Fast-Food Restaurant Advertising on Television and Its Influence on Childhood Obesity

Shin-Yi Chou *Lehigh University*

Inas Rashad *Georgia State University*

Michael Grossman *City University of New York*

Abstract

Childhood obesity is an escalating problem around the world that is especially detrimental as its effects carry on into adulthood. In this paper we employ the 1979 Child–Young Adult National Longitudinal Survey of Youth and the 1997 National Longitudinal Survey of Youth to estimate the effects of television fast-food restaurant advertising on children and adolescents with respect to being overweight. A ban on these advertisements would reduce the number of overweight children ages 3–11 in a fixed population by 18 percent and would reduce the number of overweight adolescents ages 12–18 by 14 percent. The elimination of the tax deductibility of this type of advertising would produce smaller declines of between 5 and 7 percent in these outcomes but would impose lower costs on children and adults who consume fast food in moderation because positive information about restaurants that supply this type of food would not be completely banned from television.

1. Introduction

Childhood obesity around the world, and particularly in the United States, is an escalating problem that has received much attention of late. In less than 30

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years, the prevalence of overweight children and adolescents in the United States has more than doubled. In the 1963–70 period, 4 percent of children ages 6–11 years and 5 percent of adolescents age 12–19 were defined as being overweight. The percentage of children who are overweight more than tripled by 1999, reaching 13 percent. For adolescents, the incidence of overweight has nearly tripled in the same period, reaching 14 percent (U.S. Department of Health and Human Services 2001).

An investigation of the nongenetic determinants of obesity among children and adolescents is an important input in designing prevention policies. On the simplest level, weight gain is caused by more energy intake than energy expenditure over a long period of time. The problem of energy imbalance is not purely due to genetics since our genes have not changed substantially during the past 2 decades. Researchers have tended to focus on environmental factors such as the availability of highly palatable and calorie-dense fast food to promote high energy intake as well as the appeal of television, video games, and computers to discourage energy expenditure. Potentially, television viewing has two effects: reductions in physical activity and increases in fast-food consumption associated with exposure to advertisements of this product.

How the commercial advertising of foods contributes to the prevalence of obesity among children and adolescents is still an ongoing debate. Despite the lack of evidence showing a direct linkage between television food advertising and childhood obesity, several industrialized countries such as Sweden, Norway, and Finland have banned commercial sponsorship of children's programs. Sweden also does not permit any television advertising targeting children under the age of 12 (Kaiser Family Foundation 2004).

In the United States, most recently, companies such as Kraft Foods have decided to curb advertising aimed at children in an effort to encourage better eating habits (Mayer 2005). The Institute of Medicine 2006 report entitled *Food Marketing to Children and Youth: Threat or Opportunity* indicated that there is compelling evidence linking food advertising on television and increases in childhood obesity. Some members of the committee that wrote the report recommended congressional regulation of television food advertisements aimed at children, but the report also said that the final link that would definitively prove that children had become fatter by watching food commercials aimed at them cannot be made.

The purpose of this paper is to explore the causal relationship between exposure to fast-food restaurant advertising on television and childhood obesity. We employ two individual-level data sets: the National Longitudinal Survey of Youth 1997 for adolescents ages 12–18 and the Child–Young Adult National Longitudinal Survey of Youth 1979 for children ages 3–11. The data for fast-food restaurant advertising on television are appended to the individual-level data by metropolitan area and year. We employ several different specifications, and most results show a positive and statistically significant impact of fast-food restaurant advertising on television on body mass index and on the probability of being overweight for children and adolescents.

2. Background

Obesity is measured by the body mass index (BMI), also termed Quetelet's index, and is defined as weight in kilograms divided by height in meters squared. Persons 18 years of age and older with a BMI greater than or equal to 30 kg/m^2 are classified as obese. An overweight child or adolescent (the term obese is reserved for adults) is defined as one having a BMI at or above the 95th percentile based on age- and gender-specific growth charts for children and adolescents in the second and third National Health Examination Surveys (NHES II and NHES III), which were conducted between 1963 and 1965 and between 1966 and 1970, respectively, and from the first, second, and third National Health and Nutrition Examination Surveys (NHANES I, NHANES II, and NHANES III), which were conducted between 1971 and 1974, 1976 and 1980, and 1988 and 1994, respectively.

Trends in the mean BMI of persons ages 3–11 (hereafter termed children) and the percentage overweight between 1963 and 2000 are presented in Table 1. Similar data for persons ages 12–18 (hereafter termed adolescents or teenagers) are presented in Table 2. These data come from heights and weights obtained from physical examinations conducted in NHES II and III, in NHANES I, II, and III, and in 1999–2000 NHANES (NHANES 99). Both tables show dramatic increases in the percentage of overweight children and teenagers between 1978 (the midyear of NHANES II) and 2000. This percentage doubled for children and almost tripled for teenagers.

In the period during which childhood obesity increased so drastically, trends in the amount of time spent watching television and exposure to food advertising by children and adolescents were not clear-cut. Around 1950, only 2 percent of households in the United States had television sets; by the early 1990s, 98 percent of households owned at least one, and over 60 percent had cable television (Huston et al. 1992). Yet the average amount of time children spent watching television fell from about 4 hours a day in the late 1970s to 2 hours and 45 minutes a day in 1999 before rising to 3 hours and 20 minutes a day in 2005 (Zywicki, Holt, and Ohlaysen 2004; Powell, Szczypka, and Chaloupka 2007).

According to estimates made by Kunkel (2001), in the late 1970s, children viewed an average of about 20,000 commercials aired on television per year. The number increased to 30,000 per year in the late 1980s and to more than 40,000 per year in the late 1990s, possibly because programs or commercials became shorter over time. Holt et al. (2007), on the other hand, estimate that the number of television advertisements viewed by children actually declined between 1977 and 2004. They also report that, while the number of television food advertisements viewed by children decreased between those 2 years, the number of restaurant and fast-food advertisements viewed increased. The last trend is consistent with the increase in

Table 1
Trends in Body Mass Index and the Percentage of Overweight Persons 3–11 Years of Age

				Males Only		Females Only	
Survey	Period	BMI	Overweight[a]	BMI	Overweight[a]	BMI	Overweight[a]
NHES II	1963–65	16.63	4.24	16.57	4.00	16.68	4.50
NHANES I	1971–74	16.44	5.33	16.46	5.74	16.42	4.92
NHANES II	1976–80	16.64	7.33	16.64	7.22	16.64	7.44
NHANES III	1988–94	17.15	10.59	17.09	10.25	17.22	10.95
NHANES 99	1999–2000	17.37	14.26	17.38	14.74	17.36	13.76

Note. The surveys are as follows: National Health Examination Survey II (NHES II), National Health and Nutrition Examination Survey I (NHANES I), National Health and Nutrition Examination Survey II (NHANES II), National Health and Nutrition Examination Survey III (NHANES III), and National Health and Nutrition Examination Survey 1999–2000 (NHANES 99). NHES II pertains to children 6–11 years of age. Survey weights are employed in all computations. Body mass index (BMI) is weight in kilograms divided by height in meters squared. Actual weights and heights are used in calculations.
[a] Percentage with BMI equal to or greater than the 95th percentile based on Centers for Disease Control and Prevention (2007) growth charts.

the share of fast-food restaurant advertising in total food product advertising from 5 percent in 1980 to 28 percent in 1997 (Gallo 1999).

While most prior studies have confirmed correlations between television watching and obesity in children, few studies have looked at the effect that fast-food restaurant advertising on television per se might have on childhood obesity (see Chou, Rashad, and Grossman [2007] for a review of both types of studies). Consumer behavior in response to advertising could be explained using Becker and Murphy (1993), which presents a model in which a brand's advertising level interacts with consumption in the consumer's utility function. In this model, by treating advertising as a complementary good, consumers may simply derive more utility from consuming a more advertised good.

More generally, fast-food restaurants would not choose to advertise if advertising did not increase the demand for their products. Unless fast-food demand perfectly crowds out demand for other foods that are equal in calories, body weight will increase since consumers will never choose to perfectly offset the increased food demand with more exercise. Of course, it may be the case that most advertising is directed toward competition among restaurants and little at stimulating consumption per se (see, for example, Schmalensee 1972). In summary, the effect of television advertising on childhood obesity is complex, dealing with the interplay among the characteristics of the children, the attitudes of their parents, and environmental settings. Our empirical study attempts to isolate the effect of fast-food restaurant advertising on television on obesity in children and adolescents.

3. Data

The microlevel data set that we use for adolescents ages 12–18 is the National Longitudinal Survey of Youth 1997 (hereafter NLSY97). This is a nationally

Table 2

Trends in Body Mass Index and the Percentage of Overweight Persons 12–18 Years of Age

				Males Only		Females Only	
Survey	Period	BMI	Overweight[a]	BMI	Overweight[a]	BMI	Overweight[a]
NHES I, III	1959–62, 1966–70	20.61	4.45	20.47	4.50	20.76	4.40
NHANES I	1971–74	20.97	6.82	20.81	6.83	21.13	6.82
NHANES II	1976–80	21.03	5.63	20.92	5.39	21.16	5.89
NHANES III	1988–94	22.11	10.62	21.95	11.48	22.28	9.72
NHANES 99	1999–2000	22.82	14.75	22.52	15.03	23.13	14.45

Note. The surveys are as follows: National Health Examination Survey I and III (NHES I, III), National Health and Nutrition Examination Survey I (NHANES I), National Health and Nutrition Examination Survey II (NHANES II), National Health and Nutrition Examination Survey III (NHANES III), and National Health and Nutrition Examination Survey 1999–2000 (NHANES 99). NHES I was used for adolescents of age 18, while NHES III was used for those between the ages of 12 and 17. Survey weights are employed in all computations. Body mass index (BMI) is weight in kilograms divided by height in meters squared. Actual weights and heights are used in calculations.

[a] Percentage with BMI equal to or greater than the 95th percentile based on Centers for Disease Control and Prevention (2007) growth charts.

representative sample of the U.S. population ages 12–16 as of December 31, 1996. The initial sample in 1997 consists of 8,984 respondents who originated from 6,819 unique households. Two subsamples make up the NLSY97 cohort. The first is a nationally representative sample of 6,748 respondents born between 1980 and 1984. The second consists of 2,236 oversampled black and Hispanic respondents for that age group. The survey has collected extensive information about youth labor market behavior and educational experiences over time. Round 1 of the NLSY97, which took place in 1997, contains a parent questionnaire that generates information about the youth's family background and history. Only 7,942 youth respondents (out of 8,984) have information available from a parent interview. The NLSY97 also contains information on time use including the amount of time spent in the prior week watching television from youth ages 12–14 in round 1.[1]

We pool three rounds of NLSY97 for the analysis: 1997 (N = 8,984), 1998 (N = 8,386), and 1999 (N = 8,209).[2] Before any state-level or advertising data are appended to the NLSY97, the pooled sample size is 14,852 when observations with missing values are deleted. Note that a large percentage of observations are dropped because of the missing values for television-watching time. This question is not asked of youth over the age of 14 in 1997 (round 1), and it is not asked after that year. Therefore, we assume that the 1997 values also apply to 1998 and 1999.

We also use the matched mother-child data from the National Longitudinal

[1] Out of 8,984, only 5,419 youth respondents were between the ages of 12 and 14 in round 1. Thus, 40 percent of our sample was dropped because of the missing values for television-watching time.

[2] We do not use the year 2000 for National Longitudinal Survey of Youth 1997 (NLSY97) because our advertising data are from 1996–99.

Survey of Youth 1979 (hereafter NLSY79) for children ages 3–11. The NLSY79 is a nationally representative sample of 12,686 individuals, of whom 6,283 are women who were 14–22 years old when they were first surveyed in 1979. In 1986, biennial interviews of all children born to female respondents began, making up the Child and Young Adult File. We use three survey years of data, 1996, 1998, and 2000. The television-watching variable is available in each of these years.

We obtained fast-food restaurant television advertising data from special tabulations performed for us by Competitive Media Reporting (CMR), the largest provider of advertising tracking services in the United States. Competitive Media Reporting was formed in 1992 by combining several advertising tracking and broadcast proof-of-performance companies. The tabulations that CMR supplied to us have exposure information and dollar expenditures for a wide array of fast-food restaurant chains in the United States from 1996 to 1999.[3] The exposure variable equals the annual number of seconds of fast-food restaurant messages aired on television. This variable is then divided by a factor of ($60 \times 60 \times 52$), or 187,200, to convert it into the weekly number of hours of fast-food restaurant advertising messages aired.

The unit of observation for the variable just described is the designated market area (DMA), which is similar to a metropolitan statistical area (MSA). The DMA is a region composed of counties (and occasionally split counties) that defines a television market. Thus, the advertising data were appended to our individual records by DMA and year.[4] Out of about 210 DMAs, the top 75 (in terms of television households) are contained in the CMR database and used in our study. As a consequence, our final sample sizes, when the advertising data are appended, are 6,034 person-years for respondents ages 3–11 (NLSY79) and 7,069 person-years for respondents ages 12–18 (NLSY97).[5]

Note that network television, syndicated television, and cable network television advertising are not included in our data because they have no local variation. National advertising effects cannot be obtained in the specifications that we employ since they contain dichotomous year indicators. Spot television ad-

[3] The corporations we chose for this analysis that we believed best reflected the fast-food industry were A&W Restaurants Inc., AFC Enterprises, Allied Domecq Plc., Arthur Treachers Inc., Carrols Corp, Chester Fried Chicken Restaurants, Chick-Fil-A Inc., Cici Enterprises Inc., Cke Restaurants Inc., Culver Franchising System Inc., Diageo Plc., Dominos Pizza Inc., Fatboys Franchise Systems Inc., Foodmaker Inc., Galardi Group, Hungry Howies Pizza & Subs Inc., Ich Corp, In-N-Out Burgers Inc., Inno-Pacific Holdings Inc., Krispy Kreme Doughnut Corp, Krystal Co, Leeann Chin, Little Caesars Enterprises Inc., Long John Silvers Inc., McDonalds Corp, Panda Express, Papa Ginos Inc., Papa Johns Intl Inc., Quality Dining Inc., Ranch 1, Rax Restaurants Inc., Showbiz Pizza Time Inc., Sizzler Intl Inc., Sonic Corp, Speedy Burgers Inc., TCBY Enterprises Inc., Triarc Cos Inc., Tricon Global Restaurants Inc. (now Yum! Brands and responsible for KFC, Pizza Hut, Taco Bell, and Long John Silver's), Wendy's Intl Inc., Whataburger Inc., and White Castle System Inc.

[4] We append 1999 advertising data to 2000 National Longitudinal Survey of Youth 1979 (NLSY79) data by designated market area (DMA).

[5] A DMA is always larger than the corresponding metropolitan statistical area (MSA) because the market reached by a television station exceeds the MSA in which it is located. Our matching algorithm employs information on the specific counties that are included in each DMA.

vertising has local variation and is reported by year and by market area by CMR. That is the type of advertising that we consider.

An important conceptual issue that arises in measuring the impact of exposure to advertising on consumer behavior is whether the effect on any one consumer depends on the total number of hours of advertising aired on television in the consumer's DMA or on the per capita number of hours aired. This depends on whether advertising is treated as a public good. Public goods are nonexcludable and nonrejectable. If street signs are public goods, then a billboard showing an ad, for example, can be viewed as a public good (or a public "bad" if over-provided). This is not as straightforward with advertisements on television, which could be excludable (unless everyone owns a television set) or rejectable (as one can turn the channel if one chooses to do so).

The advertising literature seems to be mixed with regard to using total exposure or this variable per capita.[6] The most compelling justification for total exposure is that two consumers cannot eat the same apple, but two consumers can watch the same advertisement. The most compelling justification for the per capita specification is that there are more television stations in larger market areas. This lowers the probability that two consumers will see the same advertisement in a larger market even if they spend the same amount of time watching television. Because the first factor seems to us to be more important than the second (two consumers in the same market area certainly can view the same advertisement no matter how large the area), we emphasize results with total exposure. In preliminary research, we found that results for per capita exposure were similar to those with total exposure.

To control for other factors that might affect caloric intake and caloric expenditure, we also include state-level variables that are appended to the individual data by state and year. These variables are the number of fast-food restaurants, the number of full-service restaurants, the price of a meal in each type of restaurant, an index of food-at-home prices, the price of cigarettes, and clean-indoor-air laws. Detailed descriptions of their sources, definitions, and roles in equations for weight outcomes can be found in Chou, Grossman, and Saffer (2004). Discussions of their estimated effects in the regressions are contained in Chou, Rashad, and Grossman (2007).

4. Empirical Implementation

We employ height and weight measures in NLSY79 and in NLSY97 to construct two dependent variables: BMI and an indicator that equals one if the child or adolescent is overweight. Given the large sample size, we fit linear probability

[6] For example, Saffer (1997), Tellis and Weiss (1995), and Tellis, Chandy, and Thaivanich (2000) use advertising only, while Saffer and Dave (2006) use exposure per capita.

models rather than logit or probit models when the overweight indicator is the outcome. Our most inclusive regression model is

$$Y_{ijt} = \gamma_0 + \gamma_1 \ln S_{ijt} + \gamma_2 \ln T_{ijt} + \beta_1 \boldsymbol{X}_{ijt} + \beta_2 \boldsymbol{M}_{ijt} + \beta_3 \boldsymbol{Z}_{ijt} + \boldsymbol{\mu}_j + \boldsymbol{\nu}_t + \varepsilon_{ijt}. \quad (1)$$

In this equation, the dependent variable (Y_{ijt}) is the weight outcome (BMI or overweight) for person i in DMA j surveyed in year t. The regressors are the natural logarithm of the number of hours of spot television fast-food restaurant advertising messages seen per week ($\ln S_{ijt}$); the natural logarithm of the number of hours per week spent watching television ($\ln T_{ijt}$); a vector of demographic variables for children or adolescents, including age, race, and gender ($\boldsymbol{X}_{ijt}$); a vector of variables containing mother's employment status, household income, a dummy for missing income, and dummy variables indicating whether the mother is overweight (BMI of 25 kg/m^2 or greater) or obese ($\boldsymbol{M}_{ijt}$); a vector of state-specific variables including the per capita number of fast-food restaurants, the per capita number of full-service restaurants, the real cigarette price, dichotomous indicators for clean-indoor-air laws, the real full-service restaurant price, the real food-at-home price, and the real fast-food restaurant price ($\boldsymbol{Z}_{ijt}$); and vectors indicating DMA ($\boldsymbol{\mu}_j$) and year ($\boldsymbol{\nu}_t$). The disturbance term is ε_{ijt}.

Whether the mother is overweight or obese helps to partially capture the genetic component that determines a child's BMI. The effect of food advertising on children and adolescents also depends on the resources allocated by parents for food consumption by the family, parental response to their children's food purchase requests, and parental control of their food consumption. We include family income and mother's employment status to control for parental influence on children's and adolescents' food consumption.

Our main variable of interest is the number of hours of spot television fast-food restaurant advertising messages seen per week (S_{ijt}). We compute this as

$$S_{ijt} = p_{ijt} A_{jt}, \quad (2)$$

where A_{jt} is the number of hours of messages aired per week and p_{ijt} is the probability that a given child or adolescent saw 1 hour of advertising. In turn, this probability is estimated as

$$p_{ijt} = K T_{ijt}/168, \quad (3)$$

where T_{ijt} is the number of hours per week that the child or adolescent watches television, 168 equals the total number of hours in a week, and K is a positive constant that presumably is smaller than one. This assumes that the ratio of hours of advertising seen to hours of advertising aired is proportional to the ratio of hours of television seen to hours available for all activities including sleep.

The assumption that K is smaller than one is reasonable since messages are aired on more than one television channel, and an individual can watch only one channel at a time. Given that assumption, p_{ijt} is less than one even in the unlikely event that the individual spends all of his or her time watching television.

From now on, we ignore K and set p_{ijt} equal to $T_{ijt}/168$. Since we employ the natural logarithm of S_{ijt} as a regressor (see below for a justification), only the regression intercept is affected by this treatment.

An advantage of the specification given by equation (1) is that it allows the amount of time spent watching television to have an effect on weight outcomes that is independent of the number of hours of fast-food restaurant advertising messages seen.

Both S_{ijt} and T_{ijt} are entered in natural logarithms for several reasons. First, both variables are positively skewed. By employing natural logarithms, we mitigate the influence of outliers in determining regression coefficients. In addition, we allow the marginal effect of each variable on BMI or obesity to be nonlinear and to diminish as the variable increases. Preliminary analyses revealed evidence in support of this type of nonlinearity.

Finally, given the definition of S_{ijt} in equations (2) and (3), equation (1) can be rewritten as

$$\begin{aligned} Y_{ijt} = {} & \gamma_0 - \gamma_1 \ln 168 + \gamma_1 \ln A_{jt} + (\gamma_1 + \gamma_2) \ln T_{ijt} \\ & + \beta_1 \boldsymbol{X}_{ijt} + \beta_2 \boldsymbol{M}_{ijt} + \beta_3 \boldsymbol{Z}_{ijt} + \boldsymbol{\mu}_j + \boldsymbol{\nu}_t + \varepsilon_{ijt}. \end{aligned} \tag{4}$$

At first glance, $\alpha \equiv \gamma_1 + \gamma_2$ should exceed γ_1 since that coefficient and γ_2 are positive. Both S_{ijt} and T_{ijt} are, however, measured with error in the equations that generate equation (4). The amount of time that children spend watching television is based on estimates reported by their mothers in NLSY79, except that this information is obtained directly from 10- and 11-year-olds. In NLSY97, the information is reported by adolescents and is available only in the first year of the panel. Clearly, our estimate of the probability that a given child saw a certain message is subject to error.

Given the issues just raised, we begin by estimating equation (4) and testing the hypothesis that α equals γ_1. This is useful because it may be unrealistic to try to obtain separate estimates of γ_1 and γ_2. Moreover, both television-viewing time and advertising may be endogenous. More overweight children may be more sedentary and thus watch more television, and advertising may be determined simultaneously with consumption in fast-food restaurants. We lack instruments to treat both variables as endogenous but can explore one in which $\ln T_{ijt}$ is omitted from equation (1). That is equivalent to constraining the coefficient of $\ln A_{jt}$ to equal the coefficient of $\ln T_{ijt}$.

By including DMA or area effects, we control for time-invariant unmeasured factors that are correlated with television advertising and weight outcomes. For example, fast-food restaurants may choose to place more advertisements in areas in which residents have a higher than average taste for high-calorie foods, and hence a larger percentage of the population is overweight. Since the children of overweight parents are more likely to be overweight than the children of normal-weight parents, advertising effects are biased if area effects are omitted.

Although an individual fixed-effects model controls for DMA fixed effects if individuals do not move, we estimate a DMA fixed-effects model for several reasons. First, as explained above, the amount of time spent watching television in the NLSY97 is available only in the first year of the panel and cannot be used as a regressor with individual fixed effects. Second, the key unobservables governing area-level advertising decisions are characteristics pertaining to the population of the area. Since an individual picked at random in an area with a strong taste for dining in fast-food restaurants is likely to share the tastes of the area, the area indicator reflects that factor.

The last factor is important because the area fixed effects model is more efficient than the individual fixed effects model. This is true because the former model involves the estimation of far fewer parameters. Indeed, preliminary results revealed similar point estimates of advertising coefficients but larger standard errors in individual fixed effects models compared with area fixed effects models.[7] We do account for the panel nature of the data and for the measurement of at least one component of the advertising variable at the area level by clustering by DMAs in obtaining standard errors of regression coefficients. This allows the disturbance term (ε_{ijt}) to be correlated for the same person over time and to be correlated among different persons in the same DMA both at a moment in time and over time.

Means and standard deviations for the NLSY79 and NLSY97 data sets are reported in Tables 3 and 4. These means and the regressions in the next section employ the NLSY sampling weights. In NLSY79, heights and weights are obtained from measurements taken by interviewers for approximately 75 percent of the sample. The remainder of the height and weight data are reported by mothers. All of our regression models for this sample include a dichotomous indicator that equals one if BMI and overweight are based on mothers' reports since they are more likely to result in errors in BMI and the classification of overweight status. In NLSY97, heights and weights are reported by adolescents.

The average BMIs are 17.62 and 22.10 kg/m^2 for children ages 3–11 and adolescents ages 12–18, respectively. Moreover, 15.8 percent of the children (NLSY79) and 10.3 percent of the adolescents (NLSY97) are overweight. All of these figures except for the last one are comparable to those from NHANES 99 in Tables 1 and 2. To be specific, adolescents are 40 percent more likely to be overweight in NHANES 99 than in NLSY97. Almost all of this difference results because adolescent girls are twice as likely to be overweight in NHANES 99 than in NLSY97. Undoubtedly, this reflects a reluctance by adolescent girls to report their true weight.

Inclusion of a gender indicator in NLSY97 regressions controls for the source of response error just described. Of course, one cannot decompose the gross difference in overweight status between adolescent males and females or the difference net of other regressors into a component due to response error and

[7] This comparison could only be done for NLSY79 because we could not estimate individual fixed effects models for NLSY97.

Table 3
Definitions, Means, and Standard Deviations of Dependent Variables

		Ages 3–11			Ages 12–18		
Variable	Definition	Whole	Male	Female	Whole	Male	Female
Body mass index	Weight (kg) divided by height (m^2)	17.62 (4.67)	17.70 (4.51)	17.53 (4.84)	22.10 (4.44)	22.54 (4.58)	21.65 (4.24)
Overweight	Equals one if BMI is ≥ the 95th percentile	.158 (.365)	.176 (.381)	.140 (.347)	.103 (.304)	.135 (.342)	.070 (.255)
Sample size	Person-year	6,034	3,087	2,947	7,069	3,665	3,404

Note. Data for ages 3–11 are from the National Longitudinal Survey of Youth 1979. Data for ages 12–18 are from the National Longitudinal Survey of Youth 1997. Standard deviations are in parentheses. BMI = body mass index.

Table 4

Definitions, Means, and Standard Deviations of Explanatory Variables

Variable	Definition	Ages 3–11	Ages 12–18
ln(TV Time)	Time spent by child watching television (hours/week; in logs)	2.966 (.788)	2.650 (.805)
ln(Messages aired)	Hours of fast-food restaurant advertising messages aired per week in respondent's DMA (in logs)	1.194 (.361)	1.269 (.383)
ln(Messages seen)	Hours of fast-food restaurant advertising messages seen per week in respondent's DMA (in logs)	−.964 (.861)	−1.205 (.911)
Age	Respondent's age (in years)	7.259 (2.532)	14.769 (1.400)
Hispanic	Equals one if respondent is Hispanic	.060 (.237)	.111 (.315)
Black non-Hispanic	Equals one if respondent is black but not Hispanic	.123 (.329)	.155 (.362)
Other race	Indicates if respondent's race is other than white, black, or Hispanic	. . .	.012 (.111)
Male	Equals one if respondent is male	.513 (.500)	.511 (.500)
Family income	Real household income (1982–84 $10,000s)	7.062 (10.180)	5.474 (4.193)
Income missing	Equals one if family income is missing	.034 (.180)	.132 (.339)
Weight reported by mother	Equals one if weight is reported by mother	.282 (.450)	. . .
Height reported by mother	Equals one if height is reported by mother	.232 (.422)	. . .
Mother overweight	Equals one if mother's BMI $\geq$ 25 kg/m^2	.482 (.500)	.493 (.500)
Mother obese	Equals one if mother's BMI $\geq$ 30 kg/m^2	.218 (.413)	.209 (.407)
Mother employed	Equals one if mother is employed	.693 (.461)	.708 (.455)
Yr98	Equals one if year = 1998	.341 (.474)	.333 (.471)
Yr99	Equals one if year = 1999	. . .	.343 (.475)
Yr00	Equals one if year = 2000	.293 (.455)	. . .
Fast-food restaurants	Fast-food restaurants per 10,000 persons in respondent's state of residence	7.116 (.564)	7.226 (.491)
Full-service restaurants	Full-service restaurants per 10,000 persons in respondent's state of residence	7.144 (.925)	7.232 (1.000)
Cigarette price	Real cigarette price in respondent's state of residence (1982–84 $)	2.486 (.532)	2.523 (.495)
Government	Equals one if smoking is prohibited in government workplaces in respondent's state of residence	.882 (.323)	.863 (.344)
Private	Equals one if smoking is prohibited in private workplaces in respondent's state of residence	.550 (.498)	.452 (.498)
Restaurant	Equals one if smoking is prohibited in restaurants in respondent's state of residence	.680 (.466)	.654 (.476)
Other	Equals one if smoking is prohibited in other public places in respondent's state of residence	.923 (.266)	.923 (.267)
Full-service restaurant price	Real full-service restaurant meal price in respondent's state of residence (1982–84 $)	8.991 (1.867)	9.258 (1.975)
Fast-food restaurant price	Real fast-food restaurant meal price in respondent's state of residence (1982–84 $)	4.529 (.266)	4.558 (.250)
Food-at-home price	Real food-at-home price in respondent's state of residence (1982–84 $)	2.011 (.230)	2.025 (.266)
N, person-year		6,034	7,069

Note. Data for ages 3–11 are from the National Longitudinal Survey of Youth 1979. Data for ages 12–18 are from the National Longitudinal Survey of Youth 1997. Standard deviations are in parentheses. DMA = designated market area; BMI = body mass index.

a component due to other factors. But as long as response error is uncorrelated with variables other than gender and as long as gender is not correlated with these variables, regression coefficients of these variables are unbiased, although their standard errors are inflated. Hence, the *t*-ratios on which tests of significance are based are conservative lower-bound estimates.

If reporting errors result in a constant percentage reduction in BMI, all slope coefficients involving this outcome, including those associated with fast-food advertising, are understated. When the probability of being overweight is the outcome, the bias is less obvious even if, as we hypothesize, overweight girls are more likely to be found in areas with relatively large amounts of fast-food advertising on television. That depends on the distribution of girls around the overweight cutoff among areas and the degree to which response error in percentage terms is correlated with true weight. If too few girls are classified as overweight in areas with relatively large amounts of advertising, the associated coefficients are conservative lower-bound estimates. Note that all percentage changes in BMI and in the number of overweight children and adolescents computed from regression results in Sections 5 and 6 employ NHANES 99 means. If slope coefficients are unbiased, this corrects for the upward bias in the absolute value of the impact of a change in advertising on the percentage change in the number of overweight adolescents that would result if NLSY97 means were employed in the computations.

5. Results

Table 5 presents results in which BMI is the dependent variable for children ages 3–11 and for adolescents age 12–18. Table 6 contains similar results in which the probability of being overweight is the dependent variable. Regressions are also run separately by gender because the results of Chow tests (not shown) indicate significant differences between male and female slope coefficients in most specifications.[8] Pooled regressions are presented for completeness, for the interest of the reader, because they are based on more observations than the gender-specific regressions and because of the response errors associated with weight outcomes of adolescent girls discussed in the previous section. Moreover, the policy initiatives that we consider in the next section are not gender specific. In almost all cases, the advertising coefficient in a given regression is a simple average of the corresponding gender-specific coefficients. Hence, the pooled coefficient can be used to evaluate the impact of the policy at issue.

In all specifications, individual characteristics and DMA and year fixed effects, are included. In specification (1) in each table, we include both the natural logarithm of television-watching time ($\ln T$) and the natural logarithm of fast-food restaurant advertising messages aired on television ($\ln A$) as explanatory variables. We find a positive and significant relationship between television-

[8] These tests allow the intercept to vary by gender.

Table 5

Regression Results: Dependent Variable Is Body Mass Index

	Specification (1)			Specification (2)		
	Whole	Male	Female	Whole	Male	Female
Ages 3–11:						
ln(Messages aired)	.232 (.763)	.066 (.155)	.544 (1.175)	. . .	. . .	. . .
ln(TV time)	.278** (3.118)	.283* (2.211)	.285** (2.386)	. . .	. . .	. . .
ln(Messages seen)	. . .	. . .	. . .	.276** (3.211)	.272* (2.169)	.297** (2.493)
T-test on equality of coefficient[a]	.885	.617	.576	. . .	. . .	. . .
R^2	.146	.174	.156	.146	.174	.156
N	6,034	3,087	2,947	6,034	3,087	2,947
Ages 12–18:						
ln(Messages aired)	.266$^+$ (1.630)	.381$^+$ (1.365)	.117 (.557)	. . .	. . .	. . .
ln(TV time)	.474** (4.479)	.556** (4.049)	.380** (3.274)	. . .	. . .	. . .
ln(Messages seen)	. . .	. . .	. . .	.463** (4.721)	.547** (4.280)	.367** (3.367)
T-test on equality of coefficient[a]	.346	.606	.298	. . .	. . .	. . .
R^2	.193	.191	.236	.193	.191	.236
N	7,069	3,665	3,404	7,069	3,665	3,404

Note. Data for ages 3–11 are from the National Longitudinal Survey of Youth (NLSY) 1979. Data for ages 12–18 are from the National Longitudinal Survey of Youth 1997. All regressions are weighted by NLSY sampling weights. *T*-ratios are reported in parentheses. Regressions are clustered by designated market area (DMA). All coefficients are adjusted for individual characteristics, state variables, DMA fixed effects, and year fixed effects. Individual variables include age, black non-Hispanic, Hispanic, other race (NLSY97 only), male, family income, missing income dummy, mother overweight, mother obese, mother employed, and dummies for weight and height reported by mothers (as opposed to actual measurements; NLSY79 only). State variables include the per capita number of fast-food restaurants, per capita number of full-service restaurants, real cigarette price, dummies for clean-indoor-air laws, real full-service restaurant price, real food-at-home price, and real fast-food restaurant price.

[a] The null hypothesis is that the coefficient of log(messages aired) is equal to the coefficient of log(TV time).

$^+$ Significant at the 10% level (one-tailed test).

* Significant at the 5% level (one-tailed test).

** Significant at the 1% level (one-tailed test).

Table 6
Regression Results: Dependent Variable Is Overweight

	Specification (1)			Specification (2)		
	Whole	Male	Female	Whole	Male	Female
Ages 3–11:						
ln(Messages aired)	.052* (2.302)	.058+ (1.565)	.049+ (1.545)	. . .	. . .	. . .
ln(TV time)	.025** (3.319)	.030** (2.560)	.021* (2.111)	. . .	. . .	. . .
ln(Messages seen)	. . .	. . .	. . .	.026** (3.670)	.032** (2.729)	.023* (2.314)
T-test on equality of coefficient[a]	.260	.464	.412	. . .	. . .	. . .
R^2	.088	.102	.102	.088	.102	.102
N	6,034	3,087	2,947	6,034	3,087	2,947
Ages 12–18:						
ln(Messages aired)	.021* (1.967)	.028* (1.846)	.014 (.822)	. . .	. . .	. . .
ln(TV time)	.021** (3.071)	.036** (3.414)	.009 (1.224)	. . .	. . .	. . .
ln(Messages seen)	. . .	. . .	. . .	.021** (3.316)	.036** (3.555)	.009+ (1.383)
T-test on equality of coefficient[a]	.961	.650	.805	. . .	. . .	. . .
R^2	.100	.108	.127	.100	.108	.127
N	7,069	3,665	3,404	7,069	3,665	3,404

Note. Data for ages 3–11 are from the National Longitudinal Survey of Youth (NLSY) 1979. Data for ages 12–18 are from the National Longitudinal Survey of Youth 1997. All regressions are weighted by NLSY sampling weights. *T*-ratios are reported in parentheses. Regressions are clustered by designated market area (DMA). All coefficients are adjusted for individual characteristics, state variables, DMA fixed effects, and year fixed effects. Individual variables include age, black non-Hispanic, Hispanic, other race (NLSY97 only), male, family income, missing income dummy, mother overweight, mother obese, mother employed, and dummies for weight and height reported by mothers (as opposed to actual measurements; NLSY79 only). State variables include the per capita number of fast-food restaurants, per capita number of full-service restaurants, real cigarette price, dummies for clean-indoor-air laws, real full-service restaurant price, real food-at-home price, and real fast-food restaurant price.

[a] The null hypothesis is that the coefficient of log(messages aired) is equal to the coefficient of log(TV time).

+ Significant at the 10% level (one-tailed test).

* Significant at the 5% level (one-tailed test).

** Significant at the 1% level (one-tailed test).

viewing time and BMI or the probability of being overweight, except when the probability that adolescent females are overweight is the outcome.[9] All 12 coefficients of advertising messages aired are positive, but only two of the six coefficients are significant when BMI is the outcome. Five of the six coefficients are, however, significant when overweight is the outcome. As is the case for television-viewing time, the exception pertains to adolescent girls.

In each of the 12 specification (1) regressions in Tables 5 and 6, we test the hypothesis that the coefficient of the log of television time is equal to the coefficient of the log of messages aired. In each case, we accept the hypothesis that the two coefficients are the same. Therefore, we estimate a second model (specification [2] in each table) in which the log of messages aired and the log of television time are omitted but the log of messages seen is included. As pointed out in Section 3, this is equivalent to constraining the coefficient of the log of television time to equal the coefficient of the log of messages aired. In this specification, all 12 coefficients are positive and significant.

To gauge the magnitudes of the effects at issue, we focus on the regressions in Table 6 in which the probability of being overweight is the dependent variable. This outcome is a negative correlate of health, while BMI is a positive correlate for children and adolescents who are below their ideal weight. Moreover, the coefficients of the log of messages seen are smaller than the coefficients of the log of messages aired in Table 6, while the reverse holds in Table 5. Hence, the coefficients in specification (2) of Table 6 may be viewed as conservative lower-bound estimates.

We employ an increase in the number of messages seen equal to its coefficient of variation in the actual variable rather than in its natural logarithm. On average, children and youths view approximately half an hour per week of fast-food advertising messages. Since the coefficient of variation of this variable is approximately equal to one in each regression, our computations reveal the impacts of an increase in exposure to this type of advertising of half an hour per week.[10] Note that this increase can occur if a given child is exposed to an additional

[9] We evaluate the significance of advertising and television coefficients with one-tailed tests since the alternative hypothesis is that these coefficients are positive.

[10] To be specific, we compute the percentage-point increase in the percentage of children or adolescents who are overweight as $100\gamma_1 \ln(1 + \Delta S/\bar{S})$, where γ_1 is the regression the coefficient of $\ln S$, $\bar{S}$ is the mean of S, and $\Delta S/\bar{S}$ is set equal to the coefficient of variation. Note that the anti–natural logarithm of the mean of the log of S is the geometric mean and is measured in the same units as S—namely, hours per week. But the antilog of the standard deviation of $\ln S$ is not measured in hours per week. Bland and Altman (1996) indicate that calculation of the standard deviation of a variable after it has been transformed to natural logarithms requires taking the difference between each log observation and the log of the geometric mean. Since the difference between the log of two numbers is the log of their ratio, it is a dimensionless pure number. For that reason and because an increase in messages seen of half an hour per week is a meaningful magnitude to consider, we base our computations on arithmetic means and the corresponding standard deviations. Note that if messages seen incorporates the constant ($K < 1$) in equation (3), then $S^* = KS$. Clearly, the coefficient of variation of S^* equals the coefficient of variation of S.

half an hour of advertising, if more children are exposed to the same amount of advertising, or by a combination of these two changes.

For boys ages 3–11, increasing exposure to fast-food advertising by half an hour per week will increase the probability of being overweight by 2.2 percentage points. This translates to a 15 percent increase in the number of overweight boys in a fixed population.[11] The corresponding figures for girls ages 3–11 are a 1.6 percentage point, or 12 percent, increase in the number of overweight girls in a fixed population. For adolescent boys and girls ages 12–18, we obtain an increase of 2.5 percentage points (17 percent) for boys and an increase of .6 percentage points (4 percent) for girls.

We have subjected the sensitivity of our results to alternative specifications and to estimation by two-stage least squares methodology. These analyses pertain to the second model in Tables 5 and 6. We summarize them here and present and discuss them in detail in Chou, Rashad, and Grossman (2007). The first alternative specification omits DMA fixed effects and state variables. The second specification adds DMA fixed effects, while the third adds state variables and linear DMA-specific trends. In general, the coefficients of the log of messages seen are very stable across these alternative specifications. One might be concerned if the effects became smaller as more location-specific variables were included because that might be evidence of omitted-variables bias. In fact, that is not the case. Hence, these estimates strengthen our confidence in those emphasized in Tables 5 and 6.

In the two-stage least squares models, the price of advertising (measured in dollars per seconds of messages aired) and the number of households with a television in the DMA serve as instruments.[12] They have the expected signs in the first stage and pass overidentification tests. Moreover, the *F*-statistics resulting from the test of the significance of the two instruments as a set range from 15 to 76, which suggests that the instrumental variables estimates are not biased because the instruments are highly correlated with the endogenous explanatory variable. Most important, the results suggest that the variable for messages seen is not endogenous. All the Durbin-Wu-Hausman tests of the consistency of ordinary least squares are accepted, regardless of the sample.

6. Discussion

The investigation of the causal relationship between fast-food restaurant advertising and body weight among children and adolescents is important when forming policies to cope with the rapid increase in obesity rates. Overall, our

[11] We use the means from the National Health and Nutrition Examination Survey 1999 (NHANES 99) data set to compute the percentage change.

[12] According to *Advertising Age* (Endicott 2005, p. S19) spending on television advertising by restaurants accounted for 6 percent of all television-advertising spending in 2004. Of course, advertising spending by fast-food restaurants in that medium was even less. This justifies our a priori assumption that the price of a fast-food restaurant advertisement is exogenous.

results show a strong positive effect of exposure to fast-food restaurant advertising on the probability that children and adolescents are overweight. As indicated in Section 1, there is conflicting evidence on trends in television and commercial viewing by children and youths since 1980. Hence, it would be premature to point to our findings as a partial explanation of the upward trend in obesity. Our results can, however, be used to estimate the impact of a fast-food restaurant advertising ban on television on childhood obesity. A complete advertising ban on television would reduce the number of overweight children ages 3–11 in a fixed population by 18 percent.[13] The impact of this policy for adolescents ages 12–18 amounts to a smaller decline of 14 percent. These computations underestimate the impact of a complete advertising ban on television because they are based on local or spot television advertising and ignore advertising associated with network, syndicated, and cable television because they have no local variation. On the other hand, the computations could overestimate the impact of an advertising ban because we ignore advertising in other media (that is, radio, magazines, outdoor, newspaper).

Another policy option is to eliminate food advertising as ordinary business expenses that reduce taxable corporate income. Since the corporate income tax rate is 35 percent, elimination of the tax deductibility of food advertising costs is equivalent to increasing the price of advertising by about 54 percent. On the basis of our results, this elimination of tax deductibility would reduce fast-food restaurant messages seen on television by 40 and 33 percent for children and adolescents, respectively, and would reduce the number of overweight children and adolescents by 7 and 5 percent, respectively.[14] These declines are smaller than would be the case with an advertising ban, but the tax policy would impose lower welfare costs on children and adults who consume fast food in moderation because positive information about restaurants that supply this type of food would not be banned completely from television.

Clearly, we have not provided enough information to fully evaluate the two policies just discussed. Indeed, we have not addressed the larger issue of whether the government should intervene in the food purchase decisions of its citizens.

[13] Calculations use specification (2) in Table 6 and means for the percentage of overweight persons from NHANES 99. The number of advertising messages seen is assumed to decline from its age- and gender-specific mean to zero. Since we employ the log of messages seen in the regressions, we compute the marginal effect of S at the mean $(\gamma_1/\bar{S})$ and then multiply this effect by $\bar{S}$. Of course, that is equivalent to computing the effect of a ban as γ_1. This is an underestimate since the effect of S on the probability of being overweight rises as S declines. In our view, this source of bias is less relevant than those discussed in the text. Since both the mean and the standard deviation of S are approximately equal to half an hour per week, the reduction in S associated with the ban is roughly equal to the increase employed in the computations in Section 5.

[14] These computations employ specification (2) in Table 6 and the reduced-form advertising price coefficients for each age group from the first stage of our instrumental variables models. To be specific, let γ_1 be the coefficient of the log of messages seen in the regression for percentage of overweight persons, let β be the coefficient of price in the regreession for the log of messages seen, let p be the mean price of a message seen, and let t be the corporate tax rate. Then the reduction in the percentage of overweight persons due to the elimination of the tax deductibility of advertising is $100\gamma_1\beta pt/(1-t)$.

In the case of children, one justification for government intervention is that society as a whole may reap substantial current and future production and consumption benefits from improvements in children's health. The case is strengthened because overweight children are extremely likely to become obese adults and because children are less likely to have information about the consequences of their actions or to heavily discount these consequences. The case is weakened because parents may more easily and immediately affect the choices made by their children than can the government.

In addition, one would need to consider the degree of government involvement that is merited and the costs of alternative policies if some intervention appears to be worthwhile. Hence, more research is required to evaluate the effectiveness of these policies and others. Our study should be viewed as one of many inputs in this process.

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