When Children Eat What They Watch

Impact of Television Viewing on Dietary Intake in Youth

Jean L. Wiecha, PhD; Karen E. Peterson, ScD, RD; David S. Ludwig, MD, PhD; Juhee Kim, ScD; Arthur Sobol, MA; Steven L. Gortmaker, PhD

Objectives: To test whether increased television viewing is associated with increased total energy intake and with increased consumption of foods commonly advertised on television, and to test whether increased consumption of these foods mediates the relationship between television viewing and total energy intake.

Design: Prospective observational study with baseline (fall 1995) and follow-up (spring 1997) measures of youth diet, physical activity, and television viewing. We used food advertising data to identify 6 food groups for study (sweet baked snacks, candy, fried potatoes, main courses commonly served as fast food, salty snacks, and sugar-sweetened beverages).

Setting and Participants: Five public schools in 4 communities near Boston. The sample included 548 students (mean age at baseline, 11.70 years; 48.4% female; and 63.5% white).

Main Outcome Measures: Change in total energy intake and intake of foods commonly advertised on television from baseline to follow-up.

Results: After adjusting for baseline covariates, each hour increase in television viewing was associated with an additional 167 kcal/d (95% confidence interval, 136-198 kcal/d; P < .001) and with increases in the consumption of foods commonly advertised on television. Including changes in intakes of these foods in regression models provided evidence of their mediating role, diminishing or rendering nonsignificant the associations between change in television viewing and change in total energy intake.

Conclusions: Increases in television viewing are associated with increased calorie intake among youth. This association is mediated by increasing consumption of calorie-dense low-nutrient foods frequently advertised on television.

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Overweight prevalence has increased sharply among all sex and racial/ethnic groups in the United States. Among 12- to 19-year old individuals, overweight (body mass index [BMI] [calculated as weight in kilograms divided by the square of height in meters] ≥ 95th age- and sex-specific percentile) prevalence increased from 4.6% in the mid 1960s to 15.5% in 2000. In many cross-sectional and longitudinal studies, a positive association exists between hours of television viewing and measures of obesity and overweight in youth. Television viewing time also predicts obesity, development of type 2 diabetes mellitus, and poor lipid profiles in adults. In randomized controlled trials among youth, changes in television viewing have been instrumental in reducing overweight.

While published studies are consistent with a causal relationship between television viewing and overweight, the mechanisms driving this are not well understood. Television viewing could influence energy balance by reducing energy expenditure relative to other uses of leisure time, by increasing energy intake (eg, through snacking and exposure to food marketing), or by a combination of these. Although television viewing itself is a sedentary activity, contributing little to nonbasal energy expenditure, studies show only a weak or modest negative correlation between time spent on television viewing and time spent in moderate and vigorous physical activity. A randomized controlled trial found that increasing screen time resulted in reduced energy expenditure and increased energy intake.

Television’s potential role in increasing energy intake must be considered in the context of the extraordinary amount of television-based food advertising that occurs annually. Television advertisements account for roughly 75% of food manufacturers’ and 95% of fast food restaurants’ advertising expenditures.

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1997, when data collection for this study ended, food industries spent $11 billion on advertising. Food manufacturers, responsible for most ($7 billion) of this, spent 25% of their advertising dollars promoting candy, cookies, salty snacks, and soft drinks—and 5% promoting fruits, vegetables, grains, beans, meat, poultry, and fish. Fast food restaurants spent more than $1 billion on advertising in 1999.

Studies suggest these dollars are spent effectively—food advertising works. For example, several studies show associations between exposure to advertisements and children's requests for specific foods, food purchasing, and food consumption. Television viewing, a major venue for advertising exposure, is directly associated with calorie intake among adults and youth in cross-sectional studies, and with intake of foods commonly advertised on television (FCAT)—soft drinks, fried foods, and snacks—among youth. These types of foods pose risks for overeating and weight gain. Fast food restaurant use, which is heavily promoted on television, is positively associated with calorie intake in youth and with BMI among adults. In a recent study, on days when children ate fast food, they consumed more calories, fat, added sugars, and sugar-sweetened beverages and fewer servings of milk, fruits, and nonstarchy vegetables than on days when they did not eat fast food. Prospective studies among children have indicated a positive relationship between intake of sugar-sweetened soft drinks and obesity incidence.

The present study examines whether increases in adolescents' television viewing time are associated with increases in total energy intake (TEI), and whether viewing increases are also associated with increases in intake of FCAT (candy, fast foods, fried potatoes, sweet baked snacks, salty snacks, and sugar-sweetened beverages). We also examine whether changes in intakes of these foods mediate the relationship between change in viewing time and change in TEI.

THEORETICAL FRAMEWORK

In light of the literature, we hypothesize that increases in television viewing time will result in increases in TEI. One causal pathway will consist of increased consumption of FCAT. To test this hypothesis, we examine a longitudinal observational cohort in which we collected measures of television viewing and food consumption at 2 time points. Statistical models in which change in an independent variable predicts change in a dependent variable may provide stronger evidence for causality than predictions involving the independent variable measured at just 1 point in time (eg, baseline). Attenuation of the association between an independent and a dependent variable by the addition of a second independent variable in the causal pathway can provide evidence for mediation in the context of a plausible theoretical framework. In addition, a mediator variable is also independently associated with exposure and outcome. Therefore, in our analyses of the relationship of change in television viewing time to change in TEI, we evaluate evidence for the mediating effects of FCAT by examining the associations between television and FCAT; FCAT and TEI; and television, FCAT, and TEI. In our models, we control for other characteristics of respondents that could potentially influence energy intake at follow-up, including baseline BMI, age, sex, indicator variables for race/ethnicity, baseline physical activity of 3.5 metabolic equivalents (METs) or more, change in physical activity of 3.5 METs or more, and school.

SUBJECTS

Data were collected as part of the Planet Health intervention and evaluation, a group randomized controlled trial that took place in 10 schools in 4 communities in the Boston metropolitan area between fall 1995 and spring 1997. Schools were matched and then randomized to the control and intervention conditions, and no differences were observed between these groups on baseline measures, including age, BMI, TEI, television viewing, or physical activity levels. The 348 students composing the analytic sample attended the 5 randomly assigned control schools that did not take part in the intervention designed to reduce obesity prevalence. The median annual household income of ZIP code areas where the control schools were located averaged $34,200, according to 1990 census data, lower than that for all households in Massachusetts in 1990 ($41,000), but similar to the US figure ($33,952). A total of 780 subjects (64.5% of those eligible) completed the baseline evaluation in fall 1995 at the control schools after excluding individuals who transferred schools at baseline, were in special education classes, were in grades other than sixth or seventh, or did not complete the English-language version of the questionnaire. Follow-up data were collected in spring 1997 for 653 subjects (84.0% of the baseline group), reflecting loss to follow-up of 18.0% for girls and 14.0% for boys. The main reason for lack of follow-up data was school transfer (half of those not followed up) and school absence (one quarter). Of the 371 subjects with complete data on all variables, 348 were included in these analyses after excluding 23 with implausible daily energy intakes (<500 or >7000 kcal). Further details on sampling and exclusions are available elsewhere. The study was approved by the Committee on Human Subjects at the Harvard School of Public Health.

The 548 subjects were a mean ± SD age of 11.70 ± 0.75 years at baseline, and 48.4% were female. Of the subjects, 63.5% were white, 15.3% were Hispanic, 13.9% were African American, 7.7% were Asian, 9.0% were American Indian, and 7.7% were another ethnicity (this total >100% because respondents could select multiple descriptors). Anthropometric data and student surveys were collected in fall 1995, when subjects were in either grade 6 or grade 7, and follow-up measurements were collected approximately 19 months later, in spring 1997 (when subjects were in grade 7 or 8).

ANTHROPOMETRIC DATA

For BMI, height without shoes was measured to the nearest 0.1 cm using a stadiometer (Irwin Shorr, Olney, Md) and weight in light clothes was measured to the nearest 0.1 kg on a portable electronic scale (model 770; Seca, Hanover, Md), calibrated using a standard weights "step-up" test (Seca).

ASSESSMENT OF DIET, PHYSICAL ACTIVITY LEVEL, AND TELEVISION VIEWING

Measures of dietary intake, physical activity level, and television viewing were obtained via an optically scannable student questionnaire, food frequency interviews, and teacher reports of children's participation in physical activity. Measures of dietary intake, physical activity level, and television viewing were obtained via an optically scannable student questionnaire, food frequency interviews, and teacher reports of children's participation in physical activity.
**Table 1. Groups of Foods Advertised on Television and Measured on the Food Frequency Questionnaire**

<table>
<thead>
<tr>
<th>Group</th>
<th>Item (Serving Type Where Specified)*</th>
<th>Response Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet snacks</td>
<td>Cookies (one)</td>
<td>Never or less than one per month, 1-3 per month, 1-6 per week</td>
</tr>
<tr>
<td></td>
<td>Brownies (one)</td>
<td>Never or less than one per month, 1-3 per month, 1-6 per week</td>
</tr>
<tr>
<td></td>
<td>Pie (one slice)</td>
<td>Never or less than one per month, 1-3 per month, 1 per week</td>
</tr>
<tr>
<td></td>
<td>Pop-Tarts or turnovers (one)</td>
<td>Never or less than one per month, 1-3 per month, 1-6 per week, 2-4 per week, 1-6 per</td>
</tr>
<tr>
<td></td>
<td>Cake (one slice)</td>
<td>week, 1 or more per day</td>
</tr>
<tr>
<td>Candy</td>
<td>Snack cakes (eg, Twinkies, one package)</td>
<td>Never or less than one per month, 1-3 per month, 1 per week</td>
</tr>
<tr>
<td></td>
<td>Chocolate (one bar or packet)</td>
<td>Never or less than one per month, 1-3 per month, 1 per week</td>
</tr>
<tr>
<td></td>
<td>Candy without chocolate (eg, Life Savers, one pack)</td>
<td>Never or less than one per month, 1-3 per month, 1 per week</td>
</tr>
<tr>
<td></td>
<td>Fruit leathers (one pack)</td>
<td>Never or less than one per month, 1-3 per month, 1-6 per week, 2-4 per week, 1-6 per</td>
</tr>
<tr>
<td></td>
<td></td>
<td>week, 1 or more per day</td>
</tr>
<tr>
<td>Fast food–type main courses</td>
<td>Fried chicken (one serving), cheeseburger (one burger), hamburger (one burger), pizza (one slice), tacos or burritos (one), chicken nuggets (six nuggets), and hot dog (one)</td>
<td>Never or less than one per month, 1-3 per month, 1 per week, 2-4 per week, 1-6 per week, 1 or more per day</td>
</tr>
</tbody>
</table>

*Manufacturers: Kool-Aid and Life Savers (Kraft Foods, Northfield, Ill); Doritos and Fritos (Frito-Lay, Division of PepsiCo, Purchase, NY); Pop-Tarts (Kellogg’s, Battle Creek, Mich); Twinkies (Interstate Bakeries Corp, Kansas City, Mo).

**DIETARY INTAKE**

The FCAT were identified from the data of Gallo. Comparable foods were identified from the youth food frequency questionnaire component of the food and activity survey, an instrument adapted and validated for use in ethnically and socioeconomically diverse populations. Six FCAT groups were created to best match the available youth food frequency questionnaire data with information on food advertising, sugar-sweetened beverages, salty snacks, fried potatoes, sweet baked snacks, candy, and main courses commonly served at fast food restaurants.

The youth food frequency questionnaire asked how often in the past 30 days food items were consumed. There were 4 to 6 response categories typically offered. For example, response categories for soda (1 of 3 items composing sugar-sweetened beverages) were never or less than 1 can per month, 1 to 3 cans per month, 1 can per week, 2 to 6 cans per week, 1 can per day, or 2 cans or more per day. For each item, the uppermost category was truncated at the highest value (eg, ≥2 glasses per day was assigned a value of 2) and the lowest category was coded as 0.5 per month. If a food item was left blank, it was recoded as a 0. Table 1 describes the food groups and the response categories for each item.

Total energy intake was estimated from all foods on the youth food frequency questionnaire by the Channing Laboratory, Boston, using calorie values assigned to standard portion sizes from releases 10 and 11 of the US Department of Agriculture Nutrient Database for Standard Reference. In a separate study, the Pearson product moment correlation coefficient for TEI estimated by comparing 2 food frequency questionnaires with three 24-hour recalls was 0.49.

**PHYSICAL ACTIVITY**

Physical activity level was assessed with the youth activity questionnaire component of the food and activity survey. The youth activity questionnaire included 16 items that estimate hours per day spent in moderate and vigorous activities (≥3.5 METs) over the past month. Walking was excluded because of low agreement among measures in other studies. The youth activity questionnaire is based on a 14-item physical activity questionnaire demonstrated to have good reproducibility and validity in adults and high school youth. In a validation study among 53 participants in Planet Health, using repeat 24-hour physical activity recalls 1 month apart, the 16 youth activity questionnaire items for activity of 3.5 METs or more had a deshatted correlation with the 24-hour recall of r = 0.80, with equivalent means.

**TELEVISION**

Time spent watching television was measured with the 11-item television and video measure. Seven of these questions asked about hours of television typically viewed during each day of the week. The midpoint of each response category was
used to estimate total viewing, and the uppermost category (eg, “5 or more hours per day”) was assigned a value of 5. Items were appropriately weighted and summed to obtain a television viewing hour-per-day estimate. Other items in the television and video measure assessed video and computer game use and were not included in this analysis. In the validation sample (n = 53), we found a deattenuated correlation of television viewing via the television and video measure and the 24-hour recall of r = 0.54, with equivalent means. Television data were imputed among 7 students missing 1 or more days of television data in 1995 and among 3 students in 1997. When weekdays were missing, the imputed value was equal to the mean of the other weekdays for that student. When weekend days were missing, the imputed value was equal to the value for the available weekend day or, for 4 students missing both weekend days in 1993, the mean value for the sample was used. Sample means for television viewing were unchanged by imputation.

DEMOGRAPHIC VARIABLES

Age was calculated from birth date and date of anthropometric examinations. Sex was classified at the time of examination by measurers or from school list data. Racial/ethnic categories were derived from the question, “How do you describe yourself?” to which students could select multiple responses from the following list: white, black, Hispanic, Asian or Pacific Islander, American Indian or Alaskan Native, or other. Participants indicating black were classified as African American. Indica tors were used to classify the 5 schools, with the largest school omitted as the referent. The distribution of subjects from each of the 5 schools was as follows: 261 (47.6%), 122 (22.3%), 79 (14.4%), 48 (8.8%), and 38 (6.9%).

STATISTICAL ANALYSES

SAS statistical software, version 8.2 (SAS Institute Inc, Cary, NC), was used for all analyses. For adjusted analyses, we used PROC SURVEYREG to estimate regressions because these take into account clustering at the school level. PROC SURVEYREG uses an implicit Taylor linearization estimation method. Change variables were calculated as the 1997 value minus the 1995 value to obtain continuous measures.

We estimated adjusted associations of change in television viewing with change in TEI in a series of regression models. Predictor variables in each model included baseline television viewing and change in viewing, baseline BMI, TEI, age, sex, indicator variables for race/ethnicity, baseline physical activity of 3.5 METs or more, change in physical activity of 3.5 METs, and indicator variables for schools.

In the first set of models, the outcome was change in TEI. We evaluated the mediating role of intake of FCAT by adding baseline and change variables for the 6 food groups individually and then simultaneously to create 7 regressions in addition to the basic model for TEI. Foods were considered potential mediators, and not confounding, variables because in our theoretical model, we posit that increases in FCAT intake follow increases in television viewing in a temporal manner and, therefore, are part of the causal pathway. Empirically, this suggests that changes in television viewing predict changes in FCAT intake, and that FCAT intake predicts TEI. Two analyses were undertaken to examine evidence for the hypothesized mediation. First, we assessed evidence for independent associations between changes in intakes of the food groups and change in TEI (all models were significant at P < .05; data not shown). Second, we estimated an additional set of regression models (shown later) to assess whether changes in television viewing predicted change in number of servings per day of each food group.

Table 2. Baseline (Fall 1995) and Follow-up (Spring 1997) Dietary and Activity Characteristics of the Cohort (N = 548)*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Baseline Value</th>
<th>Follow-up Value</th>
<th>Crude Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dietary</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total daily intake, kcal</td>
<td>2141 ± 1076</td>
<td>2299 ± 1128</td>
<td>158 ± 1199</td>
</tr>
<tr>
<td>Baked sweet snacks†</td>
<td>1.18 ± 1.53</td>
<td>1.43 ± 1.56</td>
<td>0.25 ± 1.75</td>
</tr>
<tr>
<td>Candy†</td>
<td>0.42 ± 0.44</td>
<td>0.51 ± 0.49</td>
<td>0.10 ± 0.52</td>
</tr>
<tr>
<td>Fast food-type main course†</td>
<td>0.70 ± 0.63</td>
<td>0.74 ± 0.60</td>
<td>0.04 ± 0.65</td>
</tr>
<tr>
<td>Fried potatoes†</td>
<td>0.12 ± 0.15</td>
<td>0.16 ± 0.17</td>
<td>0.05 ± 0.20</td>
</tr>
<tr>
<td>Salty snacks†</td>
<td>0.64 ± 0.59</td>
<td>0.72 ± 0.58</td>
<td>0.09 ± 0.68</td>
</tr>
<tr>
<td>Sugar-sweetened beverages†</td>
<td>1.21 ± 1.10</td>
<td>1.43 ± 1.09</td>
<td>0.22 ± 1.14</td>
</tr>
<tr>
<td>All foods commonly advertised on television†</td>
<td>4.27 ± 3.19</td>
<td>5.00 ± 3.27</td>
<td>0.74 ± 3.29</td>
</tr>
<tr>
<td>Physical activity and inactivity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Television viewing, h/d</td>
<td>2.44 ± 1.41</td>
<td>2.29 ± 1.38</td>
<td>-0.16 ± 1.30</td>
</tr>
<tr>
<td>Reported activity</td>
<td>1.34 ± 1.09</td>
<td>1.28 ± 1.03</td>
<td>-0.06 ± 0.97</td>
</tr>
</tbody>
</table>

Abbreviation: MET, metabolic equivalent.
*Data are given as mean ± SD.
†All food values are in servings per day.

RESULTS

Dietary and activity data are summarized in Table 2. The mean ± SD BMI at baseline was 20.73 ± 3.99. The TEI increased from baseline to follow-up. Although the average hours of television viewing changed little, 152 subjects (27.7%) increased television viewing by 1 h/d or less and 83 (15.1%) increased viewing by more than 1 h/d (data not shown). All mean FCAT intakes increased during the study period. The highest daily number of servings at follow-up were reported for baked sweet snacks, sugar-sweetened beverages, and fast food–type main courses, and the combined category indicated roughly 5 servings of FCAT per day, or 35 per week.

In adjusted analyses, baseline viewing and change in television viewing predicted change in daily TEI (Table 3). With no foods in the model, each hour of increase in television viewing was associated with a 167-kcal increment. Baseline television viewing time was also independently associated with change in TEI. The FCAT mediated these associations; coefficients for television viewing time (baseline and change) were greatly reduced, and some were rendered insignificant when foods were added into the models. For example, adjusting for sugar-sweetened beverages reduced the kilocalories associated with a 1-hour increase in television viewing from 167 to 123, a 26% reduction; and adjusting for fast food–type main courses or all FCAT combined rendered the association between television viewing and TEI nonsignificant. Baseline television viewing predicted change in calorie intake when no foods were in the model, but was no longer a predictor in models controlling for change in baked sweet snacks, candy, fast food–type main courses, sugar-sweetened beverages, or all foods combined.

In support of the hypothesis of mediation, Table 4 shows that increased television viewing time was also associated with increased intake of FCAT. These relation-
Identifying the mechanisms by which television increases risk of obesity through its influence on energy balance is important in providing evidence for causality for this well-documented observation. We show that, among youth, increases in television viewing predict increases in TEI, and that increasing intakes of FCAT mediate this relationship.

These results build on other recent research. Epstein et al\textsuperscript{32} found that in experimental manipulations, increasing screen time by 50\% was associated with a 250-kcal/d increase in energy intake among youth. Increasing consumption of non–nutrient-dense foods high in added sugars and fats, a pattern typical of fast food meals that include a burger, French fries, and soda, may compromise diet quality by increasing energy intake,\textsuperscript{25,31} displacing more healthful food options,\textsuperscript{30} and promoting weight gain.\textsuperscript{33} The growth in fast food consumption in placing more healthful food options,\textsuperscript{30} and promoting weight gain.\textsuperscript{33} The growth in fast food consumption in

### Table 3. Adjusted Change in Daily Caloric Intake Associated With Baseline and Each 1-h/d Increase in Television Viewing and Evidence for Mediation of This Relationship by Change in Intake of Foods Commonly Advertised on Television (N = 548)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Additional Kilocalories at Follow-up Associated With Each Hour of Television Viewing at Baseline</th>
<th>Additional Kilocalories at Follow-up Associated With Each Hour Increase in Television Viewing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic model (no foods in model)*</td>
<td>127.0 (27.7 to 226.2) .02</td>
<td>167.0 (135.9 to 197.9) .001</td>
</tr>
<tr>
<td>Baked sweet snacks†</td>
<td>33.5 (−31.0 to 98.1) .22</td>
<td>74.5 (17.7 to 131.3) .02</td>
</tr>
<tr>
<td>Candy</td>
<td>50.3 (−69.1 to 169.6) .31</td>
<td>70.7 (9.9 to 131.5) .03</td>
</tr>
<tr>
<td>Fast food–type main courses</td>
<td>44.8 (−47.4 to 36.9) .25</td>
<td>42.1 (−16.9 to 101.1) .12</td>
</tr>
<tr>
<td>Fried potatoes</td>
<td>77.9 (18.9 to 136.9) .02</td>
<td>99.3 (71.0 to 127.6) .001</td>
</tr>
<tr>
<td>Salty snacks</td>
<td>67.7 (10.9 to 124.4) .03</td>
<td>87.8 (33.4 to 142.2) .01</td>
</tr>
<tr>
<td>Sugar-sweetened beverages</td>
<td>66.6 (−26.6 to 159.6) .12</td>
<td>122.8 (68.2 to 177.5) .003</td>
</tr>
<tr>
<td>All foods</td>
<td>−36.1 (−103.3 to 31.2) .21</td>
<td>−5.1 (−81.7 to 71.5) .86</td>
</tr>
</tbody>
</table>

*Estimated from a regression equation controlling for baseline body mass index, total energy intake, physical activity duration of 3.5 metabolic equivalents or more, and age; change in physical activity duration of 3.5 metabolic equivalents or more; and sex, race/ethnicity, and school indicator variables. All change values are the 1997 value minus the 1995 value.

†Coefficients in subsequent models were estimated from separate regression equations controlling for variables as in the basic model, with the addition of change in daily servings of the food group shown controlling for baseline servings per day of the food group.

### Table 4. Adjusted Change in Servings per Day of Foods Commonly Advertised on Television Associated With Baseline and 1-h/d Increase in Television Viewing (N = 548)*

<table>
<thead>
<tr>
<th>Type of Food†</th>
<th>Additional Servings per Day at Follow-up Associated With Each Hour of Baseline Television Viewing</th>
<th>Additional Servings per Day at Follow-up Associated With Each Hour Increase in Television Viewing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baked sweet snacks†</td>
<td>0.21 (0.08 to 0.33) .01</td>
<td>0.21 (0.14 to 0.29) .002</td>
</tr>
<tr>
<td>Candy</td>
<td>0.06 (0.03 to 0.10) .006</td>
<td>0.08 (0.02 to 0.14) .02</td>
</tr>
<tr>
<td>Fast food–type main courses</td>
<td>0.06 (0.04 to 0.08) .001</td>
<td>0.09 (0.06 to 0.12) .001</td>
</tr>
<tr>
<td>Fried potatoes</td>
<td>0.02 (−0.004 to 0.04) .08</td>
<td>0.03 (0.01 to 0.05) .004</td>
</tr>
<tr>
<td>Salty snacks</td>
<td>0.06 (0.01 to 0.12) .04</td>
<td>0.09 (0.04 to 0.14) .009</td>
</tr>
<tr>
<td>Sugar-sweetened beverages</td>
<td>0.14 (0.12 to 0.16) −.001</td>
<td>0.11 (0.01 to 0.22) .04</td>
</tr>
<tr>
<td>All foods</td>
<td>0.54 (0.37 to 0.72) .001</td>
<td>0.60 (0.41 to 0.78) .001</td>
</tr>
</tbody>
</table>

*Estimated from a regression equation controlling for baseline intake of the test food group, body mass index, total energy intake, physical activity of 3.5 metabolic equivalents or more, and age; change in physical activity of 3.5 metabolic equivalents or more; and sex, race/ethnicity, and school indicator variables.†Baked sweet snacks include brownies, cake, cookies, donuts, pies, Pop-Tarts (Kellogg’s, Battle Creek, Mich), and snack cakes; candy: candy other than chocolate, chocolate, and fruit leathers; fast food-type main courses: cheeseburgers, chicken nuggets, fried chicken, hamburgers, hot dogs, pizza, and tacos/burritos; fried potatoes: French fries and potato puffs; salty snacks: corn chips, crackers, potato chips, and pretzels; and sugar-sweetened beverages: fruit drinks, nondiet iced tea, and nondiet soda.

ships are necessary to demonstrate that intakes of these foods can mediate television’s effect on TEI. The table shows the coefficients for change in servings per day of these foods associated with baseline and change in television viewing. With the exception of fried potatoes, higher intakes of all foods at follow-up were significantly positively associated with baseline television viewing level. Moreover, change in television viewing was significantly associated with change in consumption of each food group. With each 1-hour increment in television viewing, increases in servings per day ranged from 0.03 (fried potatoes) to 0.21 (baked sweet snacks) across food groups, or 0.2 to 1.4 servings per week.
counted for 9% of eating occasions and 12% of calories. Concurrent evidence suggests that total average daily energy intake among youth have increased, reflecting in part increased intake of added sugars. Among adolescents, about 40% of added sugars derive from soda, consumption of which increased by 131% between the late 1970s and the mid 1990s. Our analyses support a link between television viewing and these unhealthy dietary changes, suggesting that television advertising for food has a powerful influence on diets. Indeed, studies show that television viewing is inversely associated with intake of fruits and vegetables, which receive little air time despite their potential to promote health in various ways and protect against weight gain.

Several limitations of the analysis relate to measurement error and its attendant effect on regression analyses. The validity of the television measure is limited by recall bias and instrument design, although prior studies indicate modest validity. Dietary intake is typically measured with a large component of random measurement error. In linear regression models with random error in the dependent variable (such as total energy or food intake), regression coefficients will be unbiased, although the $R^2$ value for the model will be reduced; conversely, random measurement errors in independent variables will attenuate regression coefficients and reduce their ability to function effectively as mediating or control variables. In using dietary intake, television viewing time, and physical activity measures as independent variables, random error due to questionnaire design, recall error, and within-person variability not captured by the instrument may, therefore, attenuate regression coefficients. When food servings are converted to energy intake, additional errors are introduced because of assumptions about serving size and food composition. Another potential source of error is in the use of television viewing time as a proxy for exposure to advertising. Although we assumed that, on average, youth who watched more television were exposed to more advertisements, we did not assess what programs or channels subjects were exposed to, both of which could affect the total “dose” of advertising. We also had limited ability to control for other potential confounding variables, such as baseline levels of moderate and vigorous physical activity and body composition, which may also have contributed to bias in estimates of association.

Causality is suggested but not proved by our findings, which are observational and not experimental. Generalizability may be limited because of the nature of our sample. Further research could address these limitations through a randomized trial to reduce television viewing in a broader population of youth using survey instruments that collected data on sources of food.

In conclusion, although children and youth are encouraged to watch what they eat, many youth seem to eat what they watch, and in the process increase their risk for increasing their energy intake. In the absence of regulations restricting food advertising aimed at children, reduction in television viewing is a promising approach to reducing excess energy intake. Although a threshold of safe exposure to television and food marketing has not been empirically demonstrated, the American Academy of Pediatrics has long advocated limiting children to no more than 2 hours of television per day to decrease sedentary time and to decrease exposure to content that may encourage a range of negative behaviors. This study adds more evidence in support of this recommendation.

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