

TITLE: Interrelationships of child appetite, weight, and snacking among Hispanic preschoolers

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Study Importance Questions

What is already known about this subject?

- Snacking among US preschoolers has increased in recent decades, raising questions about contributions to excessive energy intakes.
- Whether some children are more at risk of dietary excess from snacks is unclear.

What this study adds:

- This investigation is the first to evaluate snacking contributions to dietary excess (e.g. added sugars) among low-income Hispanic preschoolers.
- Findings provide new evidence that more frequent snacking was associated with greater daily intakes of energy and added sugars.
- Overweight children with greater enjoyment of food appeared to be more prone to dietary excess from snacks.

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ABSTRACT

Background: Snacking among US preschoolers has increased in recent decades, raising questions about whether snacking contributes to dietary excess.

Objective: This research aimed to characterize snacking contributions to dietary excess and to evaluate associations with appetite and weight among preschool-aged children.

Methods: A cross-sectional, observational study of 187 Hispanic low-income preschoolers. Three 24-hour dietary recalls were used to assess snacking frequency and parameters of dietary excess including energy, saturated fat, trans fats, and added sugars. Parental reports of child satiety responsiveness, food responsiveness, and enjoyment of food were obtained. Child height and weight were measured.

Results: Children consumed 28% (395 kcal) of daily energy from snacks eaten 2.3 ± 1.0 occasions/d. Greater snacking frequency was associated with greater daily intakes of energy ($p < 0.05$) and added sugars ($p < 0.001$). Among overweight/obese children, higher enjoyment of food was associated with more frequent snacking and greater energy intake from snacks ($p = 0.01$). Inverse associations of enjoyment of food with snacking frequency and energy intake were seen among normal weight children ($p < 0.05$).

Conclusions: More frequent snacking among low-income Hispanic preschoolers may contribute to excessive intakes of energy and added sugars, particularly among overweight/obese children with greater motivation to eat.

INTRODUCTION

Prevailing wisdom says that young children need snacks, generally defined as foods eaten between meals, to meet nutritional needs. The American Academy of Pediatrics as well as the U.S. Department of Agriculture recommend 2 snacks per day for preschool-aged children.^{1,2} However, secular increases in frequency of snacking among young children have raised concerns about the contribution of snacking to dietary excess and obesity. In 2009, US preschoolers consumed 182 calories more per day from snacks than in 1977.³ These trends are consistent across preschoolers from varied socio-economic status and race/ethnicities.³ Data from the 2009-2010 National Health and Nutrition Examination Survey (NHANES) indicate that preschoolers currently snack almost 3 times daily, consuming approximately 400 calories or 28-29% of daily energy from snacks.^{3,4} Desserts, sugar sweetened beverages, and salty foods are among the most frequently consumed snacks by US children 2-18 y.³ In 2009-2010, children's snacks consisted of 19-21% protein, 39-42% sugars, and 25-27% fats.⁴ While children consume a significant amount of energy from snacks and the snacks eaten tend to be of poor nutritional quality, the extent to which snacking contributes to excessive dietary intakes are unclear, particularly among preschool-aged children for whom snacks are believed to be nutritionally most important.

Whether snacking poses the same risk of dietary excess for all children is also unknown. Heavier children have been reported to be less responsive to satiety cues,^{5,6}

and more responsiveness to food cues.^{5,7} In turn, there is evidence these appetitive traits may influence weight gain in early development.^{6,7} Taken together, such evidence suggests that snacking may pose a greater risk of dietary excess for overweight/obese children and those who demonstrate poor appetite regulation. To date, these hypotheses have not been tested.

This research was conducted to evaluate snacking contributions to dietary excess among low-income Hispanic preschool-aged children. In particular, associations of snacking frequency with children's intakes of energy, saturated and trans fat, and added sugars were characterized. Further, this research considered whether snacking poses the same risk of dietary excess for all children, by evaluating associations of child weight status and appetite with snacking frequency and energy. Understanding snacking contributions to children's diets addresses an important research need identified by the Dietary Guidelines for Americans (DGA) Advisory Committee to evaluate effects of common variations in dietary patterns on nutrient intakes among small children⁸. Further, the focus on Hispanic children is significant given that they are disproportionately affected by obesity.⁹

METHODS

Design

A secondary analysis of baseline data from a larger 18-month longitudinal study of parental influences on eating self-regulation during preschool among Hispanic

children was conducted. Caregiver reports of child appetite were assessed by questionnaire and caregiver reports of child food intake, including snacking, were assessed using three 24-hour recalls. Child height and weight were measured.

Participants

Convenience sampling was used to recruit 4-5 year-old Hispanic children and their caregivers from two Head Start programs districts in Houston, Texas. Eligibility for Head Start includes a family income equal to or below the federal poverty level. Participants were recruited through parent meetings, flyers sent home with children, engagement of the Head Start manager and staff in recruitment, and telephone calls to the home. Eligibility was assessed via phone. Children with food allergies and/or special diets were excluded. Parents provided consent for their own and their child's participation. Procedures were approved and carried out in accordance with standards of Baylor College of Medicine and Temple University Institutional Review Boards.

Procedures

Demographic, anthropometric, and questionnaire data were collected at the United States Department of Agriculture/Agricultural Research Service Children's Nutrition Research Center at Baylor College of Medicine. Dietary recalls were completed via telephone interviews by trained staff.

Measures

Demographic information. Caregivers provided basic demographic information on child age, sex, race, and caregiver sex, marital status, employment status, and education.

Child and caregiver body mass index. Child and caregiver weight (kg) and height (cm) were measured in duplicate using electronic scales (Health-o-Meter model 752KL, Sunbeam Products, Inc.) and stadiometers (Seca model 214, Seca Inc.) to the nearest 0.1 kg and 0.1 cm, respectively. Child BMI-for-age percentiles and z-scores were calculated in children in accordance with Centers for Disease Control reference standards.¹⁰ Child overweight ($\geq 85^{\text{th}}$ - 95^{th}) and obesity ($\geq 95^{\text{th}}$) were categorized using BMI-for-age percentiles.¹¹ Caregiver BMI scores were categorized as normal weight (BMI ≤ 24.9), overweight (BMI ≥ 25), or obese (BMI ≥ 30).¹²

Dietary intake. Two weekday and one weekend 24-hour dietary recalls were collected by trained research staff. All recalls were conducted via telephone. Caregivers were asked to complete the recalls for the child and were asked to obtain information from Head Start staff on meals consumed at the preschool program. Caregivers were provided a Food Amounts booklet with 2D measures as an aid to estimate portion size. The Nutrition Data System for Research Software version 2013 was used to estimate snacking and daily intakes of energy and selected macronutrients associated with dietary excess. The 2010 U.S. Dietary Guidelines for Americans recommend reducing intake of macronutrients associated with excessive energy intake including solid fats

(e.g. saturated and trans fats) and sugars, particularly those added during food processing.¹³ Therefore this research focused on energy, saturated fat, trans fats, and added sugar as the main parameters of excessive dietary intake. Total fat, total carbohydrate and sugars were also reported. Eating occasions were classified by participants (i.e. breakfast, lunch, dinner, snack, or other). Snacks were defined as any food and/or beverage characterized by participants as a snack. Following previous research, any food or beverage consumed within 15 minutes of the previous eating occasion was considered part of the previous occasion.³ Of 860 eating occasions defined as snacks in this dataset, 55 involved a beverage only. Additionally, of the 3124 food and beverage items consumed as part of a snack, 945 were beverages. All dietary data are presented as three-day mean values.

Parent report of children's eating behavior. The Children's Eating Behaviour Questionnaire¹⁴ (CEBQ) is a 35-item questionnaire assessing parent perceptions of 8 trait-like dimensions of child eating behavior. This study focused on Satiety Responsiveness (5 items; e.g. "My child leaves food on his/her plate at the end of a meal"), Food Responsiveness (4 items; e.g. "Given the choice, my child would eat most of the time"), and Enjoyment of Food (4 items; e.g. "My child enjoys eating") given associations with weight status,^{6,7,15} and evidence of genetic influence.¹⁶ Questions utilized a 5-point "never" to "always" Likert-type response options, with possible scores from 0-4. The CEBQ has demonstrated good internal consistency and test-retest

reliability in ethnically diverse children,^{15,17} including low-income Hispanic children.¹⁸

Internal consistency (Cronbach's α) of the Food Responsiveness, Enjoyment of Food, and Satiety Responsiveness subscales in this sample were 0.79, 0.72, and 0.68, respectively.

Statistical analyses

Analyses were conducted using SAS Version 9.3 (Cary, NC). Descriptive statistics were calculated for all variables of interest. ANOVA was used to evaluate associations between snacking frequency and children's snack and daily nutrient intakes, including energy saturated fat, trans fat, added sugar. Unadjusted models are presented; results did not differ from those produced by sensitivity analyses adjusting for child age (months) and gender, and parent educational attainment, marital status, employment status, and BMI. Pearson's correlations were used to describe bivariate relationships between child weight and appetite traits. Ordinary Least Squares regression was used to evaluate child appetite and weight status as predictors of snacking frequency and energy consumed from snacks. Interactions between child weight status and each appetitive trait were tested in separate models to avoid potential co-linearity and to avoid interpreting three-way interactions. All data are presented as mean \pm SD unless otherwise indicated. Statistical significance was inferred from p-values \leq .05.

RESULTS

Participant demographics

Analyses were performed with data from 181 of 187 children who had complete dietary data. Demographic characteristics of those children and caregivers are presented in **Table 1**. Of 181 children, 94 were male and 87 were female. All children identified as Hispanic or Latino and were between the ages of 4 to 5. All interviewed caregivers were female, and all but 2 identified as the mother of the enrolled child. Most caregivers were married or cohabiting (70%, n=126) and most were unemployed (77%, n=140), with close to a majority reporting a high school diploma or less (65%, n=118).

Snacking frequency, energy, and macronutrient intakes

The number of daily snacking occasions ranged from 1 to 5.3, with a mean of 2.3 snacking occasions/d. Most children either consumed 1 (~30% of the sample) or 2 snacks (~40% of the sample) daily; however, approximately 1 in 4 children consumed 3 or more snacks daily. Neither snacking frequency nor snacking energy intake were associated with child (i.e. age, weight status) and caregiver demographic characteristics (i.e. marital status, education, employment, and weight status) (data not shown).

Children's daily energy intake from snacks was 395 kcal, representing 28% of total daily energy intake (**Supplemental table**). Similar proportions of daily saturated and trans fat intakes (28-29%) were consumed from snacks. However, more than 40% of children's daily intakes of added sugars came from snacks.

As shown in **Table 2**, children who snacked more frequently tended to consume greater amounts of energy from snacks ($p < 0.0001$). More frequent snacking was also

associated greater intakes of saturated fats, trans fats, and added sugars from snacks (all $p < 0.0001$). Additionally, more frequent snacking was associated with greater daily intakes of energy, carbohydrates, sugars, and added sugars (all $p < 0.001$). Conversely, more frequent snacking was associated with a lower percentage of daily energy from fat ($p < 0.001$).

Associations of snacking frequency and energy with child weight and appetite

Almost half of the children were either overweight or obese (47%, $n=86$). Parent ratings of satiety responsiveness (mean \pm SD = 2.9 ± 0.5), food responsiveness (mean \pm SD = 2.2 ± 0.9), enjoyment of food (mean \pm SD = 3.8 ± 0.7) were associated with child weight status. Higher child BMI-for-age z-scores were associated with lower satiety responsiveness ($r = -0.22$, $p < 0.01$), higher food responsiveness ($r = 0.16$, $p < 0.05$) and greater enjoyment of food ($r = 0.16$, $p < 0.05$).

Parent reports of child appetite and weight were evaluated as predictors of snacking frequency and energy. Neither child appetite nor weight status were associated with snacking frequency or energy consumed from snacks when considered independently as main effects. Rather, associations of child appetite with snacking frequency and energy appeared to differ by child weight status (**Figure**). Among overweight/obese children, snacking frequency (**Panel b**, $p = 0.01$) and energy consumed from snacks (**Panel b**, $p = 0.01$) was higher among children with greater enjoyment of food, whereas the opposite relationship was seen for normal weight

children. Similarly, among overweight/obese children, energy consumed from snacks tended to be greater among children with higher food responsiveness (**Panel d**, $p = 0.05$), whereas the association was not significant for normal weight children. Interactions of satiety responsiveness and child weight status were not significant for the outcomes of snacking frequency or energy intake from snacks (**Panels e and f**).

DISCUSSION

Surprisingly few studies have considered snacking contributions to dietary intake among young children for whom snacks are believed to be most important.^{3,4,19-21} In this study, more frequent snacking among Hispanic preschoolers was associated with greater intakes of nutrients that are recommended to be consumed in limited quantities (e.g. added sugar). This analysis was also the first to evaluate the role of child appetite and weight in snacking contributions to dietary excess among preschool-aged children. Among preschoolers with overweight and obesity, energy consumed from snacks was higher among children who demonstrated high food enjoyment and food responsiveness. These findings provide new evidence that snacking may confer greatest risk of dietary excess for overweight and obese children with greater food motivation.

A handful of studies have reported associations of snacking with parameters of dietary excess. Associations of snacking frequency with snacking and daily energy are consistent with a previous analysis of US children aged 2-18 y by Nicklas, O'Neil, and

Fulgoni, in which a variety of snacking patterns were associated with higher daily energy intakes compared to not snacking.²⁰ The association of more frequent snacking with increased daily energy intake observed in this study suggests that children may not compensate for energy consumed at snacking occasions by eating less at meals. While more frequent snacking among children may be associated with greater energy intakes, the extent to which the observed energy intakes were excessive is not possible to discern at an individual level given that children's energy requirements were not assessed. In this study, mean daily energy intakes at each level of snacking frequency were roughly close to the 1200-1600 kcal/d range of estimated energy needs for children 3-5 y.¹³ The amount of energy consumed from snacks by children who consumed more than 2 snacks daily, however, exceeded the mean energy consumed from snacks by US preschoolers (464 kcal, based on an upper limit for daily energy needs of 1600 kcal/d for 3-5 year-old children¹³ and an assumption of 28-29% of daily energy consumed snacks⁴). Moreover, greater snacking frequency was related to children's intake of several nutrients believed to contribute to excessive energy intake and recommended to be limited in children's diets.¹³ These findings align with those from studies of older children which demonstrate that snacking frequency is positively associated with excess intake of added sugars²² and solid fat.²⁰

The relationship between snacking and weight status among children is debated. Several studies, including a meta-analysis, have observed an inverse relationship

between eating frequency (i.e. number of eating occasions) and body weight,²³ while others found no relationship,²⁴ or a positive association among children consuming diets high in sweetened beverages, salty snacks, and sweet foods.²⁵ In this study, the association of child weight status with energy consumed from snacks varied by children's food responsiveness and enjoyment of food. Enjoyment of food and food responsiveness represent trait-like dimension of eating behavior that, like other aspects of appetite, have a heritable component.¹⁶ Although distinct dimensions, both reflect heightened food approach or motivation to eat¹⁵ and have been positively associated with child weight.^{6,15} In the present study, higher levels of appetitive drive did not appear have negative associations with snacking frequency or energy intakes among children of healthy weight. That higher snacking frequency and energy intakes were seen among normal weight children with lower levels of enjoyment of food could represent a "grazing" pattern of eating. In contrast, overweight children with greater enjoyment of food snacked more frequently and had higher intakes of snacking and daily energy as well as added and total sugars. Overall, these findings suggest that snacking may not pose appreciable risk of dietary excess for normal weight preschoolers, but may be problematic for overweight and obese children with greater appetitive drives. These findings may also reflect a more general predisposition of overweight/obese children towards reward sensitivity. A recent representative cross-sectional study of Belgian adolescents showed associations of reward sensitivity and unhealthy snacks²⁶. Further,

previous research has observed greater deficits in reward sensitivity and inhibitory control among heavier children that appear to contribute to overeating tendencies.^{27,28} Prospective or experimental studies are needed to disentangle relationships between child appetite, snacking behaviors, and self-regulatory abilities.

Several limitations restrict the interpretation of this research. First, the findings need to be replicated in children of other racial/ethnic groups as meal and snacking patterns may reflect socio-cultural influences. The use of a convenience sample may also limit the representativeness and generalizability of the findings. At the same time, the observed mean snacking frequency and energy (as a proportion of daily energy intake) were similar to national estimates for children 2-6 y based on NHANES data.^{3,4} Second, that caregivers provided data on both child snacking as well as child appetite, may have introduced measurement bias. Parents of overweight children have been observed to underreport children's food intake.²⁹ If present in these data, this type of bias would hypothetically underestimate associations between the variables of interest. Finally, psychometric properties of the CEBQ are not yet well-described in ethnically diverse samples. A confirmatory factor analysis of the CEBQ among low-income Hispanics and African Americans in New York City, NY revealed some deviations from the original factor structure³⁰, although comparisons with the original model were only indirect. However, this study observed acceptable internal consistencies for the subscales of interest. Further, associations of child appetite with BMI-for-age z-scores

observed in this study are consistent with those reported in white and higher income samples.¹⁵

In conclusion, this research provides new evidence that frequent snacking may contribute to greater intakes of energy and added sugars among low-income Hispanic preschoolers. Findings further suggest that overweight/obese children with stronger appetitive drive may be particularly at risk of excessive intakes from snacks. These findings suggest that providing frequent snacking opportunities may be more detrimental than beneficial for overweight/obese preschoolers who are oriented towards food. Additional research is needed to understand the temporal relationships between appetitive traits, snacking behaviors, and child weight as well as how to optimally structure snacking for those children with heightened food motivation.

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Table 1
Socio-demographic characteristics of study sample (n=181)

Child	% (n)
Gender	
Female	48.1 (87)
Male	51.9 (94)
Age (y)	
4	65.8 (119)
5	34.3 (62)
BMI percentile	73.5 (25.8) ¹
Weight status	
Underweight	1.1 (2)
Normal weight	51.4 (93)
Overweight	21.6 (39)
Obese	26.0 (47)
Caregiver	% (n)
Marital Status	
Single	30.4 (55)
Married / Co-habiting	69.6 (126)
Employment	
Employed	22.7 (41)
Not employed	77.4 (140)
Educational attainment	
< High school	40.3 (73)
Completed high school	24.9 (45)
Some college/completed college	34.8 (63)
Weight status²	
Normal weight	17.1 (28)
Overweight	31.1 (51)
Obese	51.8 (85)

¹Mean (SD)

²BMI not reported for pregnant caregivers (n=14) and those missing weight measurements (n=1)

Table 2

Children's snacking and total daily intakes by daily snacking frequency (n=181)

	Snack Frequency (occasions/d)				Estimate of linear trend (P _{df=1})
	1/d (n=60)	2/d (n=77)	3/d (n=31)	≥ 4/d (n=19)	
	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	
Snack Intake					
Energy (kcal)	249.0 (21.7)	409.3 (19.1)	541.8 (30.2)	629.5(46.6)	<0.001
Fat (g)	7.8 (1.0)	12.5 (0.8)	15.2 (1.3)	17.3 (2.1)	<0.001
Saturated Fat (g)	3.1 (0.4)	4.8 (0.3)	6.0 (0.5)	7.0 (0.8)	<0.001
Trans Fat (g)	0.35 (0.07)	0.54 (0.06)	0.62 (0.09)	0.83 (0.14)	0.002
% snack energy	26.6 (1.1)	26.8 (1.0)	23.9 (1.6)	24.1 (2.4)	0.21
Carbohydrate (g)	39.3 (3.5)	65.7 (3.1)	91.1 (4.8)	106.8 (7.4)	<0.001
Sugars (g)	24.2 (2.5)	41.6 (2.1)	62.0 (3.4)	69.6 (5.2)	<0.001
Added Sugars (g)	12.2 (1.9)	20.8 (1.7)	28.4 (2.6)	33.7 (4.0)	<0.001
% snack energy	64.8 (0.02)	64.8 (0.01)	68.6 (0.02)	68.6 (0.03)	0.18
Total Daily Intake					
Energy (kcal)	1341.7 (50.2)	1382.5 (44.3)	1421.4 (69.9)	1625.4 (107.9)	0.02
Fat (g)	47.5 (2.3)	46.8 (2.1)	46.7 (3.2)	50.0 (5.0)	0.66
Saturated Fat (g)	17.1 (0.9)	16.4 (0.8)	16.5 (1.2)	18.3 (1.9)	0.57
Trans Fat (g)	1.8 (0.1)	1.7 (0.1)	1.7 (0.2)	1.9 (0.3)	0.62

% daily energy	31.3 (0.01)	30.2 (0.01)	29.0 (0.01)	27.1 (0.01)	0.005
Carbohydrate (g)	178.4 (7.2)	193.8 (6.3)	205.6 (10.0)	247.0 (15.4)	<0.001
Sugars (g)	91.0 (4.5)	104.3 (3.9)	116.4 (6.2)	139.4 (9.6)	<0.001
Added Sugars (g)	39.5 (3.4)	50.3 (2.9)	51.5 (4.6)	70.6 (7.1)	<0.001
% daily energy	53.4 (0.01)	56.3 (0.01)	58.2 (0.01)	61.4 (0.02)	<0.001

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Figure Legend

Figure

Associations between appetite characteristics and daily snacking frequency and energy by children's weight status. Interactions of child appetite and weight status to predict snacking frequency and energy were tested using ordinary least squares regression. Greater snacking frequency (Panel 2a) and energy (Panel 2b) were observed among overweight/obese children with greater enjoyment of food ($p=0.01$). Greater snacking energy was also observed among overweight/obese children with greater food responsiveness (Panel 2c, $p=0.05$).

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