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Food and beverage television advertising exposure and youth consumption, body mass index and adiposity outcomes

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Abstract

This study examined the relationships between exposure to food and beverage product television advertisements and consumption and obesity outcomes among youth. Individual-level data on fast-food and soft drink consumption and body mass index (BMI) for young adolescents from the Early Childhood Longitudinal Study – Kindergarten Cohort (1998–1999) and adiposity measures for children from the U.S. National Health and Nutrition Examination Survey (2003–2004) were combined with designated market area (DMA) Nielsen media advertising ratings data. To account for unobserved individual-level and DMA-level heterogeneity, various fixed- and random-effects models were estimated. The results showed that exposure to soft drink and sugar-sweetened beverage advertisements are economically and statistically significantly associated with higher frequency of soft drink consumption among youth even after controlling for unobserved heterogeneity, with elasticity estimates ranging from 0.4 to 0.5. The association between fast-food advertising exposure and fast-food consumption disappeared once we controlled for unobservables. Exposure to cereal advertising was significantly associated with young adolescents' BMI percentile ranking but exposures to fast-food and soft drink advertisements were not. The results on adiposity outcomes revealed that children's exposure to cereal advertising was associated with both percent body and trunk fatness; fast-food advertising was significantly associated with percent trunk fatness and marginally significantly associated with percent body fatness; and, exposure to SSB advertising was marginally significantly associated with percent body and trunk fatness. The study results suggest that continued monitoring of advertising is important and policy debates regarding the regulation of youth-directed marketing are warranted.

1. Introduction

Childhood obesity in North America is a major public health challenge. In 2011–12, 17.7% of children aged 6–11 and 20.5% of adolescents aged 12–19 in the U.S. were classified as obese, while estimates for 2009–11 show that 11.7% of Canadian children aged 5–17 were obese (Ogden et al. 2014; Roberts et al. 2012). Data for 2013–14 reveal that time spent watching television each week (hours:minutes) remained high in both the U.S. and Canada among children aged 2–11 (24:15 and 20:00, respectively) and teens aged 12–17 (20:26 and 19:24, respectively) (Television Bureau of Canada, 2015). Indeed, the food and nutrition environment in the U.S. is described as obesogenic and a contributor may be exposure to television advertising for unhealthy food and beverage products directed at youth. U.S. children aged 6–11 and adolescents aged 12–17 years old, respectively, saw, on average, approximately 13 and 16 television advertisements per day for food-related products in 2011 (Powell, Harris and Fox, 2013). The Federal Trade Commission reported that, in 2009, \$1.8 billion was spent on marketing of food and beverages to youth in the U.S., of which the single largest medium (\$632.7 million or 35.4%) was on television (Federal Trade Commission, 2012). Of all food-related youth-directed marketing, the largest expenditures were for fast food, carbonated beverages, and cereal product categories (Federal Trade Commission, 2012). Despite the establishment of the self-regulatory Children's Food and Beverage Advertising Initiative (CFBAI) in 2006 aimed at improving the nutritional quality of television advertisements directed at children in the U.S., it has been documented that the vast majority of foods and beverages marketed to children do not meet nationally or internationally recognized nutrition standards (Harris et al., 2011; Harris et al., 2012; Harris et al., 2010; Hingle et al., 2015; Kunkel et al., 2009; Kunkel et al., 2015; Powell et al., 2011).

Product advertising is hypothesized to complement utility derived from individuals' consumption/behavioral decisions (Becker and Murphy 1993). Early advertising theories proposed a hierarchy of advertising effects, where cognitive responses precede an affective emotional response, which in turn precedes conation or intent to buy the product (Fishbein and Ajzen, 1975; Lavidge and Steiner, 1961). Subsequent work suggested that responses are not necessarily hierarchical, but rather depend on the type of product and individual and that appeal to emotion and tastes are key factors (Batra and Ray 1986; Kempf and Smith 1998; MacKenzie et al. 1986; Meuhling 1987; Vakratsas and Ambler 1999). For example, youth's utility may be further enhanced from advertisements with media characters.

Economic analyses of food and beverage advertising have focused on whether brand advertising increases overall demand for a product category (i.e., soda or fast food) or just for the brand itself, reducing rivals' market share with no effect on overall consumption of, say, soda. The evidence suggests that advertising can do both – increase total demand and motivate brand switching. There is broad empirical evidence that brand advertising tends to take share away from competing brands, and thus advertising is a form of competition (Bagwell 2007). Evidence on the effect of brand advertising on overall demand, however, is quite mixed, with results varying across industries. There has been limited research testing such hypotheses on the overall causal effects of food advertising, particularly with respect to effects for youth. The hypothesis that advertising contributes to obesity assumes that

advertisements for food products alter consumers' preferences for food, so that they consume more or different types of products than they would have otherwise, resulting in higher total caloric intake. The food industry has argued that the causes of obesity are complex and advertising aims to change brand preference and has little or no effect on aggregate demand (Hoek and Gendall 2006). However, it is argued that particularly among youth, advertising may contribute to excessive consumption by normalizing a behavior. For example, "advertising of fast food [i.e., promotions and super sizing] maintains the impression that consumption of these products is consistent with a healthy diet, but offers little or no guidance about what is required to achieve a balanced and moderate food intake." (Hoek and Gendall 2006, p.414)

A 2006 Institute of Medicine (IOM) report concluded there was strong evidence for children aged 2–11 that television advertisements influenced short-term food consumption patterns and moderate evidence that they influenced usual dietary intake but insufficient corresponding evidence for teens aged 12–18 and evidence for both age groups that exposure to television advertising was significantly associated with adiposity (Institute of Medicine, 2006). However, the latter body of evidence was based on associations with television viewing that did not disentangle the causal pathway of advertising effects since television viewing may contribute to obesity through several mechanisms including the displacement of physical activity, snacking while watching television, and the influence of food advertising.

Following the 2006 IOM report, a limited number of previous papers have linked television advertising data to nationally representative individual-level data on children's and adolescents' consumption and/or body weight outcomes, controlling for television viewing. In a pioneering study, Chou, Rashad and Grossman (2008) found that greater exposure to fast-food advertising was statistically significantly associated with higher body mass index (BMI). However, controlling for TV viewing time, greater advertisement occurrences were only weakly associated with higher BMI among youth 12–18 years and not associated with higher BMI for 3–11 year olds. Their advertising measure was based on occurrences of the annual number of seconds of fast food restaurant messages aired (but not necessarily viewed) on local spot television in the largest 75 designated market areas provided by Competitive Media Reporting. Although this study did not take advantage of the individual-level longitudinal nature of their data, they did control for media market-level fixed effects. Andreyeva, Kelly and Harris (2011) estimated a cross-sectional model that linked Nielsen advertising exposure data from the top 55 media markets to 5th grade students' data and found that exposure to 100 additional regular carbonated soft drink advertisements in the years 2002 through 2004 was associated with 9.4% higher SSB consumption in 2004 and a similar increase in exposure to fast-food advertisements was associated with 1.1% higher fast-food consumption. Advertising exposure was not found to be associated with children's body weight with the exception of a significant association for fast-food advertising among those who were already overweight. The existing literature has focused on the cross-sectional association of television advertising with obesity as measured by body mass index (BMI) – but not longitudinal analyses or adiposity measures (Andreyeva, Kelly and Harris 2011; Chou, Rashad and Grossman 2008).

This present study adds to the literature by examining the impact of exposure to food and beverage product advertising using longitudinal analyses to account for unobserved time-invariant heterogeneity. Further, in exploratory cross-sectional analyses, we add to the literature by assessing measures of body fatness in addition to body weight outcomes. This study draws on television ratings data from Nielsen Media Research (NMR) linked to individual-level panel data from the Early Childhood Longitudinal Study – Kindergarten Cohort (ECLS-K) (1998–1999) and cross-sectional data from the U.S. National Health and Nutrition Examination Survey (NHANES) (2003–2004) to examine the association of advertising exposure to the heavily advertised food and beverage product categories of fast food, soft drink and sugar-sweetened beverages (SSBs), and cereal with consumption and with body weight and clinically measured adiposity (i.e., body fatness) outcomes.

2. Data

2.1 ECLS-K Data

Individual-level longitudinal data were drawn from two waves (5th graders in 2004 and 8th graders in 2007) of the ECLS-K that contain detailed self-reported survey information, including consumption patterns, and measured anthropometric data obtained from students. The restricted geocoded version of the ECLS-K allowed us to merge the television ratings data and the local area Census data. After dropping observations with missing covariates, we obtained an analytic sample of 8340 observations.

Dietary Outcome Measures—Information on adolescents’ frequency of fast-food consumption was collected in response to the question, “During the past 7 days, how many times did you eat a meal or snack from a fast food restaurant such as McDonald’s, Pizza Hut, Burger King, KFC, Taco Bell, Wendy’s and so on?” Information on frequency of soft drink consumption was based on the following question: “During the past 7 days, how many times did you drink Soda pop (for example Coke, Pepsi, Mountain Dew), sports drinks (for example Gatorade), or fruit drinks that are not 100% fruit juice (for example Kool-Aid, Hi-C, Fruitopia, Fruitworks)?” The categorical responses given by adolescents were converted into a numerical scale using midpoints to make it suitable for linear regression analysis. Recent studies that examined these outcomes in ECLS-K also found the linear regression model to be suitable for analysis (Andreyeva et al., 2011; Khan et al., 2012).

Anthropometric Outcome Measure—Our outcome measure for adolescent body weight was based on the gender-age-specific BMI percentile ranking. BMI (weight in kilograms/height in meters squared) was calculated from measured height and weight data obtained by ECLS-K staff.

Individual and Household Characteristics—Individual and household characteristics were controlled in regression analyses, including age and aged squared in months, gender, parent’s marital status (married, never married, separated/divorced, and widowed), indicator for the year of survey, weekly number of days the young adolescent ate breakfast with his/her parents, and weekly number of days the young adolescent ate dinner with his/her parents. We also controlled for the weekly number of hours the youth watched television.

Household socioeconomic status (SES) indicators included mother's highest educational achievement (less than high school education, high school education, and college degree or higher) and six income categories shown in Table 1. In addition, we controlled for whether the household was in an urban, suburban or rural area as defined by the U.S. Census Bureau, and included indicators for the month of interview (February through July) to control for seasonality of food and beverage television advertising as well as consumption patterns.

2.2 NHANES Data

Clinically measured individual-level adiposity outcomes for children aged 8–11 were obtained from the NHANES 2003–2004. The NHANES is an ongoing nationally representative survey designed to evaluate the health and nutritional status of the population in the US. Detailed descriptions of the NHANES have been published elsewhere (Centers for Disease Control and Prevention, 2011). The biennial survey was conducted over the 2-year period with approximately half of the respondents examined each year. The survey responses for children were provided by a household survey respondent. A confidential restricted-access version of the NHANES provided the actual year and month of the medical examination and the county FIPS and zip codes for linkage with the Nielsen television ratings data and Census data.

Clinically measured anthropometric outcomes and control variables—The NHANES 2003–2004 contained a number of clinically measured height, weight, and body composition measures that allowed the computation of adiposity measures. In addition to being able to compute the percentile ranking of the age-gender-specific BMI distribution, the NHANES 2003–2004 also contained information on body composition measured by dual energy x-ray absorptiometry (DXA). The NHANES DXA body composition measurements contained detailed information on the amount of body fat versus non-body fat mass that can be used to compute adiposity in body regions. For this paper, we constructed percent body fatness to reflect overall adiposity and percent trunk fatness to reflect visceral/abdominal adiposity. The body composition measurements in the NHANES have been previously used to assess the association of percent body fat with lipid concentrations among children and adolescents (Lamb et al., 2011) and with food prices among adolescents (Grossman, Tekin and Wada 2014).

The NHANES 2003–2004 contained 666 valid observations for DXA-based adiposity measures for children aged 8–11. After merging with the external dataset on television advertising exposures, the final sample consisted of 414 children for whom both the outcome and the independent variables of interest were available for analyses. Given the small sample size for which the DXA measures were available, we consider this work to be exploratory.

Control variables in the multivariate cross-sectional analyses included age, gender, race/ethnicity, marital status of the head of the household, income-based SES indicators, and educational attainment. Race/ethnicity indicators consisted of non-Hispanic black (black), non-Hispanic white (white), Hispanic, and other races (consisting mostly of Asians, Native Americans and other racial categories). Income-based SES was indicated by three levels of

the federal poverty-income-ratio (PIR): 0–130% of the federal poverty level (FPL), 131–185% of the FPL, and greater than 185% of the FPL). Marital status and educational attainment of the survey respondents were also included as proxies for household characteristics. Median household income from the Census 2000 was also merged to the individual-level NHANES observations at the zip code level to control for unobserved heterogeneity in neighborhood quality.

2.3 Television Ratings Data

Local spot and national television ratings data for food and beverage product advertisements were obtained monthly from 2003 through 2007 from NMR for the 88 full-discovery designated market areas (DMAs) in the U.S. available during that time period, which cover approximately 80% percent of the U.S. population. National advertising exposure was adjusted using DMA-level cable penetration rates (Szczypka et al., 2003).

The NMR advertising data are based on individual ratings of television programs, obtained by monitoring household audiences across DMAs. Ratings are measured in units of Targeted Ratings Points (TRPs) for specific subgroups of the population. TRPs were obtained for children aged 2–11 and adolescents aged 12–17. An advertisement with 100 TRPs per month, for example, is estimated to have been seen an average of one time by 100 percent of households with televisions in that DMA during that month. For each year, the monthly age-specific TRPs captured exposure to local spot and national (broadcast network, cable network, and syndicated) television food advertising from all programming (except Spanish language programming). The monthly TRPs were aggregated at the brand level and then categorized across food product categories using an NMR product classification code that defines product category based on that used by the Publisher's Information Bureau (Publishers Information Bureau, 2006).

Given that food consumption frequency measures were available in the ECLS-K for fast food and soft drink beverages, we were particularly interested in assessing the relationship between the advertising exposure measures related to these consumption items. Therefore, we assessed advertising exposure for fast food, soft drinks (which included SSBs plus diet soda). We also examined two narrower categories of soft drinks: SSBs and regular soda. The SSB advertising measure was defined using a combination of product classification codes and brand-specific nutrition information to include regular soda, as well as fruit drinks, bottled water with added sugar, isotonic drinks (sports drinks), and other sweetened drinks. Further, in models that examined body weight outcomes, exposure to cereal advertising also was assessed.

To assign local spot and national ratings data to each respondent in the ECLS-K and NHANES, we used the month of interview and the zip code and county geographic identifiers for each year to match youth to DMAs. There is no geographical overlap between DMAs. Together, zip code, county of residence, and date of survey allowed us to match each respondent to a unique DMA. For each individual, we generated his/her exposure to food and beverage advertising in the DMA in which he/she lived by using TRPs in that DMA during the two (NHANES) and three (ECLS-K) previous months from the month of interview (including the month of interview). Due to low sample sizes and the fact that we

only had the monthly advertising data available starting in 2003, we used two rather than three months prior advertising exposure to the date of interview for the NHANES data. For the ECLS-K, for 5th grade students, we assigned an average of the TRPs for 2–11 year olds and TRPs for 12–17 year olds; for 8th grade students, we used the TRPs for 12–17 year olds. For NHANES children, the TRPs for 2–11 year olds were used.

This study was approved by the Institutional Review Board at the University of Illinois at Chicago and the National Center for Education Statistics.

3. Methods

The empirical models in this study examined the relationship between consumption, BMI, and body fatness adiposity outcomes, and measures of exposure to food-related television advertising controlling for individual-level hours of television viewing, household- and individual-level characteristics, local area controls, and time trends. Taking advantage of the panel design of the ECLS-K data, we estimated various models that included individual random and fixed effects and DMA-level fixed effects to account for individual- and DMA-level unobserved time-invariant heterogeneity.

A reduced form equation that represents the model of young adolescents' food consumption (FC) and obesity (BMI percentile, percent body fatness, or percent trunk fatness) outcomes of the following form was estimated:

$$Outcome_{imt} = \beta_0 + \beta_1 TVAD_{imt} + \beta_2 TVVIEW_{it} + \beta_3 X_{imt} + \mu_m + \gamma_t + v_i + \varepsilon_{imt} \quad (1)$$

where the outcome indicated either FC_{imt} or $Obesity_{imt}$. $TVAD_{imt}$ measured the 3-month (ECLS-K) and 2-month (NHANES) average of television advertising exposure for individual i in DMA m , at time t . $TVVIEW_{it}$ measured individual i 's average weekly hours of television viewing at time t . X_{it} was a vector of individual and household characteristics, including the month of interview. β were conformable vectors of parameters to be estimated. μ_m was a vector of DMA fixed effects and γ_t was a vector of time fixed effects. v_i was the constant individual-specific residual and ε_{imt} was the standard residual term. To account for both unobserved time-invariant individual- and DMA-level heterogeneity, the longitudinal panel data were used to estimate various models that included individual-level random effects (RE), individual-level fixed effects (FE) and DMA-level FE. Specifically, we estimated five models for the ECLS-K data: 1) a cross-sectional model; 2) an individual-level RE model; 3) an individual-level FE model; 4) a DMA-level FE model; and, 5) an individual-level RE model with DMA-level FE. Since the NHANES data were pooled cross-sections over time (2003 and 2004, in this study), we estimated DMA-level fixed effects models, but not individual-level fixed or random effects models, using these data.

4. Results

4.1. ECLS-K Data: Longitudinal Results

The summary statistics from the ECLS-K sample are shown in Tables 1A and 1B. On average, the young adolescents in 5th and 8th grades consumed soft drinks and fast food, respectively, 5.6 and 2.7 times per week, and were, in the 66th percentile of the age-gender-specific BMI distribution (mean BMI of 21.5 units). The average weekly number of fast food, soft drink, SSB, regular soda and cereal advertisements seen on local spot and national programming over the last three months preceding the date of youth's interview was 25.0, 9.7, 9.3, 2.8, and 12.0, respectively. From 5th grade in 2004 to 8th grade in 2007, fast-food consumption decreased from a frequency of 3.0 to 2.4 times per week, on average, and soft drink consumption fell from 6.1 to 5.1 times per week. BMI percentile fell from 66.2 to 65.4. From 5th to 8th grade, youth's average weekly number of advertisements seen over a 3-month period increased from 20.7 to 28.6 for fast food, and fell from 11.4 to 8.2 for soft drinks, 10.9 to 7.9 for SSBs, 3.8 to 1.9 for regular soda, and 15.0 to 9.1 for cereal (changes from 5th to 8th grade not shown in tables).

Table 2 presents the results for the five estimation models of soft drink consumption from different specifications that separately included exposure to soft drink, SSB, regular soda, and fast-food advertisements. The results show that exposure to soft drink advertisements was significantly associated with higher frequency of soft drink consumption; this finding was robust to models that accounted for both individual-level and DMA-level unobserved time-invariant heterogeneity. Exposure to one additional soft drink advertisement per week generally or one additional SSB or regular soda advertisement per week was associated with increased soft drink consumption of about 0.3 to 0.4 times per week, although this association was not statistically significant for regular soda in the individual-level FE model and only marginally significant in the individual-level RE with DMA-level FE model. The soft drink advertising elasticity of soft drink consumption was in the range of 0.4 to 0.5 across different models. Exposure to fast-food advertising was also significantly related to greater frequency of SSB consumption. Exposure to one additional fast-food advertisement per week was associated with greater frequency of soft drink consumption by about 0.07 to 0.08 times per week. Based on the elasticity estimate, a 10% reduction in exposure to fast-food advertisements was associated with a 3 to 4% reduction in SSB consumption. However, the effect was not statistically significant when DMA-level FE were controlled and only marginally significant in the individual-level FE model.

Table 3 presents results from models that assessed the impact of advertising exposure on fast-food consumption. The results showed that while greater exposure to fast-food advertisements was significantly associated with higher frequency of fast-food consumption in the cross-sectional model, once individual- or DMA-level unobserved time-invariant heterogeneity was controlled in FE models, the exposure effect fell and was no longer statistically significant. The results showed that neither soft drink, nor SSB, or regular soda advertisements were statistically significantly associated with fast-food consumption in any model.

Table 4 shows that greater exposure to cereal ads was significantly associated with higher BMI percentile in models that controlled for individual- and DMA-level unobservables through FE and RE estimation. Exposure to one additional cereal ad per week was associated with 0.30–0.50 units higher BMI percentile. No significant associations were found between exposure to either fast-food or SSB advertising and adolescent BMI percentile.

4.2. NHANES Data: Percent Body and Trunk Fatness Results

Table 5 reports the summary statistics based on the variables used in our NHANES analysis. With respect to body composition, the mean percent body fat was 31.2%. On average, adiposity in the body trunk was lower than the rest of child's body (the mean percent trunk fat of 26.9%). On average, children were reported to have viewed 2.5 hours of television per day during the previous week and were exposed to 19.8, 9.5 and 20.0 fast-food restaurant, SSB, and cereal advertisements per week, respectively, on local spot and national television programming. 56% of the children were white and 18%, 19%, and 7% were black, Hispanic, and of other races, respectively.

Table 6 reports on the associations of percent body and trunk fatness and television advertising exposure measures for cereal, fast-food restaurant and SSBs in cross-sectional models while controlling for the full set of control variables shown in Table 5 including daily hours of television viewing. Exposure to cereal advertising was significantly associated with both higher percent trunk and body fatness. Although exposure to fast-food restaurant and SSB advertisements was not significantly associated with BMI percentile in any models using the ECLS-K data, exposure to fast-food advertisements was found to be significantly associated with higher percent trunk fatness and marginally significantly associated with higher percent body fatness. Further, exposure to SSB advertisements was marginally significantly associated with both higher body and trunk fatness. It is worth noting that neither non-SSB nor full-service restaurant advertisements were associated with either BMI percentile, percent body fatness, or percent trunk fatness (results not shown).

5. Conclusions

Overall, the results show that exposure to soft drink and SSB ads are related to higher frequency of soft drink consumption among youth, even after controlling for unobserved individual-level and DMA-level unobserved time-invariant heterogeneity, with an elasticity estimate of 0.4 to 0.5 depending on the model. Fast-food ads were found to be associated with soft drink consumption (elasticity of 0.3 to 0.4 depending on the model) but the association was not statistically significant in the DMA-level FE model and only marginally significant in the individual-level FE model. Indeed, fast-food and SSB consumption are complements, and previous research using individual-level FE models found that fast-food consumption among adolescents is significantly related to higher SSB consumption (Powell and Nguyen, 2013). Although the estimates for soft drink consumption were robust to the controls for unobserved time-invariant heterogeneity, the association between fast-food advertising exposure and fast-food consumption disappeared once we controlled for unobservables using FE and RE models.

Previous cross-sectional findings by Andreyeva, Kelly and Harris (2011) found that greater exposure to regular carbonated soft drink ads and fast-food advertisements were significantly associated with higher soft drink consumption but with smaller estimated associations (respective elasticities of 0.03 and 0.07). If we estimate models based on local television advertising exposure only, instead of total local and national advertising exposure, we also obtain lower elasticity estimates. However, in a policy context, it is important that the elasticity estimates reflect percentage changes based on youth's total exposure to television advertising. Further, although Andreyeva, Kelly and Harris (2011) also found significant associations between exposure to fast-food advertisements and frequency of fast-food consumption based on cross-sectional models, they were unable to assess whether those associations persisted once unobservables were controlled.

Whereas previous studies found some limited evidence that fast-food advertising was associated with youth's BMI for those already overweight (Andreyeva, Kelly and Harris 2011) and in models that did not control for television viewing time (Chou, Rashad and Grossman 2008), this study did not find any significant associations between fast-food advertising exposure and body weight in either cross-sectional or longitudinal models for adolescents. However, in our analyses that drew on the NHANES data where we were able to assess body and trunk fatness, we found that greater exposure to fast-food advertisements were associated with significantly higher percent trunk fat among pre-adolescent children aged 8–11. These results were based on cross-sectional estimates and small sample sizes and therefore should be interpreted with caution and should be considered as exploratory. Nonetheless, they do suggest that future research if possible should examine body fatness measures in addition to BMI. The assessment of body composition with DXA has taken on importance as obesity rates have increased in the U.S. (Centers for Disease Control and Prevention 2008). Although BMI is a widely accepted measure of obesity, it is a proxy and not a perfect measure of body fatness (Ahima and Lazar 2013; Centers for Disease Control and Prevention 2008; Ogden et al., 2014; Wada and Tekin 2010). In particular, visceral or abdominal adiposity measures may be a better predictor of mortality than BMI (Ahima and Lazar 2013; Reis et al. 2009).

In this study, in addition to examining exposure to SSB and fast-food advertising, we also assessed exposure to cereal advertisements given that they are the third largest category of marketing expenditures and second largest category after fast food in terms of exposure to food products marketed to youth and previous research has shown that the vast majority of cereal advertisements seen on television by children are for high-sugar cereals, which suggests that exposure may impact weight outcomes (Harris et al. 2012; Powell, Schermbeck and Chaloupka 2013; Powell et al. 2011). Exposure to cereal advertisements was found to be associated with higher BMI percentile ranking in longitudinal models and it was associated with higher body and trunk fatness.

Overall, this study provides new evidence based on longitudinal data and body and trunk fatness adiposity measures that show significant associations between exposure to food and beverage advertising and youth's consumption, BMI percentile, and adiposity outcomes. The findings are subject to several limitations. The ECLS-K panel was limited to only two periods and the fixed effects models controlled for time-invariant but not time-varying

heterogeneity. Also, the within-person and within-DMA variation in advertising over time was moderate (e.g., fast-food advertising z-score IQR of about 0.7), which may have limited the identification of an effect using the FE models. The NHANES data are cross-sectional and do not permit causal inference; although, we did control for DMA-level fixed effects. Further, the body fatness measures in NHANES were only available for the 2003–2004 wave for a limited sample of children aged 8–11 years. To further build the evidence base, future research should focus on employing models with longer panels of longitudinal data, and should assess outcome measures of body and trunk fatness and waist circumference. The present results also point to the importance of continued monitoring of the nutritional content of food and beverage product advertisements seen by children and adolescents and to the importance of continuing the policy debate regarding the regulation of youth-directed marketing including reducing youth's exposure to advertising for unhealthy products by raising nutrition standards and age limits for youth-directed marketing and by encouraging media companies to implement nutrition standards for food, beverage, and restaurant companies that market to youth on their programming.

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References

- Ahima RS, Lazar MA. The Health Risk of Obesity—Better Metrics Imperative. *Science*. 2013; 341:856–858. [PubMed: 23970691]
- Andreyeva T, Kelly IR, Harris JL. Exposure to food advertising on television: Associations with children's fast food and soft drink consumption and obesity. *Econ Hum Biol*. 2011; 9:221–233. [PubMed: 21439918]
- Bagwell, K. The Economic Analysis of Advertising. In: Armstrong, M., Porter, R., editors. *Handbook of Industrial Organization*. North-Holland; Amsterdam: 2007. p. 1701–1844.
- Batra R, Ray ML. Affective responses mediating acceptance of advertising. *Journal of Consumer Research*. 1986; 13(2):234–249.
- Becker GS, Murphy KM. A simple theory of advertising as a good or bad. *The Quarterly Journal of Economics*. 1993; 108(4):941–964.
- Centers for Disease Control and Prevention. National Health and Nutrition Examination Survey: Technical Documentation for the 1999–2004 Dual Energy X-Ray Absorptiometry (DXA) Multiple Imputation Data files. 2008. Available at: http://www.cdc.gov/nchs/data/nhanes/dxa/dxa_techdoc.pdf
- Centers for Disease Control and Prevention. National Health and Nutrition Examination Survey Data. Department of Health and Human Services, Centers for Disease Control and Prevention; Hyattsville, MD: U.S: 2011. <http://www.cdc.gov/nchs/nhanes.htm>
- Chou SY, Rashad I, Grossman M. Fast Food Restaurant Advertising on Television and Its Influence on Childhood Obesity. *The Journal of Law and Economics*. 2008; 51(4):599–618.
- Federal Trade Commission. A Review of Food Marketing to Children and Adolescents: Follow-Up Report. Federal Trade Commission; Washington, DC: 2012. Available at: <http://www.ftc.gov/sites/default/files/documents/reports/review-food-marketing-children-and-adolescents-follow-report/121221foodmarketingreport.pdf>

- Fishbein, M., Ajzen, I. Belief, attitude, intention and behavior: An introduction to theory and research. Reading, MA: Addison-Wesley; 1975.
- Grossman M, Tekin E, Wada R. Food Prices and Body Fatness among Youths. *Economics & Human Biology*. 2014; 12:4–19. [PubMed: 24246131]
- Harris, JL., Schwartz, MB., Brownell, KD., Javadizadeh, J., Weinberg, M., Sarda, V., Munsell, C., Shin, C., Milici, FF., Ustjanauskas, A., Gross, R., Speers, S., Cheyne, A., Dorfman, L., Gonzalez, P., Mejia, P. Sugary Drink FACTS: Evaluating Sugary Drink Nutrition and Marketing to Youth. Rudd Center for Food Policy & Obesity, Yale University; 2011. Available at: www.sugarydrinkfacts.org/resources/SugaryDrinkFACTS_Report.pdf
- Harris, JL., Schwartz, MB., Brownell, KD., Sarda, V., Dembeck, C., Munsell, C., Shin, C., Ustjanauskas, A., Weinberg, M. Limited progress in the nutrition quality and marketing of children's cereals. Rudd Center for Policy & Obesity, Yale University; 2012. Cereal FACTS. Available at: www.cerealfacts.org/media/Cereal_FACTS_Report_2012_7.12.pdf
- Harris, JL., Schwartz, MB., Brownell, KD., Sarda, V., Ustjanauskas, A., Javadizadeh, J., Weinberg, M., Munsell, C., Speers, S., Bukofzer, E., Cheyne, A., Gonzalez, P., Reshetnyak, J., Agnew, H., Ohri-Vachaspati, P. Fast Food FACTS: Evaluating Fast Food Nutrition and Marketing to Youth. Rudd Center for Food Policy and Obesity, Yale University; 2010. Available at: www.fastfoodmarketing.org/media/FastFoodFACTS_Report.pdf
- Hingle MD, Castonguay JS, Ambuel DA, Smith RM, Kunkel DL. Alignment of Children's Food Advertising With Proposed Federal Guidelines. *American Journal of Preventive Medicine*. 2015; 48:707–713. [PubMed: 25863586]
- Hoek J, Gendall P. Advertising and obesity: A behavioral perspective. *J Health Commun*. 2006; 11(4): 409–423. [PubMed: 16720538]
- Institute of Medicine. Food Marketing to Children and Youth: Threat or Opportunity?. The National Academies Press; Washington, D.C: 2006.
- Kempf DS, Smith RE. Consumer processing of product trial and the influence of prior advertising: A structural modeling approach. *Journal of Marketing Research*. 1998; 35(3):325–338.
- Khan T, Powell LM, Wada R. Fast Food Consumption and Food Prices: Evidence from Panel Data on 5th and 8th grade Children. *Journal of Obesity*. 2012; doi: 10.1155/2012/857697
- Kunkel, D., McKinley, C., Wright, P. The Impact of Industry Self-Regulation on the Nutritional Quality of Foods Advertised on Television to Children. Oakland, CA: Children Now; 2009.
- Kunkel DL, Castonguay JS, Filer CR. Evaluating Industry Self-Regulation of Food Marketing to Children. *American Journal of Preventive Medicine*. 2015; 49(2):181–187. [PubMed: 25960392]
- Lamb MM, Ogden CL, Carroll MD, Lacher DA, Flegal KM. Association of body fat percentage with lipid concentrations in children and adolescents: United States, 1999–2004. *Am J Clin Nutr*. 2011; 94(3):877–883. [PubMed: 21775565]
- Lavidge RJ, Steiner GA. A model for predictive measurements of advertising effectiveness. *Journal of Marketing*. 1961; 25(6):59–62.
- MacKenzie SB, Lutz RJ, Belch GE. The role of attitude toward the ad as a mediator of advertising effectiveness: A test of competing explanations. *Journal of Marketing Research*. 1986; 23(2):130–143.
- Meuhling DD. An investigation of factors underlying attitude-toward-advertising-in-general. *Journal of Advertising*. 1987; 16(1):32.
- Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the united states, 2011–2012. *JAMA*. 2014; 311(8):806–814. [PubMed: 24570244]
- Powell LM, Nguyen BT. Fast-food and full-service restaurant consumption among children and adolescents: Effect on energy, beverage, and nutrient intake. *JAMA Pediatrics*. 2013; 167(1):14–20. [PubMed: 23128151]
- Powell LM, Harris JL, Fox T. Food Marketing Expenditures Aimed at Youth: Putting the Numbers in Context. *Am J Prev Med*. 2013; 45(4):453–461. [PubMed: 24050422]
- Powell LM, Schermbeck RM, Chaloupka FJ. Nutritional Content of Food and Beverage Products in Television Advertisements Seen on Children's Programming. *Childhood Obesity*. 2013; 9(6):524–531. [PubMed: 24206260]

- Powell LM, Schermbeck RM, Szczypka G, Chaloupka FJ, Braunschweig CL. 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*. 2011; 165(12):1078–1086. [PubMed: 21810626]
- Publishers Information Bureau. Membership guide. 2006. Available at: <http://www.magazine.org/content/files/pibmembershipguide.pdf>
- Reis JP, Macera CA, Araneta MR, Lindsay SP, Marshall SJ, Wingard DL. Comparison of overall obesity and body fat distribution in predicting risk of mortality. *Obesity*. 2009; 17(6):1232–1239. [PubMed: 19197258]
- Roberts KC, Shields M, de Groh M, Aziz A, Gilbert J-A. Overweight and obesity in children and adolescents: Results from the 2009 to 2011 Canadian Health Measures Survey. Statistics Canada, Catalogue no. 82-003-XPE • Health Reports. 2012; 23(3)
- Szczypka, G., Emery, S., Wakefield, MA., Chaloupka, FJ. The adaptation and use of Nielsen Media Research Commercial Ratings Data to measure potential exposure to televised smoking-related advertisements. 2003. ImpacTeen Research Paper Series No. 29
- Television Bureau of Canada. TVBASICS 2014–1025. 2015. Available at http://www.tvb.ca/page_files/pdf/infocentre/tvbasics.pdf
- Vakratsas D, Ambler T. How advertising works: What do we really know? *Journal of Marketing*. 1999; 63(1):26–43.
- Wada R, Tekin E. Body composition and wages. *Economics & Human Biology*. 2010; 8(2):242–254. [PubMed: 20362520]

Table 1A

Summary Statistics for Outcome Variables and Advertising Exposure Measures for the ECLS-K Sample, by Year (2004 Year (2007))

Variable Name	2004, 2007 Mean (SD)	2004 Mean (SD)	2007 Mean (SD)
Outcome Measures			
Number of times soft drinks consumed in past 7 days	5.6 (6.9)	6.1 (7.5)	5.1 (6.4)
Number of times fast food consumed in past 7 days	2.7 (4.1)	3.0 (4.8)	2.4 (3.5)
BMI Percentile	65.7 (30.0)	66.2 (29.5)	65.4 (28.6)
Advertising Exposure Measures			
Fast-food ads/week	25.0 (5.3)	20.7 (3.4)	28.6 (3.8)
Soft drink ads/week	9.7 (2.3)	11.4 (2.1)	8.2 (1.2)
SSB ads/week	9.3 (2.1)	10.9 (1.9)	7.9 (1.1)
Regular soda ads/week	2.8 (1.2)	3.8 (1.0)	1.9 (0.4)
Cereal ads/week	12.0 (3.1)	15.0 (1.8)	9.1 (0.7)

Notes: N=8,340, N=4,320 in 2004 and N=4,020 in 2007. ECLS-K stands for Early Childhood Longitudinal Study - Kindergarten Cohort. SSB stands for sugar-sweetened beverage. Standard deviation (SD) are in parentheses. Sample weights are used to make the sample statistics nationally representative.

Table 1B

Summary Statistics for Individual, Household and Local Area Characteristics for the ECLS-K Sample (2004 Sample (2007))

Variable Name	Mean (SD) or Frequency (%)
Female	48.3%
Male	51.7%
White	58.9%
Black	16.5%
Hispanic	18.4%
Other	3.8%
More than one race	2.3%
Parents married	71.6 %
Parents never married	9.0%
Parents separated or divorced	17.2%
Parents widowed	2.2%
Mother completed less than high school	15.2%
Mother completed at least high school	21.9%
Mother completed at least some college	34.2%
Mother completed bachelor's degree or more	28.5%
Parental Income 0–20,000 (\$)	12.2%
Parental Income 20,001–35,000 (\$)	15.5%
Parental Income 35,001–50,000(\$)	16.2%
Parental Income 50,001–75,000(\$)	18.1%
Parental Income 75,001–100,000 (\$)	16.3%
Parental Income 100,001+ (\$)	21.7%
Household residence is urban	78.6%
Household residence is suburban	9.9%
Household residence is rural	11.5%
Days per week eat breakfast with parents	3.3 (2.4)
Days per week eat dinner with parents	5.3 (1.8)
Hours of television child watches weekly	22.9 (17.1)
Child's age in months	154.0 (18.7)

Notes: N=8,340. ECLS-K stands for Early Childhood Longitudinal Study - Kindergarten Cohort. Standard deviation (SD) are in parentheses. Sample weights are used to make the sample statistics nationally representative.

Association between Exposure to Television Advertising for Food and Beverage Products and Soft Drink Consumption among Young Adolescents in the ECLS-K (2004 (2007)

Table 2

	Cross-sectional Model	Individual-level Random Effects Model	Individual-level Fixed Effects Model	DMA-level Fixed Effect Model	Individual-level Random Effects with DMA-level Fixed Effects Model
	Coefficient (SE) [Elasticity]	Coefficient (SE) [Elasticity]	Coefficient (SE) [Elasticity]	Coefficient (SE) [Elasticity]	Coefficient (SE) [Elasticity]
Soft drink ads/week	0.299 *** (0.080) [0.533]	0.280 *** (0.078) [0.498]	0.251 ** (0.114) [0.446]	0.304 *** (0.097) [0.541]	0.294 *** (0.094) [0.523]
SSB ads/week	0.302 *** (0.083) [0.516]	0.282 *** (0.082) [0.482]	0.253 *** (0.121) [0.432]	0.311 *** (0.105) [0.531]	0.299 *** (0.101) [0.510]
Regular soda ads/week	0.423 *** (0.142) [0.220]	0.378 *** (0.143) [0.196]	0.224 (0.192) [0.116]	0.352 *** (0.170) [0.183]	0.327 * (0.169) [0.170]
Fast-food ads/week	0.079 *** (0.026) [0.354]	0.075 *** (0.026) [0.334]	0.081 * (0.042) [0.361]	0.072 (0.049) [0.320]	0.073 (0.045) [0.326]

Notes: N=8,340. ECLS-K stands for Early Childhood Longitudinal Study - Kindergarten Cohort. DMA stands for designated market area. SSB stands for sugar-sweetened beverage. Regressions include the full set of individual household and local area characteristics listed in Table 1, except for the time-invariant characteristics and age and age squared in the individual-level fixed effects model.

Standard errors (SE) are robust and clustered at the DMA level.

* significance at 10%;

** significance at 5%;

*** significance at 1%.

Association between Exposure to Television Advertising for Food and Beverage Products and Fast-food Consumption among Young Adolescents in the ECLS-K (2004 (2007)

Table 3

	Cross-sectional Model	Individual-level Random Effects Model	Individual-level Fixed Effects Model	DMA-level Fixed Effects Model	Individual-level Random Effects with DMA level Fixed Effects Model
	Coefficient (SE) [Elasticity]	Coefficient (SE) [Elasticity]	Coefficient (SE) [Elasticity]	Coefficient (SE) [Elasticity]	Coefficient (SE) [Elasticity]
Fast-food ads/week	0.044 ** (0.020) [0.423]	0.036 (0.023) [0.344]	-0.000 (0.063) [-0.003]	-0.014 (0.041) [-0.137]	-0.013 (0.046) [-0.120]
Soft drink ads/week	0.016 (0.074) [0.062]	0.011 (0.078) [0.040]	0.012 (0.138) [0.048]	-0.011 (0.102) [-0.041]	-0.005 (0.112) [-0.017]
SSB ads/week	0.017 (0.076) [0.064]	0.012 (0.081) [0.044]	0.015 (0.144) [0.053]	-0.009 (0.106) [-0.034]	-0.003 (0.116) [-0.009]
Regular soda ads/week	0.042 (0.113) [0.047]	0.013 (0.119) [0.014]	-0.106 (0.183) [-0.119]	-0.127 (0.136) [-0.142]	-0.117 (0.146) [-0.130]

Notes: N=8,340. ECLS-K stands for Early Childhood Longitudinal Study - Kindergarten Cohort. SSB stands for sugar-sweetened beverage. Regressions include the full set of individual household and local area characteristics listed in Table 1, except for the time-invariant characteristics and age squared in the individual-level fixed effects model.

Standard errors (SE) are robust and clustered at the designated market area level.

* significance at 10%.

** significance at 5%.

*** significance at 1%.

Table 4

Associations between Exposure to Television Advertising for Food and Beverage Products and Body Mass Index Percentile among Young Adolescents in the ECLS-K (2004 (2007)

	Cross-sectional Model	Individual-level Random Effects Model	Individual-level Fixed Effects Model	DMA-level Fixed Effects Model	Individual-level Random Effects with DMA level Fixed Effect Model
	Coefficient (SE) [Elasticity]	Coefficient (SE) [Elasticity]	Coefficient (SE) [Elasticity]	Coefficient (SE) [Elasticity]	Coefficient (SE) [Elasticity]
Cereal ads/week	0.164 (0.182) [0.031]	0.310 ** (0.143) [0.059]	0.448 ** (0.210) [0.085]	0.477 * (0.247) [0.090]	0.410 ** (0.164) [0.078]
Fast-food ads/week	-0.066 (0.129) [-0.025]	-0.063 (0.089) [-0.024]	-0.081 (0.102) [-0.031]	-0.147 (0.133) [-0.056]	-0.103 (0.100) [-0.039]
SSB ads/week	-0.095 (0.337) [-0.014]	0.000 (0.253) [0.000]	0.095 (0.294) [0.014]	-0.424 (0.304) [-0.061]	-0.059 (0.278) [-0.009]

Notes: N=8,340. ECLS-K stands for Early Childhood Longitudinal Study - Kindergarten Cohort. SSB stands for sugar-sweetened beverage. Regressions include the full set of individual household and local area characteristics listed in Table 1, except for the time-invariant characteristics and age squared in the individual-level fixed effects model.

Standard errors (SE) are robust and clustered at the designated market area level.

* significance at 10%.

** significance at 5%.

*** significance at 1%.

Table 5
Summary Statistics for Children Aged 8–11 Years Old in the NHANES Sample (2003–2004)

Variable Name	Mean (SD) or Frequency (%)
Outcome Measures	
Percent body fat	31.2 (7.7)
Percent trunk fat	26.9 (9.2)
Advertising Exposure Measures	
Cereal	20.0 (5.3)
Restaurants	26.7 (4.3)
Fast-food	19.8 (3.1)
Full-service	6.9 (1.6)
Beverages	11.9 (4.4)
SSBs	9.5 (3.8)
Non-SSBs	2.4 (0.7)
Control Measures	
Child Age 8 years	24%
Child Age 9 years	25%
Child Age 10 years	28%
Child Age 11 years	23%
Male	48%
Female	52%
White	56%
Black	18%
Hispanic	19%
Other race	7%
TV viewed (hours per day)	2.5 (1.3)
Household size	4.6 (1.3)
Survey Respondent Married	26%
Survey Respondent Non-married	62%
Survey Respondent Marital status missing	3%
Survey Respondent Less than high school	32%

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Variable Name	Mean (SD) or Frequency (%)
Survey Respondent High school	28%
Survey Respondent College	32%
Survey Respondent Beyond college	21%
Household PIR <= 1.30	46%
1.30 > Household PIR >= 1.85	11%
Household PIR >= 1.85	55%
Area median household income (\$10,000)	4.5 (1.7)
Year = 2003	57%
Year = 2004	43%

Notes: N=414. NHANES stands for National Health and Nutrition Examination Survey. SSBs stands for sugar-sweetened beverages.
PIR stand for poverty to income ratio. All estimates are weighted to account for the sampling structure of the NHANES.

Table 6

Associations of Food and Beverage Television Advertising with Adiposity Outcomes among Children Aged 8–11 Years Old in the NHANES (2003–2004)

Cross-sectional Model with DMA Fixed Effects			
Coefficient (SE)			
Weekly advertising exposures	Percent body fatness	Percent trunk fatness	
Cereal ads/week	2.368 *** (0.571)	3.114 *** (0.664)	
Fast-food ads/week	1.709 * (0.946)	2.496 ** (1.178)	
SSB ads/week	3.590 * (1.909)	4.041 * (2.302)	

Notes: N=414. NHANES stands for National Health and Nutrition Examination Survey. DMA stands for designated market area. SSB stands for sugar-sweetened beverage. All estimates are weighted to account for the sampling structure of the NHANES. Parentheses contain robust standard errors clustered at the DMA level.

Each estimate represents a separate regression that includes control variables described in the text and Table 1.

- * significance at 10%.
- ** significance at 5%.
- *** significance at 1%..