

Associations of Television Content Type and Obesity in Children

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Obesity continues to be a major public health concern for America's children, with obesity rates for preschool children tripling in the past 30 years and quadrupling for children aged 6 to 11 years.¹

Television viewing has been shown to be associated with obesity cross-sectionally^{2–8} and in longitudinal data in many,^{9–14} but not all,^{15–17} studies. Comprehensive literature reviews of these disparate results conclude that the association between television viewing and obesity is on average small, but negative.^{18,19}

A constructive way to reconcile the disparate findings is to recognize that different kinds of television content may exert different effects on obesity. Television might lead to obesity through 3 primary pathways^{20,21}: by displacing time that would otherwise be spent in physical activity; by promoting eating while viewing, which may foster both lower-quality and higher-quantity food intake; and by exposing children to food advertising, which adversely affects their diets.

These pathways have quite different implications for the ways different kinds of television content might affect obesity. The hypotheses involving displacement of physical activity and eating while viewing suggest that all types of television have an equal and significant effect on obesity. If the advertising hypothesis is more accurate, only commercial television viewing should be associated with obesity and not noncommercial television or DVD viewing. Of course, all pathways might be operative, in which case we would expect significant associations between all types of content and obesity but associations of greater magnitude for commercial content.

A review of the literature on the role of media in childhood obesity identified no scholarly articles analyzing the associations of different types of television content with obesity status in children.²² We used nationally representative longitudinal data to analyze the effects of different kinds of television content on body mass index (BMI).

Objectives. We tested the associations of content types of children's television viewing with subsequent body mass index (BMI) to assess the plausibility of different causal pathways.

Methods. We used time-use diary data from the Panel Survey of Income Dynamics to measure television viewing categorized by format and educational and commercial content. Analyses were stratified by age because children younger than 7 years are less able to understand the persuasive intent of advertising. BMI z scores in 2002 were regressed on television viewing, socio-demographic variables, mother's BMI, and BMI in 1997 (for older children only).

Results. Among children aged 0 to 6 years in 1997, commercial viewing in 1997 was significantly associated with BMI z scores in 2002 in fully adjusted regressions. Among children older than 6 years, commercial viewing in 2002 was associated with 2002 BMI. These results were robust after adjustment for exercise and eating while watching television.

Conclusions. The evidence does not support the contention that television viewing contributes to obesity because it is a sedentary activity. Television advertising, rather than viewing per se, is associated with obesity. (*Am J Public Health*. 2010;100:334–340. doi:10.2105/AJPH.2008.155119)

METHODS

We used data from the Panel Survey of Income Dynamics, a longitudinal study overseen by the National Science Foundation that began in 1968 with a variety of funding sources and 4800 families. In 1997 the study added the Child Development Supplement, a questionnaire administered to the primary caregivers of 3563 children aged 0 to 12 years.²³ The questionnaire, funded by the National Institute of Child Health and Human Development, included detailed demographic data, psychological and behavioral assessment of parents and children, and time-use diary data from 1 randomly chosen weekday and 1 randomly chosen weekend day during a school year (September–May). Such time-use diaries have been used extensively in research and have shown excellent validity in comparisons with direct observation of activities.^{24,25} In 2002, the respondents to the first questionnaire were followed up with a second, similar instrument.

Time-use diaries were completed by 2569 families in 2002. Of these, 376 did not complete the 1997 diaries, and an additional 92 were not assessed for BMI or were missing data

for important covariates. Missing values were dealt with by case-wise deletion, which in observational data results in minimal bias. Twenty-four underweight children (BMI < 12 kg/m²) were dropped from the analyses, leaving an analysis sample of 2037.

Outcomes and Variables

The outcome measure was BMI (defined as weight in kilograms divided by height in meters squared), converted to z scores according to 2000 growth charts published by the Centers for Disease Control and Prevention.²⁶ We used BMI z scores rather than absolute BMI because children's height and weight increase as part of normal development and because our sample comprised boys and girls of different ages. In the 2002 wave of the Child Development Supplement, both height and weight were measured. In 1997, the height of children 5 years and older was measured, and their weight was recorded from parental report. BMI data were not available for children younger than 5 years in 1997.

The time-use diaries in both 1997 and 2002 asked parents to report their child's activities throughout the course of an entire weekday and an entire weekend day. When the activity

involved watching television in any format, the parents were asked to report the format (i.e., television or DVD or video) and the name of the show watched. We used these data to classify hours of television viewing per day into 5 collectively exhaustive and mutually exclusive categories.^{27,28}

Educational viewing on broadcast or cable.

The content of these programs was determined to have an educational objective. The majority of these shows were aired by the Public Broadcasting System. The others were presented without in-program commercials. Many of these shows, including *Sesame Street*, *Barney*, and *Blue's Clues*, included content about nutrition or the value of physical activity.²⁹ The shows often included sponsorship messages in interstitials (brief announcements between programs), and the sponsors were sometimes food corporations such as McDonald's. Children viewing this content type were exposed to potentially beneficial anti-obesity messages but also to pseudo-advertising through interstitials.

Educational viewing on video or DVD. Only the format differed from the first category; the content was educational by the same definition. Although DVDs occasionally included advertising trailers, they rarely included food advertising. Children viewing this content type were exposed to potentially beneficial anti-obesity messages and not to pseudo-advertising through interstitials.

Entertainment viewing on video or DVD.

Examples of noneducational programs were *Scooby Doo* and *The Little Mermaid*. Children viewing this content type were not exposed to commercials during or between programs, but they were also not exposed to anti-obesity messages, and they may have been exposed to marketing tie-ins to food products.

Children's entertainment viewing on broadcast or cable. Noneducational programming almost always included in-program commercials. Product placement was banned in shows targeted at children. Children viewing this content type were exposed to in-program commercials but not product placement.

General-audience entertainment viewing on broadcast or cable. Children viewing this content type were exposed to in-program commercials and to product placement of obeso-genic foods.

If the association between television viewing and obesity operates by reducing physical activity, the association should be weakened when the amount of the child's physical activity is controlled. Accordingly, we included measures of exercise in our analyses. Physical exercise was captured through the time-use diaries. We categorized a child's exercise time, the average number of minutes per day spent in either moderate or vigorous physical activity, as (1) no reported exercise, (2) total moderate and vigorous activity averaging 1 to 30 minutes per day, or (3) total moderate and vigorous activity averaging more than 30 minutes per day.

Our analyses controlled for several other children's and family attributes that may affect both television viewing and a variety of health behaviors associated with obesity: the child's gender, age, and race/ethnicity, and the mother's BMI (self-reported in 1999) and education. We included the average duration of sleep, calculated from time-use diary data, to control for the possibility that television viewing reduces sleep time,³⁰ which in turn may lead to obesity. Sampling weights were used to permit inferences valid for the population.

Statistical Analysis

We split the sample into 2 age groups, younger than 7 years and 7 years and older, with separate multivariate linear regressions for each group. Young children are unable to distinguish television advertising from the program that surrounds it, and children younger than 7 years are not able to understand that the intent of advertising is to sell them things they would otherwise not want.^{31–33}

The differences in the 5 content types would be expected to exert different effects on obesity: if sponsorship interstitials have a meaningful effect on obesity, associations of obesity should be significantly greater with broadcast educational television than with video educational television. If the anti-obesity messages of educational television have a meaningful effect on obesity, associations should be significantly greater with video entertainment television than with video educational television. If product placement has a meaningful effect on obesity, associations should be significantly greater with children's broadcast entertainment than with general-audience

broadcast entertainment. If in-program commercials have a meaningful effect on obesity, associations should be significantly greater with the video and educational categories than with the broadcast entertainment categories. We tested these expectations statistically and combined categories when coefficients did not differ significantly.

To test whether the effect of television content types was independent of the effects of exercise, we included the 1997 and 2002 values of these variables in subsequent regressions. To test whether the television–obesity relationship was mediated by eating in front of the television, subsequent regressions included a variable for 2002 indicating how often the child was permitted to eat in front of the television.

It is possible that an association between early television viewing and subsequent obesity reflects an unmeasured preference of obese children to watch television. To mitigate this possibility, we controlled for baseline BMI of older children.

RESULTS

Table 1 shows the descriptive statistics of the variables. Children younger than 7 years in 1997 watched an average of 0.88 hours per day of commercial television and 0.74 hours per day of noncommercial television. Children aged 7 years and older in 1997 watched an average of 1.47 hours per day of commercial television in 1997 and 0.48 hours per day of noncommercial television. Between 1997 and 2002, viewing of noncommercial television decreased and viewing of commercial television increased.

Among the younger children, associations with obesity did not differ significantly between broadcast educational television and video educational television ($P=.42$), between video entertainment television and video educational television ($P=.61$), or between children's broadcast entertainment television and general audience broadcast entertainment television ($P=.33$).

Among the older children, associations with obesity did not differ significantly between broadcast educational television and video educational television ($P=.06$), video entertainment television and video educational

TABLE 1—Children's BMI and Television Viewing: Panel Survey of Income Dynamics, 1997–2002

	Children Aged 0–6 Years in 1997		Children Aged 7–13 Years in 1997	
	Children Observed, No.	% or Mean (SD)	Children Observed, No.	% or Mean (SD)
BMI z score in 1997			836	0.28 (1.34)
BMI z score in 2002	1118	0.60 (1.14)	915	0.58 (1.13)
Television viewing in 1997, h/d				
Commercial	1118	0.88 (1.11)	915	1.47 (1.25)
Noncommercial	1118	0.74 (0.95)	915	0.48 (0.70)
Television viewing in 2002, h/d				
Commercial	1118	1.54 (1.25)	915	1.75 (1.58)
Noncommercial	1118	0.49 (0.73)	915	0.45 (0.77)
Physical activity in 1997, min/d				
None	1118	27.3	915	22.2
1–30	1118	19.1	915	17.0
>30	1118	53.6	915	60.8
Physical activity in 2002, min/d				
None	1118	39.9	915	51.1
1–30	1118	17.8	915	10.9
>30	1118	42.3	915	38.0
Eating in front of the television in 2002 ^a	1114	2.50 (1.31)	914	2.77 (1.40)

Note. BMI = body mass index.

^aFrequency score on a 5-point Likert scale.

television ($P=.33$), or children's broadcast entertainment television and general audience broadcast entertainment television ($P=.37$; data not shown but available on request).

To improve model efficiency, we consolidated the viewing categories into 2 categories: commercial viewing (consisting of children's broadcast entertainment and general-audience broadcast entertainment) and noncommercial viewing (consisting of broadcast educational television, video educational television, and video entertainment television).

Table 2 shows the results of regressions of BMI z scores on these 2 viewing categories. For children younger than 7 years in 1997, each hour per day of commercial viewing in 1997 was significantly associated with a 0.11 increase in BMI z scores in 2002, after control for socio-demographic covariates, including mother's BMI (Table 2). No other category of television viewing had a significant association with z scores. These results were robust to the inclusion of physical activity and eating while watching television (Table 2). The frequency of eating in front of the television was not itself significant.

For children aged 7 years or older in 1997, none of the television-viewing variables had significant effects when included without the child's baseline BMI or the potential mediators, although the effect of commercial television viewing in 2002 showed a trend toward significance ($P=.06$). Because of the concern that more obese children may favor watching television, we performed a regression that included the child's baseline BMI (Table 3). In this regression, the magnitude of the association with 2002 commercial content was similar, but the effect became statistically significant. None of the other content categories had significant effects. These results remained significant when physical activity and eating while watching television were controlled. Eating in front of the television was not independently associated with obesity.

DISCUSSION

Television has often been presented as a sedentary activity in academic research and

policy pronouncements. In the popular imagination this presumption is conveyed in the term *couch potato*.¹⁹ Our results strongly challenge this perception. In our analysis, only viewing of commercial content—programs in which children are exposed to in-program advertisements—was associated with obesity. Moreover, this result remained when we controlled for several potential confounders (the mother's BMI, the mother's educational level, and the amount of the child's sleep).

In these regressions, the mother's BMI was a proxy for both the diet and physical activity patterns in the household, as well as genetic factors that might influence the child's BMI. For the older children, the results were not moderated when the child's baseline BMI was controlled. Commercial viewing was a significant predictor of children's obesity even with these controls, strongly suggesting that the viewing–obesity relationship is not confounded by other variables but is in fact causal.

By contrast, viewing of noncommercial television (educational television presented without in-program commercials or videos or DVDs) had no statistically significant association with subsequent or concurrent obesity.

Our findings are consistent with previous research.^{15,34} Most convincingly, 2 randomized trials of interventions to reduce television viewing found statistically significant effects on calorie intake and obesity but not on physical activity.^{35,36} The results of these trials, together with the evidence from our very different approach, make a strong case that television viewing does not affect obesity through a pathway involving reduced physical activity. These results imply that it is the viewing of television advertisements for foods of low nutritional quality that leads to obesity, not television watching per se.

Consistent with expectations that children's cognitive ability to understand advertising differs by age—roughly before and after age 7 years—we found a slightly stronger association of commercial content with obesity before 7 years of age than after.

Food marketers spend \$10 billion a year on their efforts to influence children's diets, and most of this is for television advertising.³⁷ Food is the most commonly advertised product on

TABLE 2—Fully Adjusted Regression of 2002 BMI z Scores on Television Viewing Among Children Aged 0–6 Years in 1997: Panel Survey of Income Dynamics

	Model 1, ^a b (95% CI)	Model 2, ^b b (95% CI)	Model 3, ^c b (95% CI)
Television viewing in 1997, h/d			
Commercial	0.11**(0.00, 0.21)	0.11**(0.00, 0.21)	0.10**(0.00, 0.21)
Noncommercial	0.03 (-0.07, 0.14)	0.03 (-0.08, 0.13)	0.04 (-0.07, 0.14)
Television viewing in 2002, h/d			
Commercial	0.06 (-0.04, 0.16)	0.06 (-0.04, 0.16)	0.06 (-0.04, 0.17)
Noncommercial	0.00 (-0.10, 0.11)	0.01 (-0.10, 0.11)	0.00 (-0.10, 0.11)
Physical activity in 1997, min/d			
None (Ref)			
1–30		-0.06 (-0.34, 0.22)	
> 30		0.01 (-0.21, 0.23)	
Physical activity in 2002, min/d			
None (Ref)			
1–30		-0.19 (-0.43, 0.05)	
> 30		0.02 (-0.18, 0.21)	
Eating in front of the television in 2002			0.03 (-0.04, 0.10)
Adjusted R ²	0.07	0.07	0.07

Note. BMI = body mass index; CI = confidence interval. Regressions were also adjusted for child's gender, age, race, ethnicity, mother's education level, and mother's BMI. Sampling weights were applied to produce population-level inferences. The sampling variance was estimated by the Huber-White method to reflect common variance among siblings.

^aBase model, n = 1118.

^bModel 1 plus physical activity mediators, n = 1118.

^cModel 1 plus eating while viewing mediator, n = 1114.

**P < .05.

children's television.^{38–42} Children younger than 5 years see an average of more than 4000 television commercials for food each year, or about 30 hours' worth.³⁸ During Saturday morning cartoons, children see an average of 1 food ad every 5 minutes.⁴³ The vast majority of foods commonly advertised on television—up to 95% in 1 study³⁹—are of poor nutritional value.^{37,38,40,41,44–49}

Abundant short-term experimental evidence shows that advertising for food of poor nutritional quality has a strong influence on children's food preferences. Randomized experiments with children in preschool and first grade have shown that children experimentally exposed even to relatively few commercials are more likely than unexposed children to have positive attitudes toward and to choose the advertised foods over alternatives.^{50–53} Moreover, 1 study found that children exposed to advertising were also more likely than were participants in a control group to choose nonadvertised sugary foods.⁵²

The effect of the advertising was thus not limited to the specifically advertised brands but had a more general adverse influence on their food choices.

The context for any relationship between television viewing and obesity at this age is alarming. Marketers target very young children, and children start watching television at very young ages. Almost 90% of children begin watching television regularly before age 2, and the average age of initiation is 9 months.⁵⁴ Marketing efforts begin with children as young as 2 years, in order to build brand awareness and brand sympathy.^{45,55,56} The typical first-grade child can already recognize and respond to more than 200 brands.⁵⁷

Implications

Our results have several important implications for research in obesity prevention. First, the current emphasis on reducing sedentary activities—particularly television—may be

misplaced. It may be more effective to focus on promoting physical activity directly than to try to limit television viewing generally.^{7,34,58,59}

Our evidence strongly suggests that steering children away from commercial television may have a meaningful effect in reducing childhood obesity.

This conclusion has implications for both policy and practice. It may be appropriate to limit the advertising of obesogenic foods on television programs targeted to children. Advertisers spend huge sums to fund commercial children's programming, making such a policy change politically difficult; the enormous costs to society of obesity, however, may make such a policy worth pursuing. In practice, primary care providers and others who advise parents may find it easier—and just as effective for obesity outcomes—to steer parents away from commercial programming rather than away from television altogether. The existence of many high-quality, enjoyable, and educational programs available on DVD for all ages should make it relatively easy for health educators and care providers to nudge children's viewing toward less obesogenic television content.

How parents talk to their children about advertising can be an important mediator of advertising's influence on children's choices. Our results suggest that parents should take their role as media literacy educators seriously. Although our data did not assess the media savviness of parents, nor their discussions with their children, presumably some parents in the data set effectively communicated the dangers of advertising to their children, possibly rendering them more resistant to its effects. If so, our results reflected an average effect across parents who were media savvy—whose children might be less likely to be affected by advertising—and parents who were less knowledgeable—in whose children the association of commercial content with obesity would be greater than we reported. It is plausible that children could become less susceptible to the influence of advertisements through family discussions about their limitations, purpose, and dangers.

Strengths and Limitations

Our study had several important strengths. To our knowledge, it was the first study to

TABLE 3—Fully Adjusted Regression of 2002 BMI z Scores on 1997 and 2002 Television Viewing Among Children Aged 7–13 Years in 1997: Panel Survey of Income Dynamics

	Model 1, ^a b (95% CI)	Model 2, ^b b (95% CI)	Model 3, ^c b (95% CI)	Model 4, ^d b (95% CI)
Child's BMI z score in 1997		0.45**(0.38, 0.51)	0.45**(0.38, 0.51)	0.44**(0.38, 0.51)
Television viewing in 1997, h/d				
Commercial	-0.02 (-0.10, 0.06)	-0.03 (-0.10, 0.04)	-0.03 (-0.10, 0.04)	-0.03 (-0.10, 0.04)
Noncommercial	-0.08 (-0.22, 0.05)	-0.02 (-0.12, 0.09)	-0.01 (-0.11, 0.10)	-0.02 (-0.12, 0.08)
Television viewing in 2002, h/d				
Commercial	0.06*(0.00, 0.12)	0.06**(0.01, 0.12)	0.06**(0.01, 0.12)	0.06**(0.00, 0.12)
Noncommercial	0.04 (-0.08, 0.16)	0.09 (-0.03, 0.21)	0.09 (-0.03, 0.21)	0.09 (-0.03, 0.21)
Physical activity in 1997, min/d				
None (Ref)				
1–30			-0.19 (-0.44, 0.06)	
> 30			0.00 (-0.20, 0.20)	
Physical activity in 2002, min/d				
None (Ref)				
1–30			-0.18 (-0.47, 0.10)	
> 30			-0.09 (-0.25, 0.06)	
Eating in front of the television in 2002				0.04 (-0.02, 0.10)
Adjusted R ²	0.10	0.37	0.37	0.37

Note. BMI = body mass index; CI = confidence interval. Regressions were also adjusted for child's gender, age, race, ethnicity, mother's education level, and mother's BMI. Sampling weights were applied to produce population-level inferences. The sampling variance was estimated by the Huber-White method to reflect common variance among siblings.

^aBase model, n = 915.

^bModel 1 with baseline BMI controlled, n = 836.

^cModel 2 plus physical activity mediators, n = 836.

^dModel 2 plus eating while viewing mediator; n = 835.

*P < .10;

**P < .05.

disaggregate the types of television viewing to which children are exposed. This disaggregation was consistent with distinct possible causal pathways in the television–obesity link. The use of a US-based nationally representative longitudinal data set ensured generalizable findings and permitted analysis that exploited temporality to make a more convincing causal case. In particular, the ability to control for baseline BMI and thereby reduce the potential for reverse causality among older children was an important strength of the analysis, in particular because it showed that omitting baseline BMI introduced a conservative bias.

Observational data have well-known limitations. Our study had several other limitations as well. Adequate measures of diet were not available to test whether the effects of advertising might be mediated through changes to children's diet. Eating in

front of the television had no significant association with obesity, and the differences in associations that would be expected because of the possible effect of product placement and food company interstitials on public television were not strong enough to have a measurable impact in our analysis.

These negative findings do not completely rule out the mechanisms investigated. It could be that our measure of eating in front of the television was too weak to adequately pick up its effects. The television environment has changed since 2002 and has changed dramatically since 1997—today more interstitials are aired and more products are featured than appeared in turn-of-the-century programming. It is possible that an analysis of more recent data would have detected more pronounced effects of product placement and interstitials. Similarly, it is possible that the

pronutritional content of educational television has become both more common and more effective since our data were collected.

The time-use diaries that provided our viewing data represented both a strength and a weakness for our study. It allowed us to categorize viewing by content in a form that was relatively accurate and free of systematic bias. However, data collection for only 2 days per child per wave left considerable room for measurement error, and this error may have been stronger for the separate viewing categories than for overall viewing.

As food advertisers increasingly flock to alternative formats, future research should attempt to analyze the longer-term and real-world effects of advertising directly, that is, outside of small-scale lab experiments. Food advertisers have extensive presence on the Internet, where advergames are becoming common,⁶⁰ and product placement is becoming more common and more sophisticated in broadcast television, movies, and video games. Advertisers are also expanding their reach to novel venues such as Web advertising, cell phone advertising, stand-alone screens in gas stations, and the Scholastic Book Club Flyer sent home periodically with grade school children.⁶¹

Conclusions

Television viewing may be a sedentary activity, but it is not for that reason that it is associated with obesity in children. The relationship between television viewing and obesity among children is limited to commercial television viewing and probably operates through the effect of advertising obesogenic foods on television. ■

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Contributors

F.J. Zimmerman designed the analysis and obtained the data. The authors collaborated on extracting the data, planning and executing the analysis, interpreting the results, and writing the article.

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Human Participant Protection

The data used are in the public domain. The research was approved by the institutional review board of Children's Hospital and Regional Medical Center, Seattle, WA.

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