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Associations of obesogenic behaviors in mothers and obese children participating in a randomized trial

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Abstract

Relatively little research has assessed the association between obesogenic behaviors in parents and their children. The objective of the present analysis was to examine cross-sectional associations in television (TV)/video viewing, sugar-sweetened beverage intake, and fast food intake between mothers and their pre-school aged children. We studied baseline data among 428 participants in High Five for Kids, a randomized controlled trial of behavior change among overweight and obese children ages 2-6.9 years. The main exposures were whether mothers viewed TV/videos <1 hour/day, drank <1 serving/day of sugar-sweetened beverages, and ate fast food <1 time/week. The main outcomes were whether children met these goals for the same behaviors. Using multivariate logistic regression adjusted for maternal and child characteristics, we estimated odds ratios of children meeting the behavioral goals. The majority of mothers ate fast food <1 time/week (73%) and drank <1 serving/day of sugar-sweetened beverages (73%), while few mothers viewed <1 hour/day of TV/videos (31%). Most children met the fast food goal (68%), but not the goals for sugar-sweetened beverages (31%) or TV/video viewing (13%). In adjusted models, the odds ratios for a child meeting the goal were 3.2 (95% CI 1.7, 6.2) for TV/video viewing, 5.8 (95% CI 2.8, 12.0) for sugar-sweetened beverage intake, and 17.5 (95% CI 9.8, 31.2) for fast food intake if their mothers met the goal for the same behavior. Obesogenic behaviors of mothers and pre-school aged children were strongly associated. Our findings lend support to obesity prevention strategies that target parental behavior and the family environment.

Keywords

childhood obesity; maternal behavior; television; fast food; sugar-sweetened beverages

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Introduction

Data from both cross-sectional[1] and longitudinal[2] studies support the notion that obesity "runs in families". The observed relationship is likely the result of genetics[3] and a combination of behavioral, social, economic, and environmental factors[4,5], yet uncertainty remains about which changes to the family environment will most effectively reduce obesity risk in children.

Health behaviors are learned within families[6] and parents play a powerful role in the development of children's food- and activity-related behaviors throughout childhood[7,8]. Mothers, in particular, play a dominant role in shaping the health behaviors of children through mechanisms such as modeling, monitoring, and establishing/enforcing health-related household rules[9], but the extent to which behaviors which contribute to the development of obesity between mothers and their obese children are associated is not known. Maternal behaviors will influence a child's behaviors directly to the extent to which the behavior is shared, for example watching TV or eating fast food meals together. The shared home environment also provides comparable access to foods among mothers and children[4]. For example, children of mothers who drink sugar-sweetened beverages will likely have access to sugar-sweetened beverages kept in the home. There are modest correlations between the nutrient intakes of mothers and children[10] and previous studies have demonstrated an association between dietary habits such as dairy consumption[11,12] and fruit and vegetable intake[13-15] among mothers and children. Limited longitudinal data suggest that parental modeling of healthful behaviors can positively influence child diet over time[12,16].

Clinicians should advise patients and their families to adopt specific behaviors to prevent excessive weight gain[17]. In 2007, an expert committee reviewed evidence about the treatment of obesity that may have application in the primary care setting and provided recommendations for a staged approach for weight management[17]. The committee examined current information about eating behaviors, physical activity behaviors, and sedentary behaviors that may affect weight gain and provided recommendations for structured weight management which involves limiting consumption of sugar-sweetened beverages, limiting television and other screen time, and limiting eating out at restaurants, particularly fast food restaurants, and offers additional support and structure to help the child achieve healthy behaviors[17]. To date, little research has examined the maternal-child associations between behaviors that are often implicated in the development of child obesity. Examining the relationship between these behaviors, commonly referred to as "obesogenic" behaviors[18,19], in mothers and children could provide important insight into how maternal behavior may predict or protect against obesity in children and may inform future family-focused obesity prevention efforts. The objective of the current study was to examine the cross-sectional association between obesogenic behaviors, specifically TV/video viewing, sugar-sweetened beverage intake, and fast food intake, of mothers and their overweight or obese pre-school aged children.

Methods

Study Design and Participants

Study subjects are children participating in the High Five for Kids Study, a cluster-randomized controlled trial to reduce obesity among children 2-6.9 years of age taking place in 10 primary care offices (5 intervention sites, 5 usual care controls) in the Boston area[20]. Children were eligible for the study if they had a body mass index (BMI) >95th percentile. Children with a BMI between the 85th and 94th percentile were also eligible if they had at least one overweight (BMI >25) parent. Children had to receive their primary care at one of

the 10 study sites and have English- or Spanish-speaking parents. We excluded children in foster care or those who did not have at least one parent who was able to follow study procedures for 2.5 years. We also excluded families for whom the primary care clinician thought the intervention was inappropriate and children with chronic conditions that could substantially interfere with growth, physical activity, or dietary recommendations.

Of the 479 children initially enrolled in the study, we excluded 2 participants who were missing baseline BMI and 2 who had implausible height measurements. Of the 475 participants that remained, 428 had baseline interviews completed by mothers. Baseline interview data provided by mothers of participants in the trial are used for the present analysis.

Measurements

For both themselves and their children, mothers reported TV/video viewing (hours and minutes per day), sugar-sweetened beverage intake (times per day, week, or month), and fast food intake (times per day, week, or month) in response to open-ended questions. To measure TV/video viewing of mothers and children, we used questions from the National Longitudinal Study of Youth (NLSY) [21]. The NLSY parent report measures of child TV/video viewing have been linked in a dose-response manner to incidence of child obesity[22]. Parental reports slightly overestimate a child's TV time compared to diaries or direct observation, but still correlate well with videotaped observational measures[23].

We used a validated semi-quantitative child food frequency questionnaire to estimate daily sugar-sweetened beverage intake over the past 4 weeks[24]. We asked mothers to estimate their own beverage intake using an analogous question format. We defined sugar-sweetened beverages as soda (not diet or sugar-free), sweetened/flavored milks, and fruit drinks (e.g., Hi-C, Kool-Aid, lemonade). Natural fruit juice was not included in the count of sugar-sweetened beverages.

We asked mothers to report their own and their child's weekly servings of fast food using a question adapted from a longitudinal study of adults[25], "In the past month, on average, how often did your child eat something from a fast food restaurant like a pizza place, McDonald's, Burger King, Taco Bell, or Dunkin Donuts?". A similar, modified question was validated by association with childhood obesity in a study of 9-14 year olds[26].

The behavioral goals for children in the intervention were ≤1 hour/day for TV/video viewing, <1 serving/day for sugar-sweetened beverage intake, and ≤1 time/week for fast food intake. The TV/video viewing goal was based on an expert committee suggestion of recommending a reduction of television and other screen to time to <1 hour per day as part of structured weight management[17]. The sugar-sweetened beverage goal was also informed by an expert committee who acknowledge that although these beverages would ideally be eliminated from a child's diet, children who consume large amounts will benefit from reduction to 1 serving per day[17]. The fast food goal was informed by a study of young adults which found a direct monotonic association between fast-food frequency (from <1 time/week, 1-2 times/week, >2 times/week) and weight gain[27]. We created dichotomous variables representing whether children met the study's behavioral goals at baseline. We created analogous exposure variables for maternal behaviors by applying the same cutoffs used for children (≤1 hour/day for TV/video viewing, <1 serving/day for sugar-sweetened beverage intake, and ≤1 time/week for fast food intake). We will describe children and mothers with behaviors below these cutoffs as "meeting the goal" for that obesogenic behavior.

We obtained height and weight measurements from the child's medical record measured pre-enrollment by a trained clinical assistant (using a Shorr stadiometer and Seca scale) at

the child's annual well-child visit. We calculated BMI and age- and sex-specific BMI percentiles using national reference data, and we defined overweight as a BMI for age- and sex- between the 85th and 94th percentile and obesity as a BMI at or above the 95th percentile [28]. Mothers reported their own heights. Mothers were then read a series of weight ranges that corresponded to normal (<25.0 kg/m2), overweight (25.0-29.9), and obese (≥30.0) BMI categories for their reported height and were ask to identify which range captured their current weight. We obtained mothers weight status in this categorical manner to maximize response rate. This approach was also likely less stigmatizing for mothers with a BMI ≥30. Mothers also reported their educational attainment, their marital status, the annual household income, and their child's race/ethnicity.

Statistical Analysis

We first examined descriptive statistics of select maternal and child characteristics. We calculated mean (SD) TV/video viewing (hours/day), sugar-sweetened beverage intake (servings/day), and fast food intake (times/week) for children and mothers and calculated the percent of children and mothers who were meeting the goal for each behavior. We used chi-square statistics to assess the associations of maternal and child characteristics with the outcome of child meeting the goal for each of the three obesogenic behaviors. In separate models for each of the three behaviors, we used logistic regression to estimate unadjusted odds ratios with 95% confidence intervals of a child meeting the behavioral goals at baseline if the child's mother was also meeting the goal for that obesogenic behavior (Model 1). Multivariate models included potential confounders including child characteristics (sex and race/ethnicity) and household/maternal characteristics (household income, marital status, maternal education, and maternal BMI category) (Model 2), and additionally child age and BMI category (Model 3). We corrected Models 1-3 for clustering by study site using generalized linear mixed models.

Because odds ratios are poor estimates of relative risks for highly prevalent outcomes, we computed the prevalence ratios by dividing the predicted probabilities that a child would meet the goal if the child's mother did or did not meet the goal. As described previously[29], we used parameter estimates from our multivariate logistic regression models (Model 2) to estimate the predicted probabilities. We assigned fixed values for household income (> $50,000) and mother's marital status (married) and education level (college graduate) and computed predicted probabilities for all combinations of other sample characteristics (sex, child race/ethnicity, and maternal weight category). We conducted all of the analyses using SAS version 9.2 statistical software (SAS Institute, Inc, Cary, North Carolina).

Results

Characteristics of the study sample are shown in Table 1. The mean (SD) age of children in the study was 4.9 (1.2) years. Due to study enrollment criteria, all children were either overweight (43%) or obese (57%). Most children had fast food ≤1 time/week (68%), but far fewer had <1 serving/day of sugar-sweetened beverages (31%) and watched ≤1 hour/day of TV/videos (13%). The majority of mothers met the goal for fast food (73%) and sugar-sweetened beverage intake (73%), but not TV/video viewing (31%).

As shown in Table 2, only 1% of Latino children watched ≤1 hour/day of TV/videos, compared to 14% of white children, 15% of black children, and 29% of children in the "other" racial/ethnic group. Racial/ethnic differences were also seen for sugar-sweetened beverage intake: only 14% of Latino children had <1 serving/day or sugar-sweetened beverages, compared to 36% of white children, 29% of black children, and 38% of children in the "other" racial/ethnic group. Children with married mothers were more likely to watch ≤1 hour/day of TV/videos (15%) than children with unmarried mothers (4%). Higher

maternal education was consistently associated with lower obesogenic behaviors in children, with children of college educated mothers more likely to meet the goals for TV/video viewing, sugar-sweetened beverage intake, and fast food intake.

As shown in Table 3, the unadjusted (Model 1) odds ratios of a child meeting a behavioral goal if the child's mother also met that goal were 3.6 (95% CI 2.0, 6.4) for TV/video viewing, 5.9 (95% CI 3.0, 11.5) for sugar-sweetened beverage intake, and 14.4 (95% CI 8.6, 24.0) for fast food intake. In multivariate models adjusted for maternal BMI category, maternal education, marital status, household income, child sex, and child race/ethnicity (Model 2), the odds ratios were 2.9 (95% CI 1.5, 5.5) for TV/video viewing, 5.7 (95% CI 2.8, 11.8) for sugar-sweetened beverage intake, and 17.2 (95% CI 9.7, 30.5) for fast food intake. Additionally controlling for child age and child BMI category in the multivariate models (Model 3) did not substantially change the estimates.

As expected, the prevalence ratios of a child meeting the goal for TV/video viewing, sugar-sweetened beverage intake, and fast food intake, were lower than the odds ratios. Depending on child sex, child race/ethnicity, and maternal weight status, the prevalence ratios of a child meeting the goal for TV/video viewing, sugar-sweetened beverage intake, and fast food intake were 2.1-2.9, 2.7-4.6, and 2.0-3.9, respectively (data not shown). We saw little variation in prevalence ratios based on maternal weight, but estimates varied by child race/ethnicity with the highest prevalence ratios for TV/video viewing (2.8) and sugar-sweetened beverage intake (4.2-4.6) seen among Latino children and the highest prevalence ratio for fast food itnake seen among white children (3.2-3.9). Probability ratios for all behaviors were slightly higher in boys (2.3-4.6) than in girls (2.0-4.3).

Discussion

In this cross-sectional, we found a strong, positive association between the obesogenic behaviors of mothers and their overweight or obese pre-school aged children. The overweight or obese children in our study were far more likely to meet behavioral recommendations for TV/video viewing, sugar-sweetened beverage intake, and fast food intake if their mothers had lower levels of these behaviors. The associations we observed in obesogenic behaviors among mothers, most of whom are themselves are overweight, and overweight or obese children help to explain the broader environmental commonalities in obese families which efforts to prevent and reduce childhood obesity must consider.

Previous studies have demonstrated efficacy of obesity interventions which target parents[30] or involve the family[31-33]. Our study complements this literature by highlighting the overlap between the obesongenic behaviors of mothers and their overweight and obese children. The relationship between obesogenic behaviors in parents and children have been explored in other studies, although not explicitly among overweight or obese children. Barradas et al. reported an association between the TV viewing habits of parents participating in a mail panel survey and their adolescent children[34], but no studies have looked at this relationship in younger children. Similarly, results from a mail-in survey of 8 to 13 year olds indicated that youth whose parents regularly drank soft drinks were 2.9 times more likely to consume soft drinks five or more times per week compared with those whose parents did not regularly drink soft drinks[35]. Another study which distributed questionnaires among parents of children recruited from pre-school kindergartens in Belgium found that mother's consumption of soft drinks was an independent predictor of child's consumption[36]. The relationship between parent and child fast food intake has not been previously explored. Understanding the extent to which this behavior is shared is important because frequent fast food family meals are associated with poorer diet quality in adolescents[37].

We were able to examine the maternal-child associations between behaviors that are often implicated in the development of child obesity, such as watching TV[38], drinking sugar-sweetened beverages[39], and eating fast food[38]. We did not collect baseline data from study participants that would allow us to explore the other behaviors proposed by the expert committee: eating breakfast daily, encouraging family meals, limiting portion size[17]. Ongoing research should explore the role of maternal behaviors in child behavior and weight and should consider other shared behaviors and characteristics of the shared environment.

The majority of mother's of overweight and obese children in our sample were themselves overweight and most were already meeting the goals for both sugar-sweetened beverages and fast food. This observation may suggest that these behaviors are valuable, but insufficient, targets to address in weight management because of the numerous other factors are contributing to excessive weight gain and the persistence of overweight and obesity. An alternative explanation is that this observation indicates the presence of self report measurement bias stemming from social desirability of engaging in low levels of obesogenic behaviors, particularly among mothers of overweight or obese children.

The present analysis is subject to limitations. The cross-sectional design does not allow us to make conclusions about temporality or evaluate the impact of changing maternal behaviors on child behavior. We were not able to estimate associations between obesogenic behaviors of mothers and non-overweight children because all children in our sample had BMIs that exceeded the 85th percentile. Further, the high prevalence of maternal overweight and obesity in our sample also limits the generalizability of our findings which may be most comparable to overweight and obese families. Measurement of obesogenic behaviors is subject to recall bias and limitations imposed by the survey instrument; however, we selected previously used and validated questions when available and estimates of sugar-sweetened beverage intake were similar to recent estimates from a national sample[40]. Observed associations could be inflated because mothers reported both their own and their child's behaviors. We recognize that this is a significant limitation of the present analysis because mothers are likely to simultaneously under report their obesogenic behaviors and the obesogenic behaviors of their children for reasons including social desirability, thereby inflating associations. We asked mothers to identify the range which captured their weight by providing them weight ranges which corresponded to weight status categories. This approach is potentially non-stigmatizing and maximized response rate, but has not been validated previously. The behavioral goals used to create the "meeting goal" variables are based on recommendations for children in the High Five for Kids Study. In the absence of widely-accepted adult recommendations, analogous cutoffs were assigned for the mothers to reflect lower levels of those behaviors. Ongoing research is needed to establish empirically-defined upper limits for obesogenic behaviors in adults.

Although longitudinal and experimental studies are needed, it would be prudent to advise all parents to limit the obesogenic behaviors they model. Further, pediatric clinicians should encourage parents to make environmental changes that could benefit the whole family, such as keeping sugar-sweetened beverages out of the home, limiting the number of TVs in the home, removing TVs from bedrooms, and not eating fast food meals as a family. An additional benefit of making such recommendations is that they do not directly target the overweight/obese child and could thereby minimize stigmatization experienced by that child.

Conclusion

Because parents are instrumental in the development a child's health behaviors, efforts to reduce obesity must consider the child's behaviors and weight status within the family

context. Behaviors that are shared by both parents and children warrant special consideration because efforts to modify a child's behaviors may be more successful within an environment where parents model and provide opportunities for engaging in more healthful behaviors.

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Abbreviations

TV	television
BMI	Body Mass Index
CI	confidence interval
SD	standard deviation

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Table 1

Characteristics and obesogenic behaviors of 428 mother-child pairs

Maternal Characteristics	N (%) or Mean (SD)
BMI	
Normal (<25 kg/m^2)	147 (35%)
Overweight (25.0-29.9 kg/m2)	131 (31%)
Obese (≥30 kg/m2)	148 (35%)
Education	
Less than college graduate	201 (47%)
College graduate	227 (53%)
Marital status	
Not Married	70 (16%)
Married	358 (84%)
Household income	
$50,000 or less	122 (29%)
$50,001 or more	299 (71%)
Maternal Obesogenic Behaviors	
TV/video (hours/day)	1.8 (1.2)
Sugar-sweetened beverages (servings/day)	0.9 (1.2)
Fast food (times/week)	1.2 (1.5)
Meeting the goal for TV/video[a]	133 (31%)
Meeting the goal for sugar-sweetened beverages[b]	313 (73%)
Meeting the goal for fast food[c]	312 (73%)
Child Characteristics	
Age (years)	4.9 (1.2)
Sex	
Male	222 (52%)
Female	206 (48%)
Race/Ethnicity	
White	246 (58%)
Black	85 (20%)
Latino	73 (17%)
Other	24 (6%)
BMI	
85th -<95th percentile	184 (43%)
≥95th percentile	244 (57%)
Child Obesogenic Behaviors	
TV/video (hours/day)	2.6 (1.5)
Sugar-sweetened beverages (servings/day)	2.2 (1.8)
Fast food (times/week)	1.2 (1.0)

Maternal Characteristics	N (%) or Mean (SD)
Meeting the goal for TV/video[a]	56 (13%)
Meeting the goal for sugar-sweetened beverages[b]	133 (31%)
Meeting the goal for fast food[c]	293 (68%)

[a] TV/video goal: ≤1 hour/day

[b] Sugar-sweetened beverage goal: ≤1 serving/day

[c] Fast food goal: ≤1 time/week

Table 2

Bivariate association of selected maternal and child characteristics with the child meeting the goals for TV/video viewing, sugar-sweetened beverage intake, and fast food intake in 428 mother-child pairs

	Child TV/video viewing		Child sugar-sweetened beverage intake		Child fast food intake	
	% meeting goal	*p-value*[a]	*% meeting goal*	*p-value*[a]	*% meeting goal*	*p-value*[a]
Maternal Characteristics						
BMI		0.13		0.24		0.27
Normal weight (n=147)	18%		35%		72%	
Overweight (n=131)	12%		26%		69%	
Obese (n=148)	10%		31%		64%	
Education		<0.01		<0.01		0.05
Less than college graduate (n=201)	8%		24%		64%	
College graduate (n=227)	18%		37%		73%	
Marital Status		0.02		0.06		0.59
Not Married (n=70)	4%		21%		66%	
Married (n=358)	15%		33%		69%	
Household income		<0.01		<0.01		0.39
$50,000 or less (n=122)	6%		20%		66%	
$50,001 or more (n=299)	15%		35%		70%	
Child Characteristics						
Sex		0.09		0.04		0.30
Male (n=222)	10%		27%		66%	
Female (n=206)	16%		36%		71%	
Race/Ethnicity		<0.01		<0.01		0.43
White (n=246)	14%		36%		68%	
Black (n=85)	15%		29%		66%	
Latino (n=73)	1%		14%		68%	
Other (n=24)	29%		38%		83%	
BMI		0.05		0.80		0.52
85th -<95th percentile (n=184)	17%		30%		70%	
≥95th percentile(n=244)	10%		32%		67%	

[a] p-values from global chi-square

Table 3

Odds ratios of child meeting the goal for TV/video viewing, sugar-sweetened beverage intake, and fast food intake if mother was meeting the goal versus if mother was not meeting the goal, in 428 mother-child pairs

	TV/video viewing	Sugar-sweetened beverage intake	Fast food intake
Model[a]	**Odds ratio (95% CI)**	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**
Model 1[b]	3.6 (2.0, 6.4)	5.9 (3.0, 11.5)	14.4 (8.6, 24.0)
Model 2[c]	2.9 (1.5, 5.5)	5.7 (2.8, 11.8)	17.2 (9.7, 30.5)
Model 3[d]	3.2 (1.7, 6.2)	5.8 (2.8, 12.0)	17.5 (9.8, 31.2)

[a] Models corrected for clustering by site using generalized linear mixed models

[b] Unadjusted model

[c] Model 1 + maternal BMI category, maternal education, marital status, household income, child sex, and child race/ethnicity

[d] Model 2 + child age and child BMI category