

## **The Influence of Parental Weight Status on the Relationship between Television Viewing and Childhood Overweight**

Elizabeth A. Vandewater, PhD<sup>1,2,3,4,5</sup>

Xuan Huang, MS<sup>1,2,3</sup>

<sup>1</sup>Human Development and Family Sciences, The University of Texas at Austin

<sup>2</sup>Center for Research on Interactive Technology, Television and Children (CRITC), The University of  
Texas at Austin

<sup>3</sup>Children's Digital Media Center (CDMC), The University of Texas at Austin

<sup>4</sup>Center for Media and Children's Health, Harvard University Medical School

<sup>5</sup>Corresponding Author. Address Human Development and Family Sciences, University of Texas at  
Austin, 1 University Station, A2700, Austin, TX 78712-1097 Tel 512-475-6886

[evandewater@mail.utexas.edu](mailto:evandewater@mail.utexas.edu).

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**Abstract**

**Background:** Epidemiologic studies of the relationship between television viewing and children's weight status typically find weak relationships, yet few have examined the possibility that these relationships are moderated by parental weight status.

**Objective:** To examine whether and to what extent the relationship between time spent viewing television and children's weight status differs according to parental weight status.

**Methods:** Data came from the second wave of the Child Development Supplement (CDS-II), a nationally representative sample of children ages 5-17 in 2002 ( $N = 1419$ ). 24h time use diaries from one randomly chosen weekday and one randomly chosen weekend day were used to assess children's time using electronic media. Childrens' weight and height were assessed using scales and tape measures, parents' weight and height were self-reported. Multinomial logistic regression models predicting child weight status from parental weight status and television viewing hours controlling for family income-to-needs ratio, education of household head, child race, child maturational status, and child activity level were conducted separately for age and gender groups (boys and girls ages 6-9, 10-13, and 14-19, respectively).

**Results:** Parent obesity dramatically increased the risk of child overweight for all children except boys ages 6-9. Television viewing hours were related to increased odds of child at-risk for overweight among boys and girls ages 6-9, and girls ages 14-19. Among boys ages 14-19, television hours were related to *decreased* odds of at-risk for overweight. Viewing hours were related to increased odds of overweight only for boys ages 6-9 and 10-13. Parental BMI significantly moderated the relationship between television viewing and childhood weight status in four of the six groups. Among younger children (girls 6-9 and boys 10-13), increased television viewing increased the risk of elevated weight status for children of normal weight parents. Among older children (girls ages 10-13 and boys ages 14-19), increased television viewing increased the risk of elevated weight status among children of obese parents.

**Conclusions:** Results indicate that the relationship between television viewing and child weight status differs greatly for different children. It is possible that such differences are at least partly responsible for lack of relationship generally found between these two variables at the population level. Results suggest that researchers interested in the relationship between childhood obesity and television viewing need to more closely examine important moderators of this relationship, particularly parental weight status.

## Introduction

The prevalence of obesity in American youth has reached alarming levels. The proportion of overweight children and adolescents, defined as a Body-Mass-Index (BMI) exceeding the 95<sup>th</sup> percentile for age and sex based norms, has tripled in the past three decades.<sup>1</sup> Current estimates indicate that approximately 10% of 2-5 year-olds and 15% of 6-19 year-olds are overweight.<sup>2</sup> Many believe that time spent watching television is at least partly to blame for obesity in the nation's youth. Children spend 3-5 hours a day watching television, more time than in any other single free-time activity except for sleep.<sup>3,4</sup> Perhaps because of this, the notion that television use must be somehow responsible for the increased prevalence of obesity in American children and adolescents in recent years is dearly held by the lay public and academics alike.<sup>5-8</sup>

Dietz & Gortmaker<sup>9</sup> reported a small but significant relationship between television viewing and obesity. They found that the prevalence of obesity in a large epidemiological sample of adolescents 12-17 increased 2% for each additional hour of television watched. It is this study that is widely cited as evidence that television causes obesity in children and adolescents.

Yet, ensuing epidemiologic studies have often been unable to find the link reported by Dietz and Gortmaker.<sup>9</sup> Robinson and Killen<sup>10</sup> found that while television viewing was associated with increased dietary intake in a large ( $N = 1,912$ ) sample of ninth graders, it was only weakly associated with body mass index, and only among White boys. Robinson et al.<sup>11</sup> found that baseline hours of television viewing were not associated with either baseline or longitudinal changes in body mass index in a large ( $N = 971$ ) sample of sixth and seventh grade girls. McMurray et al.<sup>12</sup> found no relationship between television or video game use and body mass index in a sample of 2389 adolescents ages 10-17 once the influence of socioeconomic status and ethnicity were controlled. Finally, Durant, Baranowski, Johnson and Thompson<sup>13</sup> also found no relationship between body mass index and television watching in a longitudinal sample of young children (ages 3-4).

Intervention designs, while promising, have yet to yield consistent findings. Gortmaker and his colleagues<sup>14</sup> designed "Planet Health", a school-based intervention designed to reduce obesity in middle school youth (grades 6-8) by altering key physical activity and dietary risk factors, including reductions in television viewing. They found reductions in the prevalence of obesity related to reduced television

viewing for girls, but not for boys, in the intervention group.<sup>14</sup> Robinson<sup>15</sup> found that compared to a control group, elementary school children who received classroom curriculum designed to reduce television use over one school year showed significant relative decreases in body mass index, and eating meals in front of the television but no differences in high-fat food intake or moderate-to-vigorous physical activity. Despite the promise of interventions, it remains unclear why some interventions seem to work for some groups of children, but not others.

Overall, then, the “mixed bag” of findings seems to suggest that *some* relationship between children’s media use and weight status exists—the problem is we can’t tell exactly what that relationship is or for whom it is strongest. We believe that the generally weak relationship found between children’s television use and their weight status may be due to the fact that the strength of this relationship differs for different groups of children, thus diluting the linear relationships in heterogeneous samples. Parental BMI represents both an environmental and genetic risk factor that may importantly moderate the relationship between media use and obesity. Parental (especially maternal) BMI has been found to explain as much as 70% of the variance in children’s BMI.<sup>16-20</sup> It seems quite possible, then, that high levels of television viewing might be particularly problematic for the weight status of children whose parents are obese. However, the possible moderating effect of parental weight status on the relationship between media use and childhood obesity is rarely examined. It is this possibility that is the focus of study here. In this study we examine the ways in which the relationship between television use and weight status differs for children at different levels of familial risk for obesity, as indicated by parental weight status.

## Method

### Sample

The data comes from the second wave Child Development Supplement (CDS-II) to the Panel Study of Income Dynamics (PSID), a representative survey of children ages 6-19 collected in 2002-2003. The sample used for the present study comprised 1,419 children aged 6 to 19 years old for whom biological parent and child BMI data were available. The resulting sample included 737 boys and 749 girls. The median income of families in CDS-II was \$53,375, with 16.1% of families falling below poverty. Twenty percent of the parents had not graduated high-school, 31% had a high-school diploma, 23% had

some college, and 26% had attained a bachelors degree or higher. Fifty-six percent were European American and 44% were African American. The study was approved by the Institutional Review Boards of the University of Michigan, where the data were collected, and the University of Texas at Austin, where analyses for this study were conducted.

## Measures

*Child Body-Mass-Index (BMI).* Weight and height information was collected via strain gauge lithium bath scales<sup>21</sup> and measurement tape, respectively, during the home interview. Children were measured in stocking feet, and, in the case of weight, in light clothing and with pockets emptied. BMI was calculated from height and weight by employing the formula from the National Center for Chronic Disease Prevention and Health Promotion (Weight [lbs] ÷ Stature [in] ÷ Stature [in] X 703). Because BMI varies by age and sex, BMI was converted to a BMI z-score using the Centers for Disease Control's BMI growth reference to determine an age- and sex-specific BMI z-score for subjects ages 2 to 20 years.<sup>2</sup>

The definition of overweight among children is a statistical definition based on the 2000 Centers for Disease Control and Prevention (CDC) growth reference for the United States.<sup>22</sup> Overweight is defined as at or above the 95<sup>th</sup> percentile of BMI-for-age. At risk for overweight is defined as at or above the 85<sup>th</sup> percentile, but less than the 95<sup>th</sup> percentile, of BMI-for-age. The BMI-for-age growth charts were developed from 5 national data sets (NHES 2, NHES 3, NHANES I, NHANES II; and NHANES III for children < 6 years). (Descriptive statistics for this and all other measures are presented in Table 1.)

*Biological Parent Body-Mass-Index (BMI).* Parents' weight and height were collected via self-report in 1999 and 2001. Evidence suggests that self-report of height and weight is highly correlated with objectively measured height and weight, thus bolstering confidence in their validity as an accurate measure of adult body composition.<sup>23,24</sup> Data collected in 2001 were utilized to calculate parental BMI. However, in a small number of cases where 2001 data were unavailable, 1999 data were utilized (for father weight status,  $N = 36$ ; for mother weight status,  $N = 42$ ). Parental BMI was used to categorize weight status of parents, using recommended cut-off points for overweight (BMI >25) and obesity (BMI >30).<sup>25</sup> Parental obesity was considered present when one or both parents had a BMI greater than 30. Parental overweight was considered present when one or both parents had a BMI greater than 25 but no more than 30.

*Amount of Children's Television Viewing.* Information on children's television viewing was assessed via two 24-hour time-use diaries providing detailed account of type, number, duration, and location of activities that children engaged in during each 24-hour period. On one randomly chosen weekday and one randomly chosen weekend day, all of the activities that the child engaged in were reported. Older children completed their own time diaries, younger children were aided by primary caregivers. A primary activity and its duration were recorded to account for every minute of the two 24-hour diaries, and, if appropriate, a secondary activity was also noted. The measure was created by summing the minutes children spent watching television as a primary or as a secondary activity across both days. This sum was then divided by 60 in order to express television viewing in hours.

#### *Covariates*

*Socio-demographic characteristics.* Based on demonstrated relationships with either television viewing, weight status, or both, a number of socio-demographic characteristics were treated as covariates in the analyses. These included: 1) *Family income-to-needs ratio* which was a proportion of the family's income by the poverty threshold for that family, with higher income-to-needs ratios reflecting more disposable income in a family, 2) *Education of household head* denoting the number of years of education completed by the household head, and 3) *Child race*.

*Child maturational status.* Because maturation-related misclassification may result in overestimations of overweight prevalence rates among early maturing adolescents and underestimations among later maturing adolescents,<sup>26,27</sup> we controlled for child maturational status. This was assessed utilizing the Khamis-Roche (KR) method for predicting % of adult stature.<sup>28</sup> The method is applicable to children ages 4 to 17 years and thus was not applied to children in the sample who were 18 or 19 years old. Percent of adult stature has been shown to be significantly correlated with maturational status (range  $r = .50$  to  $.70$ ) and thus a good proxy for maturational status when other, more invasive measures, are not available.<sup>29-31</sup> It is calculated using current stature (in) current weight (lb) and mid-parent stature (in) where mid-parent stature represents the average height of both parents. The regression equation for predicting adult stature takes the form: predicted adult stature =  $\beta_0 + \beta_1$  stature +  $\beta_2$  weight +  $\beta_3$  mid-parent stature, where  $\beta_1$ ,  $\beta_2$ , and  $\beta_3$  are the coefficients by which stature, weight, and mid-parent stature,

respectively, should be multiplied. Percent of adult stature at a given age is then predicted adult stature / current stature.

*Child Activity Level.* Because activity level may confound the relationship between time spent watching television and child weight status, we controlled for children's energy expenditure. To estimate energy expenditure, we take the factorial approach recommended by the WHO/FAO/UNU.<sup>32</sup> The factorial approach involves the summation of energy expended during periods that an individual is sleeping and resting or engaged in occupational, discretionary, or maintenance physical activities, plus the energy needed for tissue accretion in growing children. This requires two pieces of information 1) the time allocated to various activities, and 2) the energy cost of those activities.

Time allocated to various activities was documented in the time-use diaries already described. To estimate the energy cost of activities, we utilized the metabolic equivalents (METs) published in the *Compendium of Physical Activities*.<sup>33,34</sup> Metabolic equivalents represent the energy cost of physical activities with one MET defined as the energy expended while sleeping.<sup>35</sup> A level of physical intensity for the METs values from the *Compendium*<sup>33,34</sup> was assigned to each activity reported in the time diaries. In the event that the activities in the *Compendium* were described with more specificity than those described in the time diaries, we followed the procedures recommended by Ainsworth et al.<sup>33,34</sup> and assigned the METs value for the more general activity. For children aged 15 and older, we used the published adult METs<sup>32,36</sup>; For children under 15, we used Torun et al.'s<sup>36,37</sup> age-specific standard fraction multipliers for the published adult MET values to account for younger children's greater energy expenditure in non-sedentary activities.

METs scores are converted into kilocalorie energy cost per hour with the following equation:  $\text{kcal} = \text{METs} * \text{RMR} * \text{duration in hours}$ . For children under 15, this equation was modified to include Torun's age-specific multipliers.<sup>36</sup> Thus, the equation for children under 15 is as follows:  $\text{kcal} = (\text{METs} * \text{Age-specific multiplier}) * \text{RMR} * \text{duration in hours}$ . Using this equation, we calculated the total number of kilocalories each child expended over the two 24-hour periods documented in the time diaries. RMR for children of a given age, sex and body weight was estimated using Schofield's equations.<sup>38</sup> Because television use also comes from the time diaries, Children's activity level was adjusted for energy expenditure during television viewing. We regressed the total number of kilocalories child expended on

energy expenditure during television viewing. The standardized residual from the regression was used as an index of children's activity level.

### **Analysis Plan**

Multinomial logistic regressions predicting child weight status were utilized to examine the possibility that the relationship between television use and weight status differs for children at different levels of familial risk for obesity, as indicated by parental weight status. Because the relations between media use and child weight status may vary by age and gender, analyses were performed for boys and girls of different age groups separately (boys aged 6-9, boys aged 10-13, boys aged 14-19, girls aged 6-9, girls aged 10-13, girls aged 14-19).

The regression models for each gender by age group predicted the odds of child at-risk for overweight or overweight compared to the odds of child normal weight based upon television viewing (in hours), parental weight status, and the interaction of television viewing and parental weight status. If the interaction term did not significantly add to the model, coefficients for the main effects model only are presented. All analyses included the following covariates: family income-to-needs ratio, years of education of household head, child race, child maturational status, and child activity level. Because of the existence of sibling pairs in the data, standard errors were corrected for non-independence.

### **Results**

Results of multinomial logistic regression models for each gender and age group are presented in Table 2. Significant interactions are plotted in Figures 1 through 4.

#### **Parental Weight Status**

Parental weight status presented an increased risk of child overweight for most of the age by gender groups. This was particularly true for older adolescent girls (ages 14-19). For these children, having at least one overweight parent was strongly related to increased odds of both at-risk for overweight (OR = 3.02) and overweight (OR=8.56), and having at least one obese parent was also related to increased odds of both at-risk for overweight (OR = 8.56) and overweight (OR = 56.01). This is the only group of children for whom having at least one overweight parent was related to increased risk of elevated weight status.

For all other groups of children, it was parental obesity which seemed to increase the risk of elevated weight status. Specifically, having at least one obese parent was related to increased odds of child overweight (but not at-risk for overweight) across the board, with one exception. Among the youngest boys (ages 6-9) parental weight status was not significantly related to odds of either child at-risk for overweight or overweight.

### **Television Viewing Hours**

Hours of television viewing were also related to child weight status. However, the overall pattern of results was much less clear than for that of parental weight status. Television viewing hours seemed to be more related to at-risk for overweight in childhood than to overweight in childhood. Specifically, television hours were related to increased odds of child *at-risk for overweight* among three groups: Boys ages 6-9, Girls ages 6-9 and Girls ages 14-19. Television viewing hours were unrelated to at-risk for overweight among early adolescent (ages 10-13) boys or girls. Among older adolescent boys, television viewing hours were related to a 20% *decreased* probability of at-risk for overweight. Television viewing hours were related to increased odds of child *overweight* only among two groups of boys – boys ages 6-9 and 10-13.

### **The Interaction of Parental Weight Status and Television Viewing**

There were a total of six significant interactions between parental weight status and television viewing for four of the six age and gender groups: early (ages 10-13) and later (ages 14-19) adolescent boys, and younger (ages 6-9) and early adolescent (ages 10-13) girls.

Among early adolescent boys, parental weight status moderated the relationship between television viewing and the probability of child overweight such that for boys of *normal* weight parents, the likelihood of overweight status increased with television viewing (see Figure 1). This relationship was not evident among early adolescent boys of obese parents. As can be seen in Figure 1, boys with at least one obese parent had an elevated risk of overweight that was unrelated to their television viewing. This same general pattern can be seen in the likelihood among young girls for child overweight – with the risk of overweight increasing with television hours viewed only among girls of normal weight parents (see Figure 3). For both early adolescent boys and young girls then, it seems that parental obesity “trumps” television viewing in terms of the likelihood of child at-risk for overweight or child overweight.

Among older adolescent boys, there were significant interactions in the prediction of both at-risk for overweight and child overweight, such that for boys of overweight or obese parents, the likelihood of at-risk for overweight status increased with television viewing. There was no such relationship between viewing and risk of elevated weight status for older adolescent boys of normal weight parents (see Figure 2). This same pattern is also evident among early adolescent girls, but much more so. Among early adolescent girls with obese parents, the probability of overweight status dramatically increased as television viewing increased (see Figure 4). For early adolescent girls of normal weight parents, increases in television viewing were unrelated to increased risk of overweight.

### Discussion

We began this study with the premise that the relationship between television viewing hours and child weight status would be moderated by parental weight status. Our results indicated that this was overwhelmingly the case. There were a total of six significant interactions between parental weight status and television viewing for four of the six age and gender groups examined here: early (ages 10-13) and later (ages 14-19) adolescent boys, and younger (ages 6-9) and early adolescent (ages 10-13) girls.

We also speculated that the relationship between television viewing and child at-risk for overweight or overweight status would be stronger for children whose parents were overweight or obese. Though a reasonable hypothesis, this was only true for some children. In fact, three of the six significant interactions indicated that that the relative risk of elevated weight increased with television viewing hours only for children with normal weight parents: the probability of child overweight among early adolescent boys (10-13), and the probability of both at-risk for overweight and overweight among young girls (6-9). Among both of these groups, the probability of elevated weight status among children with obese parents was so high on its own that television viewing made little difference (see Figures 1 and 3). For children with normal weight parents however, television viewing made a great deal of difference in the relative risk of elevated weight status, with more hours of television viewing related to increased probabilities of at-risk for overweight and overweight (Figures 1 and 3).

The other three significant interactions showed a relationship more similar to that which we originally proposed: the probability of elevated weight status increased with television viewing only among children whose parents were obese. This was particularly true for early adolescent girls, but was

also evident among older adolescent boys. Among these gender and age groups, children of normal weight parents could seemingly watch television with impunity—at least with regards to the risk of elevated weight status.

Though not completely consistent, it may be worth noting that the first pattern of findings (with the risk elevated for children of normal weight parents) occurred among relatively younger groups of children (girls ages 6-9 and boys ages 10-13), while the second pattern (with elevated risk among children of obese parents) occurred in relatively older children (girls ages 10-13 and boys ages 14-19). These findings may be due to developmental changes with respect to the relationship between parental weight status and child weight status, or between television viewing and weight status. Whatever the case, they certainly have implications for intervention designs. It seems that among younger children (particularly those of normal weight parents) decreasing television viewing may be an important component of prevention of childhood at-risk for overweight or overweight. For older children however, decreasing television viewing as either an overweight prevention or intervention strategy seems most likely to have an impact on children with obese or overweight parents. These findings highlight the importance of attending to familial characteristics (in this case parent weight status) when attempting to assess the relationship between television viewing and child weight status.

### **Parental Weight Status and Child Weight Status**

We believe that these findings point to the crucial importance of including parental weight status in research examining factors related to child weight status. Parental weight status was consistently and strongly related to child weight status. This was particularly true if at least one parent was obese. Having at least one obese parent increased the risk of child overweight by a minimum odds of 4.42 and a maximum odds of 56.01.

### **Television Viewing and Child Weight Status**

Overall, television viewing seemed to be more implicated in increased odds of child-at-risk for overweight than child overweight. However, the pattern of results is far from consistent. Despite the seemingly intractable conviction that television viewing is strongly and consistently related to childhood obesity, this pattern of results is, in fact, much like those from previous research in this area – equivocal and not particularly strong. The relationships are there for some children but not others, or are even

reversed (with more television viewing related to decreased risk of elevated weight). Moreover, the magnitude of the effects were not particularly large – the highest positive odds ratio was 1.87 (the lowest, 1.21).

### **Limitations and Future Directions**

In these analyses we examined age and gender groups, controlling for ethnicity. It is quite possible (indeed probable) that the relationship between television viewing and child weight status varies importantly by ethnicity as well as age and gender. Unfortunately, sample size limited our ability to examine associations among different age and gender groups also defined by ethnicity. Examining the extent to which ethnicity plays a role in the relationships among parental weight status, television viewing and child weight status will be an important area for future research.

Parental weight status represents both genetic and environmental influences on children's weight status. Though we cannot separate these influences in these data, doing so is an important component to furthering understanding of the nature of familial influences on childhood obesity. Similarly, though we had theoretical reasons for focusing on parental weight status – other familial factors, such as parents own activity levels, media use, family eating habits, etc., clearly merit further investigation.

### **Conclusions**

We believe that the varied nature of these results highlight the notion that the relationship between television viewing and child weight status is neither simple, nor the same across children of differing genders and ages. This may go a long way toward explaining the generally weak or non-existent association between television viewing and child weight status found in existing research based upon heterogeneous populations. These findings also have important implications for prevention and intervention designs. Specifically, our findings suggest that expecting reductions in body-mass-index with reductions in television viewing will be evident in some groups of children, but not others. The implication is that it is not reasonable to assume that one strategy will work for all children – in this case, one size does *not* fit all.

We understand that this message is somewhat at odds with both popular and scholarly convictions that television viewing is largely to blame for the current epidemic of at-risk for overweight and overweight among American children. Though not an unreasonable hypothesis, empirical evidence for it,

is to date, surprisingly inconsistent.<sup>10,11,13</sup> The findings of this study suggest that parental weight status is an important moderator of the relationship between television viewing and child weight status—and that researchers interested in understanding and intervening in childhood obesity would do well to collect information from parents as well as children. As noted, in this study we focused exclusively on parental weight status as a moderator of the relationship between television viewing and child weight status. It seems reasonable to assume that there may be other important familial moderators (or mediators) as well. To date however, surprisingly few studies, either epidemiological or experimental in nature, include parental or familial context information in their data collection schemes. Thus, we know little about the contextual factors affecting relations between television viewing and childhood overweight.

Our view is that it behooves us to understand the true nature of the role that media use plays in the development of obesity. To do this, we feel strongly that research agendas must move beyond a focus on single linkages between television viewing and childhood overweight so that we may arrive at a more nuanced and complex understanding of the ways in which (and perhaps for whom) they are related and unrelated. As a very real threat to public health, it is crucial to identify central contributing factors to the development of obesity, so that we may appropriately target prevention and intervention efforts. It seems safe to say that technology is here to stay, and is virtually guaranteed to play an ever increasing role in our daily lives. Thus, a thorough understanding of the nature of its impact on health and well-being is a vital component of the public health agenda in the U.S.

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