

Associations Between the Home Food Environment and Obesity-promoting Eating Behaviors in Adolescence

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Abstract

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Objective: This study examines relationships between multiple aspects of the home food environment and obesity-promoting characteristics of 12- to 13-year-old adolescents' diets, specifically frequency of consumption of high-energy fluids, sweet snacks, savory snacks, and take-out foods.

Research Methods: This was a cross-sectional study including 347 adolescents 12 to 13 years of age and their parents. Data were collected via self-completed surveys. The adolescents' diets were assessed using a Food Frequency Questionnaire derived from existing age-appropriate National Nutrition Survey data. An extensive range of domains within the home food environment were assessed. Bivariate linear regression analyses were run split by gender. Forced entry multiple linear regression analyses (adjusting for all variables significant in bivariate analyses as well as for maternal education) were also performed, stratified by the sex of the child.

Results: The influence of mothers, either as models for eating behaviors or as the providers of food, was pervasive. Mothers' intake of high-energy fluids ($p = 0.003$), sweet

snacks ($p = 0.010$), savory snacks ($p = 0.008$), and take-out food ($p = 0.007$) was positively associated with boys' intake of all these foods. In addition, mothers' intake of high-energy fluids was positively associated with daughters' consumption of these drinks ($p = 0.025$). Furthermore, availability of unhealthy foods at home was positively associated with girls' sweet snack ($p = 0.001$), girls' savory snack ($p < 0.001$), boys' savory snack ($p = 0.002$), and, in the bivariate analyses, girls' high-energy fluid consumption ($p = 0.002$).

Discussion: This study of home food environment influences on adolescent diet highlights the pervasive influence of mothers in determining adolescents' obesity-promoting eating, providing direction for obesity prevention strategies and future research.

Key words: home food environment, adolescents, eating behaviors, obesity prevention.

Introduction

The proportion of adolescents who are overweight or obese is high and rapidly increasing (1). Adolescence is one of the most vulnerable periods for the development of obesity and appears to be a period for entrainment of obesity-related morbidity (2–4). Diet is likely to be one of the important precursors of overweight and obesity. Dietary quality declines from childhood to adolescence (5), with dietary habits likely to promote fatness being actively adopted. For example, the consumption of fruit, vegetables, and milk decreases from childhood to adolescence (5,6), while soft-drink consumption increases (5–7). Understanding the drivers of these dietary changes is essential to inform targeted approaches for obesity prevention in this vulnerable age group.

A few quantitative studies have suggested that a range of factors is likely to influence the development of adolescent eating behaviors. For example, parental influences on ado-

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Adolescent General Survey

Parent General Survey and Food Survey

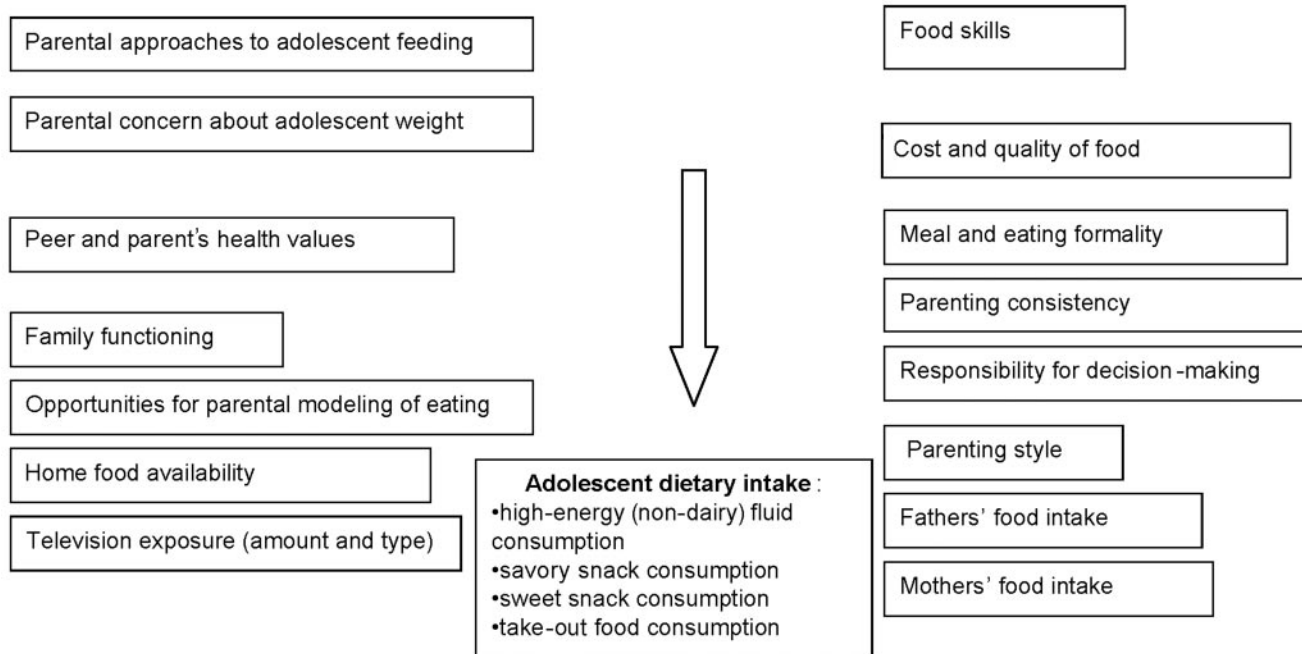


Figure 1: Model of family environment predictors of obesity-promoting eating behaviors.

lescent eating have been broadly described, ranging from the observations of generic familial similarities in dietary intake (8) to specific descriptions of associations between mothers' and adolescents' high-energy fluid consumption (9) and consumption of fruits and vegetables and high-fat foods (10). In younger groups, significant positive correlations between children and mothers have also been reported for the consumption of chips, chocolate confectionery (11), high-energy fluids (12), and snacks (13).

Descriptions of parents' influence on children's and adolescents' eating include studies of associations with parenting style, with opportunities to eat meals together (opportunities for parental modeling), and with parental provision of food within the home environment (food availability). In considering parenting style, two studies reported positive associations between mothers' authoritative parenting style (where parents set clear boundaries but are also responsive to child needs and wishes) and adolescent fruit consumption (14,15). The opportunity for adolescents to share family meals appears to exert an important and positive influence on a range of healthful eating behaviors (10,16,17). Studies of the impact of home food availability on adolescent diet are scant. In adolescents, Grimm et al. (9) reported home availability as an important predictor of 8- to 13-year-olds' soft-drink consumption, while Hanson et al. (18) reported that the strongest correlates of fruit and vegetable intake were availability of these foods at home.

Cullen et al. (19) also reported that child-reported availability of fruits, fruit juices, and vegetables predicted consumption of these items in fourth to sixth grade children. In addition to parental influences, television viewing is widely reported as influential on adolescent eating behaviors, including eating insufficient fruits and vegetables (20,21) and increased soft-drink (9) and fat intakes (22).

To date, few potential predictors of adolescent eating, stratified by sex of adolescent, have been considered. The aim of this study was to examine the association between the home food environment and a range of dietary behaviors considered to promote obesity (Figure 1).

Research Methods and Procedures

Subjects

Between July 2002 and February 2003, 345 (79.1%) students 12 to 13 years of age, who participated in the longitudinal Nepean Study (1996 to 1998), were followed up in the Nepean Kids Growing-Up Study. The students were part of a birth cohort born between August 1989 and April 1990, at Nepean Hospital, Penrith, in Western Sydney, Australia. Details have been published previously (23). Five additional students volunteered to participate at this stage. Of the 350 participants, 338 attended an interview, and 12 completed the entire study at home and returned their questionnaires by mail.

The Ethics Committees of the Children's Hospital at Westmead and Wentworth Area Health Service gave ethical approval for the study. Written consent was obtained from the student's mother or father, and each student signed a study agreement form.

Data Collection

Initially, questionnaires were mailed to participating families. Adolescents and their parents completed a general questionnaire (one for adolescents and one for the parents collectively) and a Food Frequency Questionnaire (FFQ)¹ (completed by the adolescent and, where possible, each parent). These instruments are described below. Participants were instructed to complete the questionnaires at home, and parents were asked to return all questionnaires at a follow-up interview. During the interview, all questionnaires were scanned for completeness, and doubtful responses were checked.

Adolescent Surveys

Adolescent General Survey. Adolescents completed a questionnaire including items on environmental factors hypothesized to be associated with food consumption. A summary of these items and their coding is presented below. All measures were informed by the literature.

Amount and Type of Television Viewing. Four items were used to assess the quantity of television viewed. Adolescents were asked to estimate hours spent, on a usual school day, watching commercial and non-commercial television, respectively. Similar questions were asked regarding a usual weekend day. Responses were converted to minutes, averaged for commercial vs. non-commercial TV, and summed to represent total TV viewing time.

Home Food Availability. Ten items were used to assess the availability of "healthy" and "unhealthy" foods in the home environment. For data reduction, a principal components factor analysis (24) with varimax rotation was performed, generating three factors. One factor, labeled "Unhealthy food availability," described the availability in the home of "junk" food, chips and snack foods, confectionary, and soft drinks (Cronbach's $\alpha = 0.73$). The remaining two factors, "Healthy food availability" and "General food availability," were not included in analyses because Cronbach's α values were low (0.44 and 0.5, respectively).

Family Functioning. Aspects of family functioning were assessed using 9 items entered into a factor analysis. Two factors were generated. One factor, condensing seven items, described adolescent satisfaction with their relationship with their parents (Cronbach's $\alpha = 0.80$). The second factor described lack of family conflict and included two reverse-

scored items (i.e., a higher score indicating less conflict) about fighting and arguing and about criticism of each other (Cronbach's $\alpha = 0.62$).

Peers' and Parents' Health Values. Six items asked about adolescents' perceptions of their closest friends', mothers', and fathers' health values (e.g., eating healthy food, staying fit and exercising), respectively. Each set of questions was summed and generated a health value score for each of these three groups, i.e., peers' health values (Cronbach's $\alpha = 0.75$), mothers' health values (Cronbach's $\alpha = 0.68$), and fathers' health values (Cronbach's $\alpha = 0.72$).

Parental Concern about Adolescent Weight. Three items adapted from Birch's Child Feeding Questionnaire (25) assessing adolescents' perceptions of parents' concern about adolescent weight were grouped in factor analysis (Cronbach's $\alpha = 0.70$).

Parenting Approaches to Adolescent Feeding. Twelve items adapted from Birch's Child Feeding Questionnaire (25) were used to assess adolescents' perceptions of their parents' approaches to feeding them. Factor analysis produced three factors. The first, "monitoring," included six items (Cronbach's $\alpha = 0.69$). These assessed how much parents were perceived to supervise adolescent intake. The second factor described the use of food as a reward and included two items (Cronbach's $\alpha = 0.82$). The third factor, "pressure," included four items that assessed adolescent perception of parents' application of pressure to eat more (Cronbach's $\alpha = 0.60$).

Adolescent Food Frequency Questionnaire. A 56-item student FFQ was developed based on data from the 1995 Australian National Nutrition Survey (NNS) (26). The 56 food and drink items included in the FFQ were those identified as major contributors to energy and fat intakes in 12- to 15-year-olds in the NNS (26). In the FFQ, each food item was expressed in household portions (e.g., slice of bread, 1 cup of milk), which were equivalent to the median portions of that food consumed by 12- to 15-year-olds in the 1995 NNS (26). Adolescents completed the questionnaire by noting the frequency, in times per week or per day, with which they consumed the listed foods and drinks. The frequency response categories were converted to times/wk as follows: 0 = "not consumed last week"; 0.143 = "consumed once a week"; 0.357 = "consumed 2-3 times a week"; 0.714 = "consumed 4-6 times last week"; 1 = "consumed once a day"; 2 = "consumed twice a day"; 3 = "consumed 2-3 times per day"; 5 = "consumed 4-6 times in a day." The individual scores were summed to generate a weekly consumption frequency. The 56 items in the FFQ were organized into eight logical food groups. Four of these groups, high-energy (non-dairy) fluids, savory snack foods, sweet snack foods, and take-out foods, are included in this paper. The construction of these groups was informed partly by similarities in nutritional properties of food items and partly

¹ Nonstandard abbreviations: FFQ, Food Frequency Questionnaire; NNS, National Nutrition Survey; FFP, family food preparer.

Table 1. Items comprising each of four food groups*

Food group	Parent FFQ items	Student FFQ items
Sweet snacks	Cakes, sweet muffins, scones or crumpets	Doughnut/cream bun/cake
	Sweet pies or sweet pastries	Sweet pies or pastry
	Other puddings or desserts	Dairy dessert and custard
	Plain sweet biscuits	Plain sweet biscuits
	Cream, chocolate biscuits	Cream, chocolate biscuits
	Chocolate (including chocolate bars)	Chocolate (including chocolate bars)
	Other confectionary	Other confectionary/sweets (eg. jelly babies, jelly beans)
Savory snacks	Ice cream	Ice confection and ice cream
	Nuts	Peanut and nut products
	Potato chips, corn chips, manufactured snacks	Potato chips, corn chips, manufactured snacks
High-energy fluids	Dry or savory biscuits, crispbread, crackers	Dry or savory biscuits
	Fruit juice/fruit juice drink	Fruit juice/fruit juice drink cordial
	Low-joule cordial/cordial	Soft drink
Take-out foods	Low-joule soft drink/soft drinks (including flavored mineral water)	
	Meat pie, sausage roll or other savory pastries	Meat pies, sausage rolls, vegetable pasties
	Pizza	Hamburgers/hot dogs
	Hamburger	Spring roll, Dim Sim (fried Chinese-style rolls)
	Hot chips	Hot chips, french fries, hash browns

FFQ, Food Frequency Questionnaire.

* Frequency of consumption scores were created by summing frequency per day of each of the nominated items within each group.

by the daily use of these foods/fluids within the total diet, that is, the behavioral context of consumption. For example, while the group “sweet snacks” contains foods that are nutritionally similar (generally high in fat and energy, providing few other nutrients), this group also aggregates foods that are likely to be eaten as snacks or as sweet additions to main meals and, in a behavioral sense, are discriminated by this. The nominated food groups and the items that comprised them are outlined in Table 1. The weekly consumption scores for individual food/drink items were summed within each of the four nominated groups to give total consumption scores.

Parent General Survey. Parents completed a questionnaire including items on environmental factors hypothesized to be associated with adolescent food consumption. No specification was made as to which parent should complete the questionnaire. A summary of these items and their coding is presented below.

Maternal Education. Maternal education was collapsed into three categories: “low,” some secondary education or less; “medium,” completed secondary school (12 years), apprenticeship, or technical certificate; “high,” university/tertiary qualification.

Food Skills. A single item assessed parents’ view of the importance of teaching adolescents to cook. A further score was created to capture parents’ assessment of adolescents’ cooking competency (Cronbach’s $\alpha = 0.73$).

Cost and Quality of Food. Five items regarding perceptions of the cost and quality of food were factor analyzed producing two factors. The factor concerned with food costs (“cost”) comprised two items (Cronbach’s $\alpha = 0.93$). The second factor, concerned with food quality (“quality”) included three items (Cronbach’s $\alpha = 0.79$). Two further items were used separately: “Our kitchen is not well set up for meal preparation” (reverse scored) and “Our family eats well at home because my partner or I have good cooking skills.”

Meal and Eating Formality. Six items assessing the degree of formality applied to meals and eating (e.g., whether meals were eaten with the television on) were summed to create a score (Cronbach’s $\alpha = 0.68$).

Parenting Consistency. Four items were used to seek level of agreement (1 = strongly disagree; 5 = strongly agree) regarding the consistency between parents about rules surrounding feeding and television viewing (Cronbach’s $\alpha = 0.80$).

Responsibility for Decision Making. Five items assessing parental responsibility for feeding and television viewing were summed to create a score for this domain (Cronbach's $\alpha = 0.74$).

Parenting Style. Twenty-six items, derived from Baumrind (27), sought to describe patterns of parenting, conceptualized in terms of the amount and quality of two underlying dimensions, demandingness and responsiveness. These items were factor analyzed generating five factors describing styles of parenting. The factor "authoritarian," describing high demandingness and low responsiveness, included eight items (Cronbach's $\alpha = 0.80$), for example, "I am clear about my parental role"; "I am firm with my child"; "I have the final say with my child"; "I am consistent with my discipline techniques." A second factor, titled "authoritative," describing high demandingness and high responsiveness, included six items (Cronbach's $\alpha = 0.78$). These included: "I listen to reasons why my child might not want to do something that I ask him/her to do"; "I make decisions in consultation with my child"; "I give my child reasons for my directions." The third factor titled "indulgent" (low demandingness, high responsiveness) included three items (Cronbach's $\alpha = 0.67$): "I use a gentle manner with my child"; "I become annoyed and impatient when my child disobeys me" (reverse scored); and "I become irritated and impatient when my child dawdles or is annoying" (reverse scored). The fourth parenting style identified by factor analysis was titled "uninvolved" (low demandingness, low responsiveness) and included four items (Cronbach's $\alpha = 0.62$), for example, "My child wins arguments with me"; "I ignore my child's misbehavior"; and "I let myself be talked out of things by my child." The final factor was titled "accepting," with three items (Cronbach's α of = 0.46), but was not included in the analyses as it was considered to be unreliable. The other two items originally included in the final factor, "I avoid open confrontation with my child" and "I find it difficult to spend time with my child," were used as separate items.

Parent FFQ

Mothers' and fathers' dietary intakes were assessed separately. This involved both mothers and fathers completing their own FFQ. The FFQ utilized was the dietary assessment tool used in the most recent Australian NNS (26), which asked the average number of times (per day/wk) a food/drink had been consumed in the last 12 months. Response categories were the same as those described for the adolescent FFQ. As with the adolescent FFQ, where appropriate, foods/fluids were grouped within four food groups: high-energy (non-dairy) fluids, savory snack foods, sweet snack foods, and take-out foods. The individual scores of nominated items were summed to give total consumption scores for each food group. The foods comprising each group are presented in Table 1.

Data Analysis

Bivariate linear regression analyses were performed between each of the independent variables and each of the dependent variables, stratified by sex. Forced entry multiple linear regression analyses (adjusting for all independent variables significant in bivariate analyses, as well as for maternal education) were also performed stratified by sex. If the independent variables were correlated at >0.3 (i.e., collinearity), then only the significant independent variable with the highest β in bivariate analyses was used.

Results

Demographics

Complete data were collected from 347 parents (311 mothers; mean \pm standard deviation age, 39.7 ± 4.1 years) and 347 adolescents (175 girls). Mean age of adolescents was 13.0 years (standard deviation, 0.2). Eighty-two percent of all parents were born in Australia, with a further 10% born in the United Kingdom or Ireland. The primary care provider for these adolescents was usually the mother (95%). Maternal education was predominantly "low" (49.9%), with the remainder divided evenly between "medium" (24.9%) and "high" (25.2%). Completed FFQs were obtained from 323 mothers and 284 fathers (at least one parent of each of the 347 adolescents), and all adolescents.

Adolescent Diet

The mean servings per day for the four food groups stratified by sex are presented in Table 2. Boys consumed significantly more sweet snacks, savory snacks, and take-out foods than did girls.

Home Food Environment

Tables 3 and 4 present mean values for adolescent and parent reports of the home food environment variables, respectively. For adolescent-reported predictors, just one difference was found by sex ($p < 0.001$), with boys reporting lower mean peer health values (6.6 ± 3.3) than girls (8.5 ± 3.2). For parent-reported predictors, three differences were found by sex ($p < 0.01$), with boys' parents reporting that their sons were less skilled at cooking (1.0 ± 1.6) than girls' parents reported for their daughters (1.5 ± 1.5), and boys' parents reporting more meal and eating formality (23.3 ± 3.2) compared with girls' parents (22.3 ± 3.1), as well as more consistency in parenting (15.7 ± 2.0 ; 14.7 ± 2.7).

Table 5 presents the results of multiple linear regression analyses for high-energy drink consumption and for sweet snack consumption (adjusting for all independent variables that were significantly related at the bivariate level and maternal education). Parents of boys who reported difficulty in finding time to spend with their child had sons who were less likely to consume high-energy drinks, while boys were

Table 2. Frequency of consumption of four food groups among boys and girls

Food group (servings per day)	Boys (mean)	Boys (standard deviation)	Girls (mean)	Girls (standard deviation)	<i>t</i> *	<i>p</i>
High-energy drinks	2.3	1.7	2.1	1.5	0.9	0.382
Sweet snacks	1.7	1.1	1.4	0.8	3.1	0.002
Savory snacks	0.8	0.5	0.6	0.5	2.6	0.009
Take-out	0.3	0.3	0.2	0.2	4.7	<0.001

* Student's *t* test assessed differences between adolescent girls and boys.

more likely to consume high-energy drinks if their parents reported an authoritarian parenting style (characterized as high demandingness and low responsiveness) and if their mothers consumed such drinks. Mothers' consumption of high-energy drinks was positively related to girls' consumption of high-energy drinks. While both unhealthy food availability (describing the availability in the home of "junk" food, chips/snack foods, confectionary, and soft drinks) and fathers' consumption of high-energy drinks were positively associated with girls' consumption of high-energy drinks in the bivariate models, these associations were no longer significant in multiple linear regression analyses.

Mothers' consumption of sweet snacks and parents pressuring their adolescent to eat more were positively associ-

ated with boys' sweet snack consumption. For adolescent girls, the availability of unhealthy foods at home was the strongest correlate of sweet snack consumption. Lack of family conflict was inversely associated with consumption of sweet snacks in girls.

Table 6 shows that parental reports that the kitchen was poorly set up for meal preparation was inversely related to boys' savory snack consumption. Mothers' consumption of savory snacks and reported availability of unhealthy food in the home were both positively associated with savory snack consumption in boys. The availability of unhealthy food in the home and parental reports that they praise their child for eating healthy food were positively associated with girls' increased savory snack consumption.

Table 3. Means for adolescent-reported home food environment variables

	Possible range*	Mean (standard deviation)
Breakfast eaten at home ^I	0 to 1	0.9 (0.4)
Dinner eaten at home ^I	0 to 1	1.0 (0.1)
Take-out eaten at home ^I	0 to 1	0.1 (0.1)
Take-out eaten away from home ^I	0 to 1	0.1 (0.1)
Average commercial TV per day (min) ^{S2}	0 to 570 ^{AR}	148 (90)
Availability of "unhealthy food" at home ^{F(4 items)}	0 to 12	6.7 (1.3)
Satisfied with parental help ^{F(7 items)}	0 to 14	11.1 (1.2)
Lack of family conflict ^{F(2 items-reverse scored)}	0 to 4	2.8 (0.9)
Peer health values ^{S3}	0 to 18	7.5 (3.3)
Mothers' health values ^{S3}	0 to 18	10.7 (3.9)
Fathers' health values ^{S3}	0 to 18	7.8 (3.5)
Parental concern re: adolescent weight ^{F(3 items)}	0 to 12	3.7 (3.3)
Parents monitor food ^{F(6 items)}	6 to 30	18.5 (3.1)
Parents reward with food ^{F(2 items)}	2 to 10	8.3 (5.1)
Parents pressure with food ^{F(4 items)}	4 to 20	12.7 (2.0)

S2 summed total TV viewing minutes per day; S3, summed 6 items with 5-point scales (0 = not at all/don't know; 3 = very much); I, value derived from an individual item (0 = never; 1 = everyday); F, value represents a factor score (number of items); AR, actual range.

* Higher scores indicate higher levels of agreement/increased frequency.

Table 4. Means for parent-reported home food environment variables

Predictor	Possible range*	Mean (standard deviation)	Predictor	Possible range*	Mean (standard deviation)
Important to me that I teach child to cook ^I	-2 to 2	1.1 (0.7)	Indulgent parenting style ^{F(3items)}	0 to 12	6.0 (1.7)
Child has good cooking skills ^{S1}	-4 to 4	1.3 (1.6)	Uninvolved parenting style ^{F(4items)}	0 to 16	5.1 (2.2)
Don't buy as fruit and vegetable cost is high ^{F(2items)}	2 to 10	3.1 (1.4)	I avoid confrontation with my child ^I	0 to 4	1.9 (1.0)
Fruit and vegetable quality/variety are low ^{F(3items)}	3 to 15	5.6 (2.1)	Difficult to spend time with my child ^I	0 to 4	1.2 (0.9)
Our kitchen isn't very well set up ^I	1 to 5	1.7 (0.9)	Mothers' high-energy drink consumption/d ^N	0 to 8.0 ^{AR}	1.8 (1.6)
Our family eats well as have good cooking skills ^I	1 to 5	4.1 (0.9)	Fathers' high-energy drink consumption/d ^N	0 to 7.9 ^{AR}	1.9 (1.8)
Praise child for eating healthy food ^I	0 to 1	0.3 (0.4)	Mothers' savory snack consumption/d	0 to 2.1 ^{AR}	0.5 (0.4)
Meal and eating formality ^{S3}	6 to 30	23.3 (3.2)	Fathers' savory snack consumption/d	0 to 2.0 ^{AR}	0.5 (0.4)
Parenting consistency ^{S4}	4 to 20	15.2 (2.4)	Mothers' sweet snack consumption/d	0 to 4.4 ^{AR}	1.2 (0.9)
Responsibility for decision making ^{S5}	0 to 5	4.1 (1.3)	Fathers' sweet snack consumption/d	0 to 4.6 ^{AR}	1.2 (0.9)
Authoritarian parenting style ^{F(8items)}	0 to 32	24.6 (3.9)	Mothers' take-out food consumption/d	0 to 1.1 ^{AR}	0.3 (0.2)
Authoritative parenting style ^{F(6items)}	0 to 24	17.3 (3.3)	Fathers' take-out food consumption/d	0 to 1.4 ^{AR}	0.4 (0.3)

FFQ, Food Frequency Questionnaire. S1, summed 2 items with 5-point scales (-2 = strongly disagree; 2 = strongly agree); S3, summed 6 items with 5-point scales (1 = strongly disagree; 5 = strongly agree); S4, summed 4 items with 5-point scales (1 = strongly disagree; 5 = strongly agree); S5, summed 5 items with 5 individual responses (1 = me, partner, shared; 0 = child, no one in particular); I, value derived from an individual item; F, value represents a factor score (number of items); AR, actual range; N, minimum number of fathers completing FFQ = 284; minimum number of mothers completing FFQ = 323.

* Higher scores indicate higher levels of agreement.

Table 6 also shows that mothers' consumption of take-out food and reports that fruits and vegetables are costly (thus impacting on purchase) were positively associated with boys' consumption of take-out food. Lack of family conflict and parenting consistency scores were inversely related to girls' take-out food consumption.

Discussion

To our knowledge, this study is unique in its description of the relative strength of associations between multiple aspects of an adolescent's home food environment and dietary behaviors likely to promote fatness in adolescence. The results demonstrate that aspects of the home food

environment depict varying degrees of association with such dietary behaviors. In particular, the impact of mothers, as role models for eating and/or as the primary gatekeepers for food, was pervasive and noteworthy.

Associations between maternal and child/adolescent intake have been well described. For example, Gibson et al. (28) showed that mother's liking of confectionery was the strongest predictor of confectionery intake in 9- to 11-year-olds, while Hanson et al. (18) reported positive associations between parental dairy intake and that of adolescent boys, and between parental dairy, vegetable, and fruit intakes and those of adolescent girls. Further, Hannon et al. (10) reported that the family food preparers' (FFP) (84% mothers)

Table 5. Results of multiple linear regression analyses for family environment and 1) consumption of high-energy (non-dairy) drinks; and 2) consumption of sweet snacks (stratified by sex and adjusted for all variables significant in bivariate analyses, and for maternal education)

Informant	High-energy (non-dairy) drink consumption per day			Sweet snack consumption per day		
	Boys		Girls	Boys		Girls
	Standardized regression coefficient	Significance	Standardized regression coefficient	Significance	Standardized regression coefficient	Significance
Parent	-0.294	<0.001				
Parent	0.226	0.002				
Mother	0.219	0.003	0.200	0.025		
Parent	Not entered*					
Father			0.164	0.058		
Adolescent			0.164	0.058	0.298	<0.001
Mother					0.203	0.010
Adolescent					0.201	0.011
Adolescent R^2		0.22		0.11	0.09	-0.175 0.12

* Not used in the adjusted regression analysis due to collinearity and a lower beta value [in bivariate (unadjusted) analysis] than the variable with which it was correlated.

eating habits predicted those of their child and, to a lesser extent, their adolescent. These authors proposed that FFPs influence their children's diets via their roles as primary food providers. The current study, in its inclusion of multiple potential predictors of adolescent eating, including measures of parents' diet and of home food availability, extends and substantially strengthens our understanding of the relative importance of FFPs on adolescent eating.

The availability of unhealthy food at home appears to be a robust predictor of consumption of obesity-promoting foods/fluids for both sexes, but particularly for girls. Grimm et al. (9) have previously noted that 8- to 13-year-olds who reported that soda was available in their homes were nearly three times more likely to report consuming soft drinks five or more times per week. In addition, the availability of less healthful food choices at home has been reported as an important barrier to choosing fruits and vegetables (29), while the strongest correlates of fruit and vegetable intake in adolescents are reported to be the availability of these foods at home (18). Those findings, along with the results of the present study, suggest that the availability of obesity-promoting foods in an adolescent's home promotes the consumption of these foods and, possibly by exclusion, reduces the consumption of lower energy density alternatives such as fruits and vegetables (not assessed in this study). Understanding the influences on the FFP (10) in the purchase and preparation of food appears likely to be an important area for future research.

In the current study, it seems that, while mothers may not be modeling the eating of particular foods (no association between mother's and child's intake), they may, as the primary caregiver of the adolescent, be providing that food for their adolescent to eat (availability of unhealthy food at home). This apparently anomalous situation might be explained by the findings of St. John Alderson and Ogden (30), who reported that mothers' own dietary knowledge (and practice) did not translate into healthy food choices for their children. Indeed, these mothers fed their children a less healthy diet than they fed themselves. This finding seems likely to reflect factors that influence mothers' food purchasing decisions, which may include adolescents' food likes and requests and the beliefs and values regarding the use of food as rewards/treats for adolescents.

These data suggest that influences on food intakes are likely to be age- and sex-specific. For example, while existing literature suggests that mothers' and their 5- to 6-year-old daughters' dietary intakes of the foods measured are likely to be similar (31), the only association found in the older age group in our study was that of high-energy fluids. The lack of association shown in this study may reflect the influence of maturation among girls and their increasing independence from parents. The retention of associations between mothers' and sons' diets might, in part, be explained by boys' reaching puberty 1 to 2 years

later than girls. This suggested influence of puberty is indirectly supported by qualitative literature suggesting that emerging adolescents' food intake is influenced by their growing independence (32). In addition, Hannon et al. (10) found that associations between dietary intakes of mothers and their offspring were weakest for their adolescent children. This shift in maternal influence has important implications for obesity prevention efforts, suggesting that the mechanisms by which mothers' and children's diets are related may change over time.

Several counterintuitive findings were revealed by these data. Parental praise for healthy eating was positively associated with girls' consumption of savory snacks. This finding may reflect the cross-sectional nature of these data. It may be that parents are more active in praising their child for eating healthfully when they are anxious about the dietary quality of their child's diet. Thus, in this instance, a parent may be anxious to draw attention to the good eating habits a child displays (in the hope of promoting these) when they are aware that their child's consumption of crisps and other savory snacks seems high. We also found that television viewing time, reported to be a predictor of adolescents' obesity-promoting eating behaviors (9,20), was not associated with any of the four dietary outcomes assessed. We speculate that this might be explained by the inclusion of a comprehensive range of potential influences on adolescent diet in this study.

While the comprehensive model of the home food environment was a strength of this study, it is important to acknowledge that there are few validated measures that seek to capture the many complex and dynamic behaviors assessed. The low reliability of some of our measures illustrates this. Similarly, the assessment of diet is known to be challenging. The assessment of scale reliability (and exclusion of unreliable measures) and the use of well-established dietary methodology are important strengths of this study. It is also important to note that this study is cross-sectional; thus, no causality can be concluded. It is possible, for example, that adolescent boys' eating influences mothers' eating, or that adolescent eating predicts home food availability. Further, although we controlled for mothers' education level in our analyses, one half of the mothers in the sample had a low level of education. Given this, the findings are likely to be less applicable to families with mothers of high educational attainment. Finally, despite assessing a broad range of potential predictors of adolescents' eating, the amount of variance explained for each of the dietary outcomes was modest. Baranowski et al. (33) report that modest explanation of variance in dietary intake is the norm. Further, while FFQs are considered to be valuable in the clarification of major dietary patterns in both adults (34) and children (35), it is possible that low variance might be explained by difficulties in accurately assessing all aspects

of dietary intake. It is also possible that important family environment variables have been inadvertently excluded or poorly characterized.

In summary, this study of home food environment influences on adolescent diet highlights that mothers, both as role models for eating and as the primary providers of care to their families, are likely to influence adolescents' obesity-promoting eating and that this influence differs between boys and girls. This understanding of the impact of mothers within the home food environment provides important direction for obesity prevention strategies and future research.

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