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June 2023 | HQ23DI00055

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Parental Weight Status and Girls' Television Viewing, Snacking, and Body Mass Indexes

Lori A. Francis, Yoonna Lee, and Leann L. Birch

Abstract

FRANCIS, LORI A., YOONNA LEE, AND LEANN L. BIRCH. Parental weight status and girls' television viewing, snacking, and body mass indexes. *Obes Res.* 2003; 11:143–151.

Objective: The purpose of this study was to examine whether television viewing (TVV) provides a context for patterns of snacking fostering overweight in young girls from overweight and non-overweight families.

Research Methods and Procedures: Participants were 173 non-Hispanic white girls and their parents from central Pennsylvania, assessed longitudinally when girls were 5, 7, and 9 years old. Path analysis was used to test patterns of relationships among girls' TVV, snacking while watching television, snacking frequency, fat intake from energy-dense snack food, and girls' increase in body mass index (BMI) from age 5 to 9.

Results: In both overweight and non-overweight families, girls who watched more television consumed more snacks in front of the television. In families where neither parent was overweight, television viewing was the only significant predictor of girls' increase in BMI. In families where one or both parents were overweight, girls who watched more television snacked more frequently, and girls who snacked more frequently had higher intakes of fat from energy-dense snacks, which predicted their increase in BMI from age 5 to 9. TVV did not directly predict girls' increase in BMI in girls from overweight families.

Discussion: The results of this study support and extend previous findings that have shown that excessive television viewing and snacking patterns are risk factors for the development of overweight in children; however, patterns of relationships may differ based on parental weight status. For overweight families, TVV may provide a context for excessive snack consumption, in addition to inactivity.

Key words: childhood, inactivity, energy intake, family environment, path analysis

Introduction

Television viewing (TVV)[1] has been implicated in the development of overweight in children (1–3). Whereas the relationship between TVV and weight status is well established (4,5), factors that mediate this relationship are less clear. Television may contribute to the development of overweight in several ways (6): by reducing children's activity and energy expenditure (7,8), through commercials that encourage children to eat energy-dense (ED) foods high in sugar, fat, and salt (9,10), or by providing a context that encourages frequent snacking or overeating (11). It is the third possibility that we examined in this study.

The purpose of this study was to assess whether children's TVV was related to their snacking frequency and their intake of snack foods high in fat and sugar content, and in turn, whether greater frequency of snacking promotes patterns of intake that foster overweight. We were specifically interested in examining whether relationships among girls' TVV, snacking patterns, and increase in body mass index (BMI) from age 5 to 9 differed in families where neither parent was overweight compared with families where one or both parents were overweight. Parents provide both genes and environments for children that may foster the development of overweight and behaviors that may promote overweight (12). While obesity runs in families, genetic factors cannot explain all of the variance in child weight gain. As models for children's food intake and

Received for review June 25, 2002.
Accepted for publication in final form November 4, 2002.
Department of Human Development and Family Studies, Pennsylvania State University, University Park, Pennsylvania.
Address correspondence to Leann L. Birch, Ph.D., Department of Human Development and Family Studies, 105 White Building, University Park, PA 16802.
E-mail: LLB15@psu.edu

[1] Nonstandard abbreviations: TVV, television viewing; ED, energy dense; BMI, body mass index.

activity patterns, parents provide opportunities for children's healthy or unhealthy dietary patterns and sedentary or active lifestyles. Previous findings reveal that overweight parents can provide obesigenic environments for children; families where parents are overweight have lower levels of physical activity and unhealthy dietary intakes (13–15) relative to non-overweight families. Thus, it is possible that weight gain in children from overweight families may result, in part, from lifestyle factors that differ from children in non-overweight families.

Research Methods and Procedures

Participants

Participants were part of a longitudinal study with data collected from girls and their parents over three occasions of measurement: when girls were 5, 7, and 9 years old. At Time 1, 197 families participated in the study; there were 192 families at Time 2 and 183 families at Time 3. Eligibility criteria for girls' participation at the time of recruitment included living with both biological parents, the absence of severe food allergies or chronic medical problems affecting food intake, and the absence of dietary restrictions involving animal products; families were not recruited based on child or parent weight status or concern about weight. At the first occasion of measurement, data were collected on girls during the summer before they entered kindergarten. At the time of recruitment, girls' mean age was 5.4 ± 0.3 years; parents' mean ages was 35.4 ± 4.8 and 37.4 ± 5.4 years for mothers and fathers, respectively. The Pennsylvania State University Institutional Review Board approved all study procedures, and parents provided consent for their family's participation before the initiation of data collection.

Measures

Dietary intake, anthropometric, physical activity, and demographic measures were obtained when the girls were 5, 7, and 9 years old, except for television viewing, which was obtained when girls were 7 and 9 years old, and girls' snacking while watching television, which was obtained when girls were 9 years old.

Girls' TVV. Using questions developed in our laboratory, mothers were asked to report the average number of hours that girls watched television on school days and nonschool days. These questions were developed based on questions used in national surveys to estimate television viewing (3). Girls' mean TVV was derived by calculating mean hours of TVV per day from reported school day and nonschool day TVV (five school days, two nonschool days).

Girls' Physical Activity. Children's tendency to participate in physical activities was assessed using the Children's Physical Activity Scale by Tucker (16). The measure contains 15 items and four possible response options ranging from completely true to completely false. Questions are intended to ascertain whether children enjoy "high-energy" or "low-energy" activities. For example, lower scores on questions such as "I would rather watch TV or play in the house than play outside" indicate a greater liking for sedentary activities.

24-Hour Dietary Recall. Recalls were conducted by trained staff members at The Pennsylvania State University Diet Assessment Center with the computer-assisted Nutrition Data System for Research (database Version 4.01_30; Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN) to estimate girls' nutrient intakes, using the same method applied in the parent–child autotutorial dietary education program study (17). Each participant was asked to provide three 24-hour recalls within a 2- to 3-week period; 2 weekdays and 1 weekend day were randomly selected during each summer of measurement. Girls reported their food intake with mothers present to ensure greater accuracy. Food portion posters (2D Food Portion Visual; Nutrition Consulting Enterprises, Framingham, MA) were used as a visual aid for estimating amounts of foods eaten. Nutrient data were averaged across 3 days to obtain an estimate of average energy and nutrient intake.

Snacking was measured by self-report as a part of the dietary recall procedure; after reporting the food item consumed, mothers and daughters reported whether the item was a meal or a snack. Food items consumed between two consecutive meals were defined as one snacking occasion. A food group analysis was conducted using the Nutrition Data System dataset to determine the average number of U.S. Department of Agriculture Food Guide Pyramid recommended servings from grains, vegetables, fruits, dairy, meat, fats, and sweets food groups. Food group assignments and number of servings were based on U.S. Department of Agriculture guidelines (18). Each food group was further categorized into subgroups, providing information on the different types of foods consumed in each food group. Based on the food subgroup data, ED snack food intake was derived by combining girls' intake from 1) the cookies/pastries subgroup, 2) the cracker/chip subgroup, and 3) the sweets/confectionaries subgroup. Although information was collected on girls' intake from other subgroups, the above subgroups were used to create a composite of ED snack foods from subgroups known to include foods high in sugar and fat. After obtaining the gram amount of all ED snacks consumed, girls' total fat and energy intake from ED snacks was calculated.

After mothers and daughters reported whether a food item was eaten as breakfast, lunch, dinner, or snack, they were asked to indicate whether this meal was eaten at the table, in front of the television, or in some other location. Girls' total number of snacks eaten in front of the television was calculated as a sum across 3 days of recall data.

Child Weight Status. Girls' height and weight were measured by a trained staff member following procedures described by Lohman et al. (19), and were used to determine BMI (kilograms per meter squared) at each occasion of measurement. Children were dressed in light clothing and measured without shoes. Height was measured in triplicate to the nearest 0.10 cm using a Shorr Productions stadiometer (Irwin Shorr, Olney, MD). Weight was measured in triplicate to the nearest 0.10 kg using a Seca Electronic Scale (Seca Corp., Birmingham, UK). International reference criteria outlined by Cole et al. (20) were used to determine the prevalence of overweight in girls in this sample. The BMI cut-offs are based on international data and correspond to the 85th and 95th percentile for children, which are associated with the classifications of overweight and obesity, respectively. Cut-offs provide age- and sex-specific cut-off points from 2 to 18 years of age. We used cut-offs for the half-year (5.5, 7.5, and 9.5 years) to account for the array of birth dates throughout the year for our sample.

Parental Weight Status. Mothers' and fathers' BMI was calculated using the same procedures described above for girls. Based on widely accepted BMI cut-offs for overweight (21), families were classified as non-overweight (BMI < 25 kg/m^2), in which neither parent was overweight ($N = 101$), and overweight (BMI ≥ 25 kg/m^2), in which one or both parents were overweight ($N = 72$).

Statistical Analyses

Of the 183 families that participated at Time 3, five fathers (from divorced families) were no longer participating in the study, two girls were missing information on TVV, two girls had extremely high scores on TVV, and one girl showed an extremely high increase in BMI from age 5 to 9. These extreme cases were identified as outliers, influencing the magnitude of associations, and were excluded from analyses, leaving a total of 173 complete cases for all analyses.

Logarithmic transformations were performed on mothers' and fathers' BMI to improve normality. Using the Statistical Analysis System software package (22), a series of Pearson's zero-order correlations were generated to describe simple relationships among variables. Path analysis was used to examine a hypothesized set of relationships among variables. Path analysis uses multiple regression techniques to estimate parameters (regression paths) while controlling for other variables in the model predicting the outcome: girls' increase in BMI. Path analysis was a useful statistical tool for this analysis because of the fact that we had strong a priori ideas about the nature of relationships among girls' television viewing, snacking behavior, and increase in BMI. Path models were examined using the AMOS software package (23), which provides a simple method of graphically assessing complex models. Multiple group comparisons are fairly easy to access and interpret using this software. The magnitude of regression paths within models and across groups is the major focus of this study; we do not report on model fit.

The significance and magnitude of regressions paths were examined in a model that explored relationships among girls' TVV, snacking while watching television, snacking frequency, fat intake from ED snack foods, and girls' increase in BMI from age 5 to 9 (Figure 1). To control for genetic and other environmental contributions shown to influence children's increase in weight status, child BMI and family income when girls were 5 years old were included as covariates. These relationships were examined in a two-group model stratified by parental weight status to determine whether parental weight status moderated the effect of TVV on snacking and weight gain among girls. Girls were divided into two groups based on parental weight status: non-overweight ($N = 101$), in which neither parent was overweight, and overweight ($N = 72$), in which one or both parents were overweight. To examine whether associations within models were significantly different across groups, the results of χ^2 difference tests were evaluated after setting each regression path to be equal (separately). A significant difference in χ^2 under such constraints provides evidence of a moderating effect of parental weight status. Significance for all relationships was determined at a level of $p \leq 0.05$; trends were noted at a significance level of $p \leq 0.10$.

Results

Child and Parental Characteristics

Descriptive statistics for variables of interest are shown in Table 1. Based on international reference criteria proposed by Cole et al. (20), 21% of 5-year-old girls were classified as overweight, whereas 4% were classified as obese. These patterns persisted for 7-year-olds (21% overweight, 5% obese) and 9-year-olds (32% overweight, 9% obese). Mothers' and fathers' mean BMI scores exceeded the current cut-offs (21): 52% of mothers and 73% of fathers were overweight when girls were 5 years old, 55% of mothers and 73% of fathers were overweight when girls were 7 years old, and 60% of mothers and 78% of fathers were overweight when girls were 9 years old.

As shown in Table 1, girls from overweight families had significantly higher BMIs at ages 5, 7, and 9 than did girls from non-overweight families. For this reason, girls' BMI at age 5 was included as a control variable in subsequent analyses comparing relationships between TVV and snacking in overweight and non-overweight families. There were no significant differences in TVV, girls' inclination to be active, snacking frequency, or family income between girls from overweight and non-overweight families. Girls from overweight families showed greater increases in BMI from

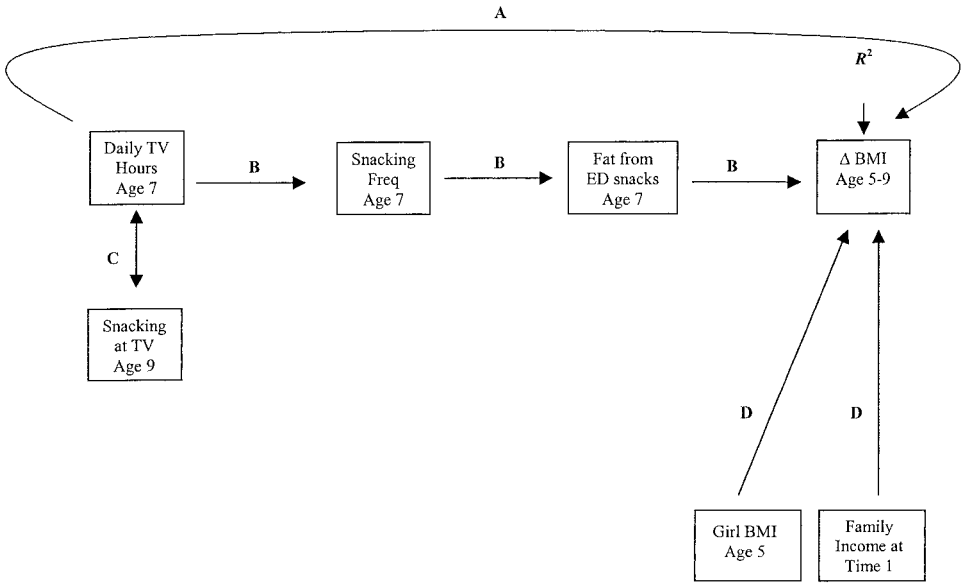

Figure 1: Path diagram of the hypothesized model. **A** represents the direct effect of TVV on girls' change in BMI from ages 5 to 9. **B** represents the indirect effects (snacking frequency and fat intake from ED snacks) of TVV on girls' change in BMI. **C** represents the association between TVV at age 7 and snacking while watching television at age 9. **D** represents the coefficients for the covariates, or Time 1 control variables. R^2 represents the total variance in girls' change in BMI explained by the model.

age 5 to 9 and had significantly higher fat intakes from ED snack food than girls from non-overweight families. There was a trend for girls from overweight families to consume more snacks overall, consume more snacks in front of the TV, and to watch more TV than girls from non-overweight families. While none of these variables differ significantly,

Table 1. Background characteristics and mean scores for variables of interest

Variable	Parent non-overweight (N = 101) BMI < 25 kg/m^2	Parent overweight (N = 72) BMI ≥ 25 kg/m^2
Child BMI (kg/m^2)		
Age 5	15.7 ± 1.5	16.2 ± 1.8*
Age 7	16.2 ± 2.1	17.3 ± 2.8*
Age 9	17.6 ± 2.7	19.8 ± 3.9*
Child change in BMI (Age 5 to Age 9)	1.9 ± 1.8	3.5 ± 2.6*
Child physical activity (1 to 5)	2.8 ± 0.4	2.7 ± 0.4
Mean daily TV (h)	1.6 ± 0.7	1.7 ± 0.8
Snacking frequency (0 to 4 times/day)	1.8 ± 0.7	1.9 ± 0.7
No. snacks at TV (over 3 days)	1.0 ± 1.1	1.3 ± 1.4
Fat from ED snack food (g)	3.0 ± 3.3	4.6 ± 5.6*
Maternal BMI time 1 (kg/m^2)†	23.3 ± 3.9	26.4 ± 5.8*
Paternal BMI time 1 (kg/m^2)†	26.8 ± 4.1	28.1 ± 4.6*
Family income	$35,000 to $50,000	$35,000 to $50,000

Values are shown as mean ± SD.
* Parental overweight group is significantly different from the parental non-overweight group at the $p \leq 0.05$ level.
† Time 1 = girls at age 5.

Table 2. Bivariate relationships among child variables for overweight (in bold) and non-overweight families

	1 Daily TV	2 No. snacks in front of TV	3 Snack frequency	4 Fat from snack	5 Δ BMI (5 to 9)
1. Daily TV viewing					
2. No. snacks in front of TV	**0.33*** 0.29*				
3. Snacking frequency	**0.30*** 0.06	**0.27*** 0.21			
4. Fat from ED snacks	**−0.04** −0.01	**0.03** 0.05	**0.26*** 0.29*		
5. Change BMI (age 5 to 9)	**−0.10** 0.29*	**−0.07** 0.00	**−0.05** −0.03	**0.26*** 0.14	

* $p < 0.05$.

taken together over time, these all may contribute to greater differences in overweight in girls from overweight families. Parents in overweight families were significantly heavier than parents in non-overweight families across all time points.

Predicting Girls' Increases in BMI

Zero-order correlations among predictors of girls' increases in BMI are shown in Table 2. Based on the strength and pattern of associations among variables of interest, path models were examined to assess relationships among girls' TVV, girls' snacking frequency, girls' intake of fat from ED snacks, and girls' increase in BMI from age 5 to 9. Girls' tendency toward physical activity was associated with girls' BMI at ages 5 and 9, but it did not predict girls' change in BMI, nor was it related to girls' TVV. Thus, it was not included in the predictive model.

Overweight vs. Non-Overweight Families

Estimates shown in Figure 2 are for a model in which all variables were simultaneously included in a model stratified by parental weight status. In girls from families in which neither parent was overweight, TVV was the only significant predictor of girls' increase in BMI from age 5 to 9, although girls' fat intake from ED snack foods approached significance. In non-overweight families, girls who snacked more frequently at age 7 reported eating a higher number of snacks while watching television at age 9. Girls in non-overweight families who snacked more frequently had higher intakes of fat from ED snack food; however, TVV was not associated with higher snacking frequency in girls from non-overweight families. No other relationships were significant.

For girls from overweight families, girls who watched more television reported eating more snacks while watching television and reported snacking more frequently. Snacking frequency was associated with higher intakes of fat from ED snack foods, which in turn predicted girls' increase in BMI from age 5 to 9. Girls' TVV, however, was not directly related to girls' increase in BMI.

In both groups, relationships remained significant after accounting for the influence of girls' BMI at age 5 and family income on girls' increase in BMI. The results of χ^2 difference tests confirmed that the relationship between TVV and snacking frequency ($\chi^2_{diff} = 4.46<1>$, $p = 0.05$) and TVV and girls' increase in BMI ($\chi^2_{diff} = 4.58<1>$, $p = 0.05$) was significantly different in girls from overweight vs. non-overweight families. No other relationships were significantly different, although most relationships were stronger in girls from overweight families.

Discussion

These findings confirm that TVV can indirectly influence children's weight status through effects on food intake. Girls who watched more television reported snacking more often while watching television. Girls who snacked more frequently had higher intakes of fat from ED snack foods. Parental weight status moderated the effects of TVV and snacking on girls' weight. In non-overweight families, girls' snacking patterns did not predict girls' increase in BMI from age 5 to 9. In these non-overweight families, girls who watched more television also consumed more snacks while watching television, but they were not necessarily snacking more frequently. TVV was the only significant predictor of girls' increase in BMI. Thus, whereas TVV contributes to

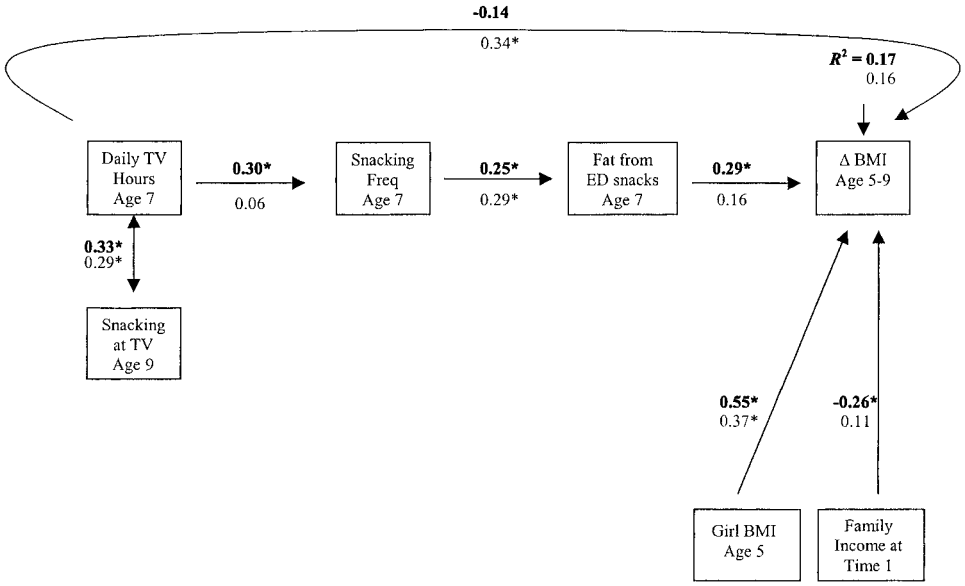

Figure 2: Path diagram comparing relationships between girls from overweight families (in bold) vs. non-overweight families. Two coefficients appear on each path. The upper path coefficients in bold typeface are for girls in overweight families; the lower path coefficients are for girls from non-overweight families. *Significant relationships are noted at $p \leq 0.05$.

girls' increase in BMI among girls in non-overweight families, this association may be a result primarily of decreases in energy expenditure rather than influences on snacking patterns. The finding that the effects of TVV and snacking differ for girls based on parental weight status reveals the contribution of TVV to weight gain in girls who are not predisposed to overweight through the genetic and environmental influence of parental weight status.

In families where one or both parents were overweight, TVV did not directly predict girls' increase in BMI, but it was indirectly related through snacking patterns; girls' TVV was associated with increased snacking while watching television and a higher frequency of snacking, which was associated with increased fat intake from ED snack foods. Patterns of intake associated with TVV predicted girls' increase in BMI from age 5 to 9. Thus, at least in this sample, in families with a genetic propensity to overweight, TVV may provide a context for snacking patterns that influence the development of overweight. Among overweight families, girls' snacking patterns, which seem to be influenced by TVV patterns, contribute to girls' increase in BMI from age 5 to 9, independent of the contribution of girls' BMI at age 5, which reflects both genetic and environmental influences.

This study examined links between television viewing and children's intake of ED snacks, providing additional information regarding the behavioral mechanisms that may explain the previously reported relationship between television viewing and childhood obesity. Children have a natural preference for sweet and high-fat foods (24) and may request these foods more often than more healthful foods (25). In addition, these requests may stem from the fact that these foods are regularly advertised during children's television programs (26–28). Recent studies have addressed the effects of television viewing on snack food intake, particularly increased intake of advertised foods on commercials (9,11); however, these studies did not include weight status as an outcome. Jahns and Popkin (29) recently reported increasing trends in snacking for U.S. children during the same period when childhood overweight increased dramatically. These findings provide limited evidence for the possible mediating effects of snacking on TVV's influence on childhood obesity.

To date, however, no evidence exists to show that secular trends in increased television viewing parallel increases in childhood overweight. It seems as though over the decades, children have consistently been watching high levels of television. Thus, it is important to examine other contextual variables within the family environment that may help to explain increasing trends in childhood overweight. The finding that parental weight status moderated effects of TVV and snacking highlights the need to examine contextual family variables that may contribute to differences between overweight and non-overweight families. Examples of possible family environmental variables are family dietary profiles, family activity patterns, and encouragement of activity. More importantly, the influence of genetic contributions to differences between overweight and non-overweight families cannot be ignored. It is possible that differences may be caused by inherited food preferences, eating styles, energy-intake regulation, growth velocity, and/or metabolic rate.

The model tested in this study extends the traditional view that television contributes to the development of overweight in children by promoting sedentary behavior and reducing children's energy expenditure (7,16). Klesges et al. (7) reported that children's metabolic rate during television viewing was lower than metabolic rate during rest. The authors conclude that this decrease in metabolic rate may play a significant role in the relationship between television and obesity. The results of this study suggest that children who watch more television may also be consuming more ED snack foods (5), and these patterns of intake may contribute to children's excessive weight gain over time, especially among children of overweight parents, who may be genetically predisposed to weight gain.

Due to the fact that heavier children show greater increases in weight status over time compared with non-overweight children (30,31), girls' BMI at age 5 was included as a predictor of girls' increase in BMI from age 5 to 9. In addition, relationships were examined separately for children from overweight and non-overweight families. Lastly, family income was included as a covariate, because it has been shown to influence weight status through several mechanisms, including dietary patterns (32,33). Among girls in overweight families, both TVV and patterns of food intake associated with TVV continued to contribute to the variance in girls' increase in BMI, even when controlling for girls' previous weight status and family income. This provides a conservative test of the effects of television viewing on snacking and the influence of snacking on girls' change in BMI from age 5 to 9, after the variance due to differences in child and parental weight status and family income at age 5 was removed. We acknowledge the power that parental BMI and child BMI at age 5 has in predicting later child weight status. By removing the variance due to parental and previous child weight status, we were able to make stronger statements about variables that explain a proportion of the variance beyond that accounted for by parental and child BMI. Thus, in this study, significant relationships between television viewing and snacking add to the prediction of girls' increase in BMI from age 5 to 9, independent of parental and child BMI at age 5.

As girls develop from age 5 to 9, normative increases in BMI occur as they approach puberty. The findings of this study, however, revealed that girls who showed the greatest increases in BMI watched more television (in non-overweight families) and consumed more fat from ED snacks (in overweight families). Parents may provide an obesigenic environment for children, influencing children's food intake by the foods made available in the home, child-feeding practices (34–36), and parents' own dietary patterns (37,38) and eating style (39,40). Parents also influence children's activity patterns by providing opportunities for children to be active (41) and by modeling physically active lifestyles (42).

In this study, TVV directly predicted girls' increase in BMI only among families where neither parent was overweight. Hence, for girls from non-overweight families who may not be exposed to the genetic and environmental effects of parental weight status, a sedentary lifestyle may be the most important factor in determining excessive weight gain. In girls' from overweight families, the effects of television were indirect. Patterns of television viewing influenced girls' weight status through influences on snacking among girls from families where either one or both parents were overweight. TVV was linked to weight gain through snacking, with increased TVV relating to more snacking in front of the TV and more frequent snacking. These were related to higher intakes of fat from ED snack foods, which predicted girls increase weight gain from age 5 to 9. This provides further support for previous recommendations for targeting reductions in TVV and other sedentary activities to reduce or prevent obesity in children (8,43). Findings reveal that the link between TVV and weight status can be through snacking patterns, at least in overweight families. This suggests that interventions should include 1) methods of reducing opportunities for children to consume ED snack foods while watching television, 2) methods of reducing snacking on ED foods, and 3) methods of including parents as agents of change (44,45), because it is evident that they are an important influence on children's eating behaviors and activity patterns.

These findings advance our understanding of environmental factors that contribute to the development of overweight in children; however, this study is not without limitations. This research was based on an exclusively white, predominantly middle-class, well-educated sample of parents and their daughters. This homogenous sample precludes generalization of the findings to other socioeconomic, ethnic, and racial groups, and to boys. This is particularly problematic because of the fact that the prevalence of obesity is higher among African-American and Hispanic children than among non-Hispanic white children (46), as are the risks of obesity associated with high rates of television viewing (47,48). African-American and Hispanic children have been found to watch more television than non-Hispanic white children (48).

In conclusion, we provide evidence that the relationship between television viewing and childhood overweight may be moderated by parental weight status, and at least among overweight families, this may be due in part to influences on children's snacking behaviors. These findings reveal that higher levels of television viewing may be promoting overweight through effects on both energy intake and activity patterns and may differ based on children's predisposition to overweight. Parents and caregivers should be encouraged to set limits on the amount of time children spend watching television and to thwart opportunities for children to learn that TVV is a context for eating. This can be done by

limiting opportunities for children to watch TV and by limiting consumption of ED foods while watching television. Parents, who are primarily responsible for purchasing foods, should provide children with more healthy snacking alternatives. There is a pressing need to dismantle obesigenic eating and activity environments, particularly in families where children are predisposed to overweight.

Acknowledgments

We thank all of the families who participated in this research study, the Penn State Nutrition Center who collected our dietary recall data, colleagues who provided input on this manuscript, and every staff member working diligently and tirelessly to collect these data. The services provided by the General Clinical Research Center of the Pennsylvania State University are appreciated. This research was supported by National Institutes of Health Grants M01 RR10732, HD32973, and NIH HD32973-03S1.

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