.

Story, M., Kaphingst, K.M., Robinson-O'Brien, R., Glanz, K., 2008. Creating healthy food and eating environments: policy and environmental approaches. Annu. Rev. Public Health 29, 253–272.

Swinburn, B., Sacks, G., Lobstein, T., et al., 2008. The 'Sydney Principles' for reducing the commercial promotion of foods and beverages to children. Public Health Nutr. 11, 881–886.

Tourangeau, K., Nord, C., Lê, T., et al., 2009. Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K), Combined User's Manual for the ECLS-K Eighth-Grade and K–8 Full Sample Data Files and Electronic Codebooks (NCES 2009-004). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education, Washington, DC.

U.S. Census Bureau, 1993. Money Income of Households, Families, and Persons in the United States, 1992. Current Population Reports P60-184. U.S. Government Printing Office, Washingston, DC.

Wada, R., Tekin, E., 2010. Body composition and wages. Econ. Hum. Biol. Accepted manuscript, Available online 20 February 2010.

White House Task Force on Childhood Obesity, 2010. Solving the problem of childhood obesity within a generation; http://www.letsmove.gov/tfco_fullreport_may2010.pdf. Accessed May 20, 2010.

Zimmerman, F.J., Bell, J.F., 2010. Associations of television content type and obesity in children. Am. J. Public Health 100, 334–340.

Zywicki, T.J., Holt, D., Ohlhausen, M., 2004. Obesity and Advertising Policy, George Mason University School of Law Working Paper 3.