HHS Public Access

Author manuscript

*J Acad Nutr Diet*. Author manuscript; available in PMC 2023 August 01.

Published in final edited form as:

*J Acad Nutr Diet*. 2022 August ; 122(8): 1534–1542. doi:10.1016/j.jand.2022.02.013.

# Frequency of sweet and salty snack food consumption is associated with higher intakes of overconsumed nutrients and weight-for-length z-scores during infancy and toddlerhood

**Amy M. Moore, Ph.D., R.D. [Postdoctoral Scholar]**,
Center for Childhood Obesity Research, The Pennsylvania State University, 129 Noll Laboratory, University Park, PA 16802 USA

**Jennifer Orlet Fisher, Ph.D. [Professor]**,
Department of Social and Behavioral Sciences, Center for Obesity Research and Education, College of Public Health, Temple University, 3223 N. Broad Street, Suite 175, Philadelphia, PA 19140 USA

**Katherine S. Morris, M.S., R.D. [Project Coordinator]**,
Division of Behavioral Medicine, Department of Pediatrics, Jacobs School of Medicine and Biomedical Sciences, University at Buffalo, Buffalo, NY 14214 USA

**Christina M. Croce, M.S., D.T.R. [Senior Research Associate]**,
Department of Social and Behavioral Sciences, Center for Obesity Research and Education, College of Public Health, Temple University, 3223 N. Broad Street, Suite 175, Philadelphia, PA 19140 USA

**Rocco A. Paluch, M.A. [Data Manager/Statistician]**,
Division of Behavioral Medicine, Department of Pediatrics, Jacobs School of Medicine and Biomedical Sciences, University at Buffalo, Buffalo, NY 14214 USA

**Kai Ling Kong, Ph.D. [Assistant Professor]**
Baby Health Behavior Lab, Division of Health Services and Outcomes Research, Children's Mercy Research Institute, Children's Mercy Hospital, Kansas City, MO 64108 USA

Center for Children's Healthy Lifestlyes and Nutrition, University of Kansas Medical Center, Kansas City, KS

Department of Pediatrics, University of Missouri-Kansas City, Kansas-City, KS

## Abstract

**Corresponding Author:** Amy M. Moore, Ph.D., R.D., Postdoctoral Scholar, Center for Childhood Obesity Research, The Pennsylvania State University, 129 Noll Laboratory, University Park, PA 16802 USA, amm9107@psu.edu.
**Author Contributions:** Conceptualization, AMM, JOF, KLK; Methodology, AMM, KLK; Analysis, AMM, KLK, RAP; Data Curation, AMM, KSM, CMC, KLK; Writing – Original Draft Preparation, AMM; Writing – Intellectual Content, Review & Editing, AMM, JOF, KSM, CMC, RAP, KLK; Funding Acquisition, KLK (PI of main study).

**Conflicts of Interest:** The authors declare no conflicts of interest.

**Background:** Current dietary guidelines recommend avoiding foods and beverages with added sugars and higher sodium before 2 years of age.

**Objective:** The aim was to describe daily snack food intake (frequency and total energy) and the associations with overconsumed nutrients (added sugars, sodium, saturated fats) and child weight-for-length (WFL) z-scores.

**Design.—**A cross-sectional, secondary analysis of baseline data from an ongoing longitudinal intervention was conducted.

**Participants and setting:** A sample of 141 caregivers with infants (9 to 11 months) and toddlers (12 to 15 months) was recruited in Buffalo, NY between 2017 and 2019.

**Main Outcome Measures:** Three 24-hour dietary recalls were used to categorize 'sweet and salty snack foods' or 'commercial baby snack foods' based on the USDA's What We Eat in America food group classifications and estimate nutrient intakes. Child recumbent length and weight were measured by trained researchers.

**Statistical Analyses:** Daily frequency (times/d), energy (kcal/d), and overconsumed nutrients from snack food intake were calculated. Multivariable regression models examined associations between the frequency of and energy from snack food intake with overconsumed nutrients and child WFL z-scores.

**Results:** Infants consumed snack foods on average 1.2 times/d contributing 5.6% of total daily energy (kcal/d), 19.6% of added sugars (g/d), and 6.8% of sodium (mg/d). Toddlers consumed snack foods on average 1.4 times/d contributing 8.9% of total daily energy (kcal/d), 40.0% of added sugars (g/d), and 7.2% of sodium (mg/d). In adjusted models including all children, greater frequency of sweet and salty snack food intake, but not commercial baby snack foods, was associated with higher WFL z-scores.

**Conclusions:** Snack foods are frequently consumed by infants and toddlers and contribute to the intake of overconsumed nutrients such as added sugars and sodium. Given the current guidelines to avoid added sugars and higher sodium before 2 years of age, additional recommendations related to nutrient-dense snack intake may be beneficial.

### Keywords

infants; toddlers; dietary intake; snack foods; overconsumed nutrients; weight

## Background

Offering nutrient-dense solid foods during the complementary feeding period from infancy into toddlerhood is essential for optimal growth and development.[1–3] Repeated exposures to healthful foods during this period influence the development of food acceptance patterns as well as shape the course of subsequent dietary patterns.[4–7] For example, studies show that the intake of nutrient-dense foods during infancy, such as fruits and vegetables[8], as well as the intake of energy-dense foods, such as sweet and salty snacks[9,10], are associated with greater intake of these foods in early childhood. As such, dietary intake during the complementary feeding period may provide a foundation for the establishment of dietary patterns that continue into early childhood.

The Dietary Guidelines for Americans (DGAs) 2020–2025 include recommendations for dietary intakes for infants and toddlers for the first time.[3] In line with recommendations from the American Academy of Pediatrics[2], the DGAs recommend introducing nutrient-dense foods from all food groups starting at approximately 6 months of age and avoiding overconsumed nutrients such as added sugars and foods higher in sodium during this sensitive period of development.[3] Data from the National Health and Nutrition Examination Survey (NHANES), however, shows energy-dense food intake among infants 6 to 11 months, with 50% consuming a sweet or salty snack or sugar-sweetened beverage on a given day.[11] These data also reveal suboptimal nutrient-dense food intake among infants in this age group, with only 78% of infants consuming any type of vegetable on a given day.[11] Similarly, data from the Feeding Infants and Toddlers Study (FITS) 2008 showed that 72% of infants from 9 to 11 months consumed at least one snack per day, with snacks contributing a mean of 93 kcal/day.[12] This increases from 12 to 23 months, where 94% of toddlers consumed at least one snack per day, with snacks contributing a mean of 288 kcal/day.[12] FITS 2016 showed that 26% of infants (6 to 11 months) and 46% of toddlers (14 to 17 months) consumed a sweet snack food, and 5.7% of infants and 17% of toddlers consumed a salty snack food each day.[13] These results are notable given that the amount of energy needed from complementary foods is relatively small until the end of the first year of life. Given that foods commonly consumed as snacks such as cookies, cakes, and chips contain high levels of discretionary energy (i.e., energy in excess of nutrient needs) and overconsumed nutrients (added sugars, sodium, and saturated fats),[11,12] whether sweet and salty snack foods have consequences for diet quality and weight among infants and toddlers are important questions.

Caregivers of young children are also exposed to a variety of commercially available baby foods and snacks, which are generally ready-to-eat or require minimal preparation.[14] Commercial baby foods such as fruit and vegetable purees and iron-fortified infant cereals are nutrient-dense and do not include added sugars or added sodium.[15–17] Infants who consume commercial baby foods are less likely to consume sweet foods such as cookies and cakes.[17] In contrast, commercial baby snack foods such as puffs and yogurt melts often include added sugars,[15] which is recommended to avoid during infancy.[2,3] Little is known about the contribution of commercially available baby snack foods in the diets of young children, making it important to understand how these snack foods independently contribute to diet quality and weight among infants and toddlers.

The impact of snack food intake on weight status during childhood has recently received considerable attention[18–20]; however, research is limited during the first 2 years of life. Previous research shows that greater intake of energy-dense snack foods is associated with increased weight trajectories among infants from families with low-incomes.[21] Similarly, in preschool-aged children from a nationally representative sample, greater frequency of snack food intake is associated with poor diet quality[22] and increased weight status.[18] In addition, energy-dense snack foods often contain added sugars that are associated with rapid infant weight gain, although breastfeeding ≥ 12 months may protect against rapid weight gain.[23] Despite these studies, little is known about snack food intake during early childhood. Therefore, additional research is needed to understand snack food intake, and understanding the unique contributions of different foods offered as snacks (e.g., sweet and salty snack

foods, commercial baby snack foods) will help inform recommendations for nutrient-dense snack food choices for young children.

The primary aim of this study was to evaluate the associations between snack food intake with overconsumed nutrients and weight-for-length (WFL) z-scores among young children. This study describes the daily frequency of (times/d) and energy from (kcal/d) snack food intake. Since there are differences in feeding recommendations[2,3] and energy requirements between the first and second years of life[24], dietary intake of the selected snack foods and overconsumed nutrients is described separately for infants (9 to 11 months) and toddlers (12 to 15 months). This study examined the associations between daily frequency of and energy from snack food intake with daily intake of overconsumed nutrients (i.e., added sugars, sodium, and saturated fats). Since the impact of snack food intake on weight depends on the frequency of and energy from snack foods[25,26], this study also cross-sectionally examined the associations between daily frequency of and energy from snack food intake with WFL z-scores. We hypothesized that more frequent snack food intake and greater energy from snack food intake would be associated with higher WFL z-scores after adjusting for confounding variables.

## Method

### Study Design and Participants

This study was a cross-sectional, secondary analysis of baseline data from an ongoing longitudinal intervention designed to explore motivation to eat in children (NCT02936284) that included caregivers who self-identified as mothers with children from 9 to 15 months of age (n = 141). Recruitment occurred in Buffalo, NY between 2017 to 2019, and families were screened for eligibility using an online survey or over the phone. Female caregivers were included in this study given their primary role in feeding young children and were eligible if they were ≥ 18 years of age and had a singleton pregnancy. Caregivers were excluded if they had a high-risk pregnancy (e.g., gestational diabetes mellitus, pre-eclampsia), used tobacco, alcohol and/or illicit drugs during pregnancy, or if their child was born preterm (< 37 weeks gestation), had a low birth weight (< 2500 g), or known medical condition (e.g., dietary restrictions, developmental delays). Eligible caregivers were enrolled and asked to provide written informed consent and parental permission for their children. The University at Buffalo's Institutional Review Board approved the study.

### Measures

Enrolled caregivers and their children were scheduled for a 1-hour baseline laboratory visit. Caregivers were sent links via email to online questionnaires prior to their visit. During the visit, caregivers received an informational packet regarding child dietary data collection procedures (e.g., estimating portion sizes, tracking breastfeeding duration).

### Demographic and Child Feeding Characteristics

Caregivers self-reported their age, sex, race and ethnicity, highest level of education, parity, and household size as well as infant age, sex, and birth weight. Breastfeeding duration and

timing of solid food introduction were also assessed at baseline using an adapted version of the feeding questionnaire used in the Infant Feeding Practices Study (IFPS) II.[27]

## Collection of Child 24-Hour Dietary Recalls

Caregivers were contacted by phone on three separate occasions (2 weekdays and 1 weekend day) to obtain three 24-hour dietary recalls for their child. Trained researchers followed modified procedures (e.g., recalls were scheduled to meet the needs of busy caregivers) from the Feeding Infants and Toddlers Study (FITS) 2008.[28] All phone calls took place within 10 days of obtaining child recumbent length and weight and occurred at a suitable time for the participant. Caregivers were asked about foods and beverages given by parents and other caregivers (e.g., childcare providers). Caregivers with a child in childcare were asked to report foods and beverages based on reports from the provider. At the start of each call, researchers asked if the previous 24 hours were a typical eating day for the child. If not, the recall was rescheduled. Trained researchers collected child dietary recalls from caregivers (as proxies) using the USDA Automated Multiple-Pass Method (AMPM), a computer-assisted dietary interview that includes standardized probes to collect dietary information on all foods and beverages consumed during the previous 24 hours.[29]

## Nutrition Analysis of Child 24-Hour Recalls

Trained researchers entered dietary recalls into the Nutrition Data System for Research (NDSR; Version 2019; Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN) dietary analysis program.[30] When reported brand name foods were missing from the program, a generic food with a comparable nutrition profile was selected by the researcher. For caregivers who were breastfeeding, procedures from the FITS were used to estimate energy and nutrients from breast milk.[31] Researchers entered 600 mL of breast milk/d for exclusively breastfed infants 9 to 12 months of age and 29.6 mL (1 fluid ounce) per every 5 minutes of breastfeeding for toddlers 12 to 15 months of age. For children who consumed breast milk and formula, the volume of formula reported was subtracted from 600 mL and the remainder entered as breast milk. All children in this analysis had three days of dietary recalls and children who exceeded ±2 SDs of their estimated energy requirements (n = 3) were excluded,[32] leaving an analytic sample of 141.

## Characterization of Snack Food Intake and Overconsumed Nutrients from Snack Foods

Two categories of snack foods were created using the USDA's What We Eat in America (WWEIA) food group classifications, irrespective of the time eaten or eating occasion: 1) 'sweet and salty snack foods' following the WWEIA 'snacks and sweets' classification (e.g., chips, crackers, cakes, cookies) and 2) 'commercial baby snack foods' (i.e., manufactured foods designed for and marketed to the caregivers of infants and toddlers[33]) following the WWEIA 'baby food: snacks and sweets' classification (e.g., puffs, melts, baby cookies).[34] Two researchers with nutrition training (AMM, a registered dietitian and CMC, a registered dietetic technician) assigned foods to the two snack categories and a third researcher with nutrition training (KSM, a registered dietitian) reviewed the categories for accuracy and resolved discrepancies. The mean of the three dietary recalls was used to calculate the frequency (times/d), energy (kcal/d), and overconsumed nutrients (added sugars (g/d), sodium (mg/d), and saturated fats (g/d)) from snack food intake.

### Participant Anthropometrics

Caregiver's height (Proscale Stadiometer, Fletcher, NC) and weight (Seca Digital Scale, Hanover, MD) were collected in duplicate by trained researchers during the baseline laboratory visit. The mean of the two measurements was used to calculate current BMI and weight status. Child recumbent length (Seca 416 Infantometer, Hanover, MD) and weight (Seca 374 Digital Baby Scale, Hanover, MD) were collected in duplicate by trained researchers during the laboratory visit. The mean of the two measurements was used to calculate age- and sex-specific WFL z-scores at baseline using World Health Organization (WHO) reference standards.[35]

### Statistical Analysis

Descriptive statistics for key variables are presented as means (standard deviations) for continuous variables and frequencies (percentages) for categorical variables. Snack foods from the three dietary recalls were categorized as 'sweet and salty snack foods' and 'commercial baby snack foods' and used to calculate the mean daily frequency (times/d), energy (kcal/d), and overconsumed nutrients from these snacks. Descriptive statistics are reported separately for infants (9 to 11 months) and toddlers (12 to 15 months) as well as for 'sweet and salty snack foods' versus 'commercial baby snack foods' categories. Multivariable regression models examined associations between the frequency of and energy from each snack food category (explanatory variables) with overconsumed nutrients and child WFL z-scores (outcome variables), adjusting for the caregiver's prepregnancy BMI and education, as well as child age, sex, birth weight, breastfeeding duration, and age of solid foods introduction, based on previous findings of an association with infant weight.[36] Results for multivariable regression models include beta coefficients, which can be negative or positive, and have a *P* value to indicate statistical significance. The beta coefficient is the degree of change in the outcome variable for every 1-unit of change in the explanatory variable. A t-test assesses whether the beta coefficient is statistically and significantly different from zero. If the beta coefficient is positive, the interpretation is that for every 1-unit increase in the explanatory variable, the outcome variable will increase by the beta coefficient value. If the beta coefficient is negative, the interpretation is that for every 1-unit increase in the explanatory variable, the outcome variable will decrease by the beta coefficient value. Residual probability plots for regression models were examined to ensure residuals were normally distributed. Data were analyzed using SAS 9.4[37] and SYSTAT 11[38] and an alpha of $< 0.05$ was used to determine statistical significance.

## Results

### Demographics

Table 1 presents baseline characteristics of caregivers and their children. All caregivers self-identified as female and were on average 32.6 ± 4.4 years of age, predominantly White (89.1%) and college-educated (84.2%). Children were on average 11 ± 1.9 months of age (n = 71, 9 to 11 months and n = 70, 12 to 15 months) and just over half were identified by their caregiver as female (55.3%), with birth WFL z-scores (−0.79 ± 1.5) and baseline WFL z-scores (0.57 ± .86) within the normal range. The majority of children were breastfed 6 months or more (68.1%) and were introduced to solid foods after 4 months (96.5%).

### Frequency of and Energy from Daily Snack Food Intake

Table 2 presents means for the frequency, energy, and overconsumed nutrients from daily snack food intake among infants and toddlers. For infants (9 to 11 months), 90.1% consumed a sweet and salty snack food or commercial baby snack food on a given day. Infants consumed these snack foods a mean of 1.2 times/d, with sweet and salty snacks consumed a mean of 0.35 times/d [range 0 – 2.3] and commercial baby snack foods a mean of 0.84 times/d [range 0 – 3.0]. Infants consumed a mean of 839 ± 199 kcal/d (milk + solid foods) with a mean of 47 kcal/d from all snack foods, accounting for 5.6% of total daily energy intake. Results by snack food category revealed that infants consumed a mean of 24 kcal/d from sweet and salty snack foods and 23 kcal/d from commercial baby snack foods.

For toddlers (12 to 15 months), 95.7% consumed a sweet and salty snack food or commercial baby snack food on a given day. Toddlers consumed these snack foods a mean of 1.4 times/d, with sweet and salty snack foods consumed a mean of 0.74 times/d [range 0 – 3.7] and commercial baby snack foods a mean of 0.62 times/d [range 0 – 4.3]. Toddlers consumed a mean of 990 ± 221 kcal/d (milk + solid foods) with a mean of 88 kcal/d from all snack foods, accounting for 8.9% of total daily energy intake. Results by snack food category revealed that toddlers consumed a mean of 60 kcal/d from sweet and salty snack foods and 28 kcal/d from commercial baby snack foods.

### Overconsumed Nutrients from Daily Snack Food Intake

For infants (9 to 11 months), all snack foods accounted for 19.6% (3.0 g/d) of total daily added sugar intake, 6.8% (39.7 mg/d) of total daily sodium intake, and 2.1% (0.32 g/d) of total daily saturated fat intake. Results by snack food category revealed that sweet and salty snack foods accounted for 5.9% (0.90 g/d) of total daily added sugar intake, 5.2% (30.4 mg/d) of daily total sodium intake, and 1.7% (0.26 g/d) of total daily saturated fat intake. Commercial baby snack foods accounted for 13.7% (2.1 g/d) of total daily added sugar intake, 1.6% (9.3 mg/d) of total daily sodium intake, and 0.39% (0.06 g/d) of total daily saturated fat intake.

For toddlers (12 to 15 months), all snack foods accounted for 40.0% (4.8 g/d) of total daily added sugar intake, 7.2% (80.8 mg/d) of total daily sodium intake, and 3.1% (0.52 g/d) of total daily saturated fat intake. Results by snack food category revealed that sweet and salty snack foods accounted for 17.5% (2.1 g/d) of total daily added sugar intake, 6.4% (71.1 mg/d) of total daily sodium intake, and 2.7% (0.45 g/d) of total daily saturated fat intake. Commercial baby snack foods accounted for 22.5% (2.7 g/d) of total daily added sugar intake, 0.87% (9.7 mg/d) of total daily sodium intake, and 0.41% (0.07 g/d) of total daily saturated fat intake.

### Associations between the Frequency of and Energy from Daily Snack Food Intake and Overconsumed Nutrients.

Table 3 presents unadjusted and adjusted multivariable regression models for associations between the frequency of (times/d) and energy from (kcal/d) daily snack food intake with overconsumed nutrients and child WFL z-scores. For all children (n = 141), associations between the frequency of sweet and salty snack food intake and added sugars (B = 3.20, SE

= 1.37, $p = 0.02$), sodium (B = 282.96, SE = 50.88, $p < 0.0001$), and saturated fats (B = 1.22, SE = 0.59, $p = 0.04$) were statistically significant in adjusted models. Meaning that for every 1 time/d increase in the frequency of sweet and salty snack food intake, added sugars increased by 3.20 g, sodium increased by 282.96 mg and saturated fats increased by 1.22 g. Associations between energy from sweet and salty snack foods and added sugars (B = 0.03, SE = 0.01, $p = 0.04$), sodium (B = 3.26, SE = 0.53, $p < 0.0001$), and saturated fats (B = 0.02, SE = 0.006, $p = 0.001$) were statistically significant in adjusted models. Meaning that for every 1 kcal increase in energy from sweet and salty snack food intake, added sugars increased by 0.03 g, sodium increased by 3.26 mg, and saturated fats increased by 0.02 g.

For all children (n = 141), associations between the frequency of commercial baby snack food intake and sodium (B = −97.56, SE = 47.70, $p = 0.04$) and saturated fats (B = −1.19, SE = 0.50, $p = 0.02$) were statistically significant, but not added sugars, in adjusted models. Meaning that for every 1 time/d increase in the frequency of commercial baby snack food intake, sodium decreased by 97.56 mg and saturated fats decreased by 1.19 g. There were no statistically significant associations observed between energy from commercial baby snack food intake with added sugars, sodium, and saturated fats.

### Associations between the Frequency of and Energy from Daily Snack Food Intake and Child WFL z-scores.

For all children (n = 141), the association between the frequency of sweet and salty snack food intake and child WFL z-scores (B = 0.25, SE = 0.11, $p = 0.02$) was statistically significant in adjusted models. Meaning that for every 1 time/d increase in the frequency of sweet and salty snack food intake, child WFL z-scores increased by 0.25. There was no statistically significant association observed between energy from sweet and salty snack food intake and child WFL z-scores. There were also no statistically significant associations observed between the frequency of or energy from commercial baby snack food intake and child WFL z-scores.

## Discussion

This analysis described daily snack food intake (frequency and total energy) and the associations with overconsumed nutrients (added sugars, sodium, saturated fats) and WFL z-scores among children 9 to 15 months of age. Findings show that the majority of infants (9 to 11 months) and toddlers (12 to 15 months) consumed a sweet and salty snack food or commercial baby snack food each day and these snacks contribute overconsumed nutrients, particularly added sugars and sodium. Findings also show that greater frequency of sweet and salty snack food intake was associated with higher child WFL z-scores. Continued efforts to reduce the intake of these snack foods are critical to support optimal growth and development during this sensitive period.

The current findings are consistent with and add to the existing literature showing that snack food intake begins during infancy.[11,12] In this sample of predominantly White, college-educated caregivers and their children, the majority of infants (90.1%) and toddlers (95.7%) consumed a sweet and salty snack food or commercial baby snack food on a given day. Current findings suggest that snack food intake is higher in this sample compared to other

nationally-representative samples.[11–13] Across all of these studies, the prevalence of snack food consumption in young children is high, and sweet and salty snack foods are notable sources of overconsumed nutrients, therefore additional research is needed to understand the impact of snack foods in the diets of young children.

There is limited research on commercial baby snack foods (e.g., puffs, melts, baby cookies) as a separate category from other foods consumed as snacks in the US.[13,21] Current findings show that infants and toddlers consume commercial baby snack foods less than 1 time/d. However, some children in this sample consumed these snack foods 4 times/d, with infants consuming these foods more frequently than toddlers, although energy contributions are comparable. Understanding the impact of commercial baby snack foods on the development of food preferences in young children would be an important next step, particularly for children who consume these foods more frequently. On the other hand, toddlers consume sweet and salty snack foods more frequently and consume greater energy from these foods compared to infants. These findings suggest that there is a shift from commercial baby snack foods to sweet and salty snack foods designed for adults as infants transition to toddlerhood.

The first two years of life are a period of rapid growth and development with high nutritional needs, which leaves little room for discretionary foods and beverages that are high in energy and overconsumed nutrients and may displace nutrient-dense foods.[39,40] Although the current findings that sweet and salty snack foods and commercial baby snack foods contribute little energy (5.6% for infants, 8.8% for toddlers), these snack foods contribute added sugars and sodium, which are recommended to avoid during this developmental period.[2,3] Additionally, food pattern modeling conducted by Dewey et al. suggests that there is little room for discretionary foods in the diets of young children, echoing recommendations to avoid added sugars before 2 years of age.[40] Current findings that snack foods contain overconsumed nutrients are consistent with recent studies showing that many commercially available baby snack foods contain added sugars and sodium.[15,17] In addition, adult foods such as cookies, cakes, and chips that are offered to infants as snacks often contain added sugars, sodium, and saturated fats. This study targeted sweet and salty snack foods and commercial baby snack foods, and thus it is unknown what other foods in the diets of young children in this sample contribute overconsumed nutrients. For example, a recent analysis of data from this sample found that the top five sources of added sugars in infant diets include other foods such as yogurt, ready-to-eat cereals, and mixed dishes[23] that were not included in this analysis. However, current findings that sweet and salty snack foods and commercial baby snack foods are sources of overconsumed nutrients are concerning, creating a need to optimize infant diets by reducing the intake of these snacks, particularly energy-dense sweet and salty snack foods.

Although research on snack food intake among young children is limited, greater intake of energy-dense snack foods has been associated with increased weight trajectories among infants from families with low-incomes.[21] In line with the *a priori* hypothesis, the frequency of sweet and salty snack food intake was associated with higher child WFL z-scores. However, in contrast with the *a priori* hypothesis, no association between energy from sweet and salty snack food intake and child WFL z-scores was observed. This finding may be related to caregivers offering their children smaller portions of these snack foods, which

contribute less energy, more frequently throughout the day. In addition, no associations between the frequency of and energy from commercial baby snack food intake and child WFL z-scores were observed. This finding may be related to differences in the energy density (kcal/g) of these snack foods, suggesting that commercially available baby snack foods may not contribute enough discretionary energy to impact child weight. In addition, these findings are cross-sectional, and thus it is unknown how these snack foods impact child weight across time and how other unmeasured factors might impact weight.

This study has several strengths including the use of three 24-hour dietary recalls to examine child snack food intake as well as the use of child recumbent length and weight measurements collected by trained researchers. However, this study is not without limitations. The sample included predominantly White female participants with high socioeconomic status from one geographic location, which limits generalizability to diverse groups that have historically been excluded or underrepresented in health research. Designing and conducting inclusive health research with people from diverse racial and ethnic groups, socioeconomic backgrounds, and gender identities is essential to help reduce health disparities. Most children were breastfed beyond 6 months of age and introduced to solid foods after 4 months of age, and thus results may differ in other groups without these protective factors. Future studies should examine snack food intake in diverse groups and across time. Differences between the current findings and nationally representative samples related to daily snack intake may be reflective of how snacks were defined in each study. For example, in NHANES and FITS 2016, snacks were defined based on eating occasion, whereas in this analysis snacks were defined based on the type of food consumed. Defining snacks based on the type of food consumed (e.g., sweet and salty snack foods, commercial baby snack foods) may exclude other foods that caregivers consider snacks (e.g., sweetened yogurt, ready-to-eat cereals) and that contribute overconsumed nutrients, which is a limitation. Related, the focus on specific types of foods does not take into consideration behavioral aspects of snacking occasions that reflect eating in between meals. Although standard best-practices for dietary data collection and analysis were followed, caregivers may have overestimated food and beverage intakes for their children.[41] Most caregivers found it difficult to identify times and eating occasions (e.g., a meal versus a snack) for their young children, who have five or more eating occasions each day, and thus it is unknown if they would identify these foods as snacks. However, given that the snack foods included in this analysis contribute overconsumed nutrients and are associated with infant higher WFL z-scores, examining these foods independently was warranted.

## Conclusion

Findings from this study reveal that infants and toddlers frequently consume snack foods that contribute discretionary energy and overconsumed nutrients, making these snack foods important targets for reducing young children's exposure to nutrients of concern such as added sugars. These findings suggest that additional research is needed to understand household and individual factors that influence energy-dense snack food intake during this early developmental period. Finally, additional recommendations may also be needed to help caregivers select nutrient-dense snacks for their young children.

## Acknowledgments:

All authors would like to thank the caregivers and their children who participated in this study and the researchers who were responsible for data collection and curation. This would not have been possible without you, thank you.

### Funding/Financial Disclosures:

This work was supported by a grant from the National Institute on Child Health and Human Development of the NIH (grant number: R01HD087082-01).

## References

1. Young BE, Krebs NF. Complementary feeding: Critical considerations to optimize growth, nutrition, and feeding behavior. Curr Pediatr Rep. 2013;1(4):247–256. doi:10.1007/s40124-013-0030-8 [PubMed: 25105082]
2. American Academy of Pediatrics. Pediatric Nutrition. 8th ed. (RE K, Greer F, eds.). Itasca, IL: American Academy of Pediatrics; 2019.
3. U.S. Department of Agriculture and U.S Department of Health and Human Services. Dietary Guidelines for Americans, 2020–2025. 9th ed. December 2020. Available at DietaryGuidelines.gov.
4. Birch LL, Doub AE. Learning to eat: Birth to age 2 y. Am J Clin Nutr. 2014;99(3). doi:10.3945/ajcn.113.069047
5. Anzman-Frasca S, Ventura AK, Ehrenberg S, Myers KP. Promoting healthy food preferences from the start: A narrative review of food preference learning from the prenatal period through early childhood. Obes Rev. 2018;19(4):576–604. doi:10.1111/obr.12658 [PubMed: 29266778]
6. Savage JS, Fisher JO, Birch LL. Parental influences on eating behavior: Conception to adolescence. J Law Med Ethics. 2007;35(1):22–34. doi:10.1111/j.1748-720X.2007.00111.x [PubMed: 17341215]
7. Birch LL, Arbor A, Savage JS, Ventura A. Influences on the development of children's eating behaviours: From infancy to adolescence. Can J Diet Pr Res. 2009;68(1):1–11. doi:10.1097/MD.0000000000000215
8. Grimm KA, Kim SA, Yaroch AL, Scanlon KS. Fruit and vegetable intake during infancy and early childhood. Pediatrics. 2014;134:S63–S69. doi:10.1542/peds.2014-0646K [PubMed: 25183758]
9. Rose CM, Birch LL, Savage JS. Dietary patterns in infancy are associated with child diet and weight outcomes at 6 years. Int J Obes. 2017;41(5):783–788. doi:10.1038/ijo.2017.27
10. Lioret S, McNaughton SA, Spence AC, Crawford D, Campbell KJ. Tracking of dietary intakes in early childhood: The Melbourne InFANT Program. Eur J Clin Nutr. 2013;67(3):275–281. doi:10.1038/ejcn.2012.218 [PubMed: 23321573]
11. Miles G, Siega-Riz AM. Trends in food and beverage consumption among infants and toddlers: 2005–2012. Pediatrics. 2017;139(6). doi:10.1542/peds.2016-3290
12. Deming DM, Reidy KC, Fox MK, Briefel RR, Jacquier E, Eldridge AL. Cross-sectional analysis of eating patterns and snacking in the US Feeding Infants and Toddlers Study 2008. Public Health Nutr. 2017;20(9):1584–1592. doi:10.1017/S136898001700043X [PubMed: 28318482]
13. Roess AA, Jacquier EF, Catellier DJ, et al. Food consumption patterns of infants and toddlers: Findings from the Feeding Infants and Toddlers Study (FITS) 2016. J Nutr. 2018;148(9):1525S–1535S. doi:10.1093/jn/nxy171 [PubMed: 30247583]
14. Maslin K, Venter C. Nutritional aspects of commercially prepared infant foods in developed countries: A narrative review. Nutr Res Rev. 2017;30(1):138–148. doi:10.1017/S0954422417000038 [PubMed: 28462729]
15. Maalouf J, Cogswell ME, Bates M, et al. Sodium, sugar, and fat content of complementary infant and toddler foods sold in the United States, 2015. Am J Clin Nutr. 2017;105(6):1443–1452. doi:10.3945/ajcn.116.142653 [PubMed: 28424192]
16. Moding KJ, Ferrante MJ, Bellows LL, Bakke AJ, Hayes JE, Johnson SL. Nutritional content and ingredients of commercial infant and toddler food pouches compared with other packages available in the United States. Nutr Today. 2019;54(6):305–312. doi:10.1097/nt.0000000000000385 [PubMed: 32655191]

17. Reidy KC, Bailey RL, Deming DM, et al. Food consumption patterns and micronutrient density of complementary foods consumed by infants fed commercially prepared baby foods. Nutr Today. 2018;53(2):68–78. doi:10.1097/NT.0000000000000265 [PubMed: 29706668]
18. Kachurak A, Davey A, Bailey RL, Fisher JO. Daily snacking occasions and weight status among US children aged 1 to 5 years. Obesity. 2018;26(6):1034–1042. doi:10.1002/oby.22172 [PubMed: 29656571]
19. Kral TVE, Chittams J, Moore RH. Relationship between food insecurity, child weight status, and parent-reported child eating and snacking behaviors. J Spec Pediatr Nurs. 2017;22(2):1–11. doi:10.1111/jspn.12177
20. Rudy E, Bauer KW, Hughes SO, et al. Interrelationships of child appetite, weight and snacking among Hispanic preschoolers. Pediatr Obes. 2018;13(1):38–45. doi:10.1111/ijpo.12186 [PubMed: 27780312]
21. Moore AM, Vadiveloo M, Tovar A, McCurdy K, Østbye T, Benjamin-Neelon SE. Associations of less healthy snack food consumption with infant weight-for-length z-score trajectories: Findings from the Nurture Cohort study. Nutrients. 2019;11(11):2752. doi:10.3390/nu11112752
22. Kachurak A, Bailey RL, Davey A, Dabritz L, Fisher JO. Daily snacking occasions, snack size, and snack energy density as predictors of diet quality among us children aged 2 to 5 years. Nutrients. 2019;11(7):1–12. doi:10.3390/nu11071440
23. Kong KL, Burgess B, Morris KS, Faith MS, Paluch RA. High intake of added sugars is linked to rapid weight gain in infancy, breastfeeding ≥12 months may protect against this: A preliminary investigation. Pediatr Obes. 2021;16(3):1–9. doi:10.1111/ijpo.12728
24. Institutes of Medicine. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington, D.C.: National Academies Press; 2005. doi:10.17226/10490
25. Piernas C, Popkin BM. Trends in snacking among U.S. children. Health Aff. 2010;29(3):398–404. doi:10.1377/hlthaff.2009.0666
26. Charvet A, Hartlieb KB, Yeh Y, Jen KLC. A comparison of snack serving sizes to USDA guidelines in healthy weight and overweight minority preschool children enrolled in Head Start. BMC Obes. 2016;3(1). doi:10.1186/S40608-016-0116-2
27. Fein SB, Labiner-Wolfe J, Shealy KR, Li R, Chen J, Grummer-Strawn LM. Infant feeding practices study II: Study methods. Pediatrics. 2008;122(SUPPL. 2). doi:10.1542/peds.2008-1315c
28. Briefel RR, Kalb LM, Condon E, et al. The Feeding Infants and Toddlers Study 2008: Study design and methods. J Am Diet Assoc. 2010;110(12). doi:10.1016/j.jada.2010.09.005
29. Raper N, Perloff B, Ingwersen L, Steinfeldt L, Anand J. An overview of USDA's Dietary Intake Data System. J Food Compos Anal. 2004;17(3–4):545–555. doi:10.1016/j.jfca.2004.02.013
30. Nutrition Coordinating Center. Nutrition Data System for Research 2019 User Manual. Minneapolis; 2019.
31. Ziegler P, Briefel R, Clusen N, Devaney B. Feeding Infants and Toddlers Study (FITS): Development of the FITS survey in comparison to other dietary survey methods. J Am Diet Assoc. 2006;106(1 SUPPL.). doi:10.1016/j.jada.2005.09.033
32. Institute of Medicine. Dietary Reference Intakes (DRIs): Estimated Average Requirements. Washington, DC: National Academies Press; 2011.
33. Harris JL, Fleming-Milici F, Frazier W, et al. Baby Food FACTS: Nutrition and Marketing of Baby and Toddler Food and Drinks; 2017.
34. U.S. Department of Agriculture ARS. What We Eat in America food categories: 2017–2018. https://www.ars.usda.gov/ARSUserFiles/80400530/pdf/1718/food_category_list.pdf
35. de Onis M, Garza C, Victora CG, Onyango AW, Frongillo EA, Martines J. The WHO Multicentre Growth Reference Study: Planning, study design, and methodology. Food Nutr Bull. 2004;25(1 SUPPL. 1):15–26. doi:10.1177/15648265040251s104
36. Weng SF, Redsell SA, Swift JA, Yang M, Glazebrook CP, Glazebrook C. Systematic review and meta-analyses of risk factors for childhood overweight identifiable during infancy. doi:10.1136/archdischild-2012
37. SAS Software. Version 9.4 of the SAS System for Windows. Cary, NC: SAS Institute Inc.; 2015.
38. Systat Software. Version 11. San Jose, CA: Systat Software, Inc.; 2004.

39. English LK, Obbagy JE, Wong YP, et al. Types and amounts of complementary foods and beverages consumed and growth, size, and body composition: A systematic review. Am J Clin Nutr. 2019;109(7):956S–977S. doi:10.1093/ajcn/nqy281 [PubMed: 30982866]

40. Dewey KG, Pannucci TR, Casavale KO, et al. Development of food pattern recommendations for infants and toddlers 6–24 months of age to support the dietary guidelines for Americans, 2020–2025. J Nutr. 2021;151(10):3113–3124. doi:10.1093/jn/nxab201 [PubMed: 34195834]

41. Fisher JO, Butte NF, Mendoza PM, et al. Overestimation of infant and toddler energy intake by 24-h recall compared with weighed food records. Am J Clin Nutr. 2008;88:407–415. doi:10.3945/ajcn.2008.27309 [PubMed: 18689377]

## Research Snapshot

**Research Question:**

How does the frequency of and energy from snack food intake relate to the intake of overconsumed nutrients and weight among infants and toddlers?

**Key Findings:**

Snack foods are frequently consumed and are contributors of overconsumed nutrients in the diets of infants and toddlers. Greater frequency of, but not energy from, sweet and salty snack food intake was associated with higher child WFL z-scores. No association between commercial baby snack food intake and child WFL z-scores was observed.

**Table 1.**

Demographics of 141 caregivers and their children participating in an ongoing longitudinal intervention designed to explore motivation to eat in young children.

| **Caregivers** | **n** | **Result** |
|---|---|---|
| Age (years), mean ± SD | | 32.6 ± 4.4 |
| Sex (female), n (%) | | 141 (100) |
| Prepregnancy BMI (kg/m$^2$)[a], mean ± SD | 140 | 28.3 ± 7.2 |
| Baseline BMI (kg/m$^2$)[a], mean ± SD | | 30.7 ± 7.7 |
| Race and ethnicity, n (%) | 137 | |
| American Indian | | 2 (1.4) |
| Asian | | 2 (1.4) |
| Black | | 5 (3.7) |
| White, non-Hispanic | | 122 (89.1) |
| Multiracial | | 6 (4.4) |
| Education, n (%) | 139 | |
| High school diploma or some college | | 22 (15.8) |
| College graduate | | 117 (84.2) |
| Parity, mean ± SD | | 1.6 ± 0.98 |
| Household size, mean ± SD | 135 | 3.7 ± 0.95 |
| **Child** | | |
| Baseline age (months), mean ± SD | | 11.9 ± 1.9 |
| Sex (female), n (%) | | 78 (55.3) |
| Birth weight (kg), mean ± SD | | 3.5 ± 0.53 |
| Birth WFL z-score[b], mean ± SD | | −0.79 ± 1.5 |
| Baseline weight (kg), mean ± SD | | 9.4 ± 1.2 |
| Baseline length (cm), mean ± SD | | 73.0 ± 3.8 |
| Baseline WFL z-score[b], mean ± SD | | 0.57 ± 0.86 |
| High WFL (WHO > 97.7), n (%)[b] | | 41 (29.1) |
| Breastfeeding duration (months), mean ± SD | | 7.7 ± 4.6 |
| Solid food introduction (age in months), mean ± SD | | 5.3 ± 1.0 |

[a]BMI, body mass index

[b]WFL, weight-for-length; Calculated using WHO reference standards.[35]

**Table 2.**

Means for the frequency (times/d), energy (kcal/d), and overconsumed nutrients from all foods and beverages and daily snack food intake at baseline among children participating in an ongoing intervention (n = 141).[a]

| | Infants, 9 to 11 months (n = 71) | | Toddlers, 12 to 15 months (n = 70) | |
|---|---|---|---|---|
| | **Mean ± SD** | **Range** | **Mean ± SD** | **Range** |
| **Frequency** | | | | |
| Snack foods (times/d)[b] | 1.2 ± 0.92 | 0 – 4.3 | 1.4 ± 1.1 | 0 – 5.7 |
| Sweet and salty snack foods (times/d)[c] | 0.35 ± 0.55 | 0 – 2.3 | 0.74 ± 0.75 | 0 – 3.7 |
| Commercial baby snack foods (times/d)[d] | 0.84 ± 0.79 | 0 – 3.0 | 0.62 ± 0.77 | 0 – 4.3 |
| **Energy** | | | | |
| Total energy (kcal/d)[e] | 839 ± 199 | 483 – 1499 | 990 ± 221 | 542 – 1498 |
| Total energy from snack foods (kcal/d)[b] | 47 ± 65 | 0 – 369 | 88 ± 102 | 0 – 611 |
| Sweet and salty snack foods (kcal/d)[c] | 24 ± 49 | 0 – 312 | 60 ± 74 | 0 – 360 |
| Commercial baby snack foods (kcal/d)[d] | 23 ± 41 | 0 – 276 | 28 ± 58 | 0 – 420 |
| **Overconsumed Nutrients** | | | | |
| **All foods and beverages** [e] | | | | |
| Added sugars (g/d) | 15.3 ± 14.6 | 0 – 53.6 | 12.0 ± 8.9 | 0 – 39.3 |
| Sodium (mg/d) | 582.3 ± 395.1 | 107.0 – 1758.0 | 1118.6 ± 455.8 | 373.0 – 2866.0 |
| Saturated fats (g/d) | 15.4 ± 3.4 | 6.9 – 22.4 | 16.9 ± 5.2 | 6.8 – 34.9 |
| **Sweet and salty snack foods** [c] | | | | |
| Added sugars (g/d) | 0.90 ± 1.8 | 0 – 8.6 | 2.1 ± 3.5 | 0 – 17.2 |
| Sodium (mg/d) | 30.4 ± 68.1 | 0 – 446.6 | 71.1 ± 93.9 | 0 – 458.2 |
| Saturated fats (g/d) | 0.26 ± 0.59 | 0 – 3.6 | 0.45 ± 0.61 | 0 – 3.0 |
| **Commercial baby snack foods** [d] | | | | |
| Added sugars (g/d) | 2.1 ± 3.1 | 0 – 9.9 | 2.7 ± 3.5 | 0 – 18.8 |
| Sodium (mg/d) | 9.3 ± 24.5 | 0 – 168.4 | 9.7 ± 29.0 | 0 – 221.6 |
| Saturated fats (g/d) | 0.06 ± 0.59 | 0 – 1.0 | 0.07 ± 0.22 | 0 – 1.7 |

[a] USDA Automated Multiple-Pass Method (AMPM) was used to collect 24-hour recalls.[29]

[b] Includes all sweet and salty snack foods (e.g., chips, crackers, cakes, cookies) and commercial baby snack foods (e.g., puffs, melts, baby cookies) consumed averaged across three, 24 hour recalls.

[c] Includes only sweet and salty snack foods.

[d] Includes only commercial baby snack foods.

[e] Includes all milks, solid foods, and beverages consumed averaged across three, 24 hour recalls. Estimated energy requirements (EER) vary by child sex and age (males, 9–11 mths.: 746–817 kcal/d, 12–15 mths.: 844–908 kcal/d; females, 9–11 mths.: 678–742 kcal/d; 12–15 mths.: 768–837 kcal/d).[24]

**Table 3.**

Unadjusted and adjusted multivariate regression models for associations between the frequency of (times/d) and energy from (kcal/d) daily snack food intake (sweet and salty snack foods[a] and commercial baby snack foods[b]) with overconsumed nutrients and child WFL[c] z-scores (n = 141).

| | Unadjusted Models | | | Adjusted Models[d] | | |
|---|---|---|---|---|---|---|
| | B[e] | SE[f] | *P* value | B[e] | SE[f] | *P* value |
| **Overconsumed nutrients** | | | | | | |
| **Frequency of sweet and salty snack foods (times/d)** | | | | | | |
| Added sugars (g/d) | 3.31 | 1.49 | **0.03** | 3.20 | 1.37 | **0.02** |
| Sodium (mg/d) | 379.55 | 53.57 | < **0.0001** | 282.96 | 50.88 | < **0.0001** |
| Saturated fats (g/d) | 1.45 | 0.54 | **0.008** | 1.22 | 0.59 | **0.04** |
| **Energy from sweet and salty snack foods (kcal/d)** | | | | | | |
| Added sugars (g/d) | 0.03 | 0.02 | 0.07 | 0.03 | 0.01 | **0.04** |
| Sodium (mg/d) | 4.26 | 0.55 | < **0.0001** | 3.26 | 0.53 | < **0.0001** |
| Saturated fats (g/d) | 0.02 | 0.001 | **0.001** | 0.02 | 0.006 | **0.001** |
| **Frequency of commercial baby snack foods (times/d)** | | | | | | |
| Added sugars (g/d) | 0.85 | 1.32 | 0.52 | −0.32 | 1.20 | 0.79 |
| Sodium (mg/d) | −151.58 | 52.89 | **0.001** | −97.65 | 47.70 | **0.04** |
| Saturated fats (g/d) | −1.32 | 0.47 | **0.001** | −1.19 | 0.50 | **0.02** |
| **Energy from commercial baby snack foods (kcal/d)** | | | | | | |
| Added sugars (g/d) | 0.02 | 0.02 | 0.38 | 0.01 | 0.02 | 0.55 |
| Sodium (mg/d) | 0.10 | 0.85 | 0.91 | −0.83 | 0.71 | 0.25 |
| Saturated fats (g/d) | −0.001 | 0.01 | 0.99 | 0.002 | 0.01 | 0.77 |
| **Child WFL z-scores** | | | | | | |
| Frequency of sweet and salty snack foods/d | 0.17 | 0.11 | 0.10 | 0.25 | 0.11 | **0.02** |
| Energy from sweet and salty snack foods (kcal/d) | 0.001 | 0.01 | 0.86 | 0.009 | 0.01 | 0.42 |
| Frequency of commercial baby snack foods/d | −0.06 | 0.09 | 0.53 | −0.04 | 0.10 | 0.66 |
| Energy from commercial baby snack foods (kcal/d) | 0.002 | 0.01 | 0.18 | 0.001 | 0.01 | 0.07 |

[a] Includes only sweet and salty snack foods (e.g., chips, crackers, cakes, cookies).

[b] Includes only commercial baby snack foods (e.g., puffs, melts, baby cookies).

[c] WFL, weight-for-length

[d] Models adjusted for caregiver's prepregnancy BMI and education, as well as child age, sex, birthweight, breastfeeding duration, and age of solid foods introduction.

[e] B, beta coefficient (defined as the degree of change in the outcome variable for every 1-unit of change in the explanatory variable)

[f] SE, standard error