Received: 4 December 2016 | Accepted: 24 February 2017

DOI: 10.1111/mcn.12454

WILEY | Maternal & Child Nutrition

ORIGINAL ARTICLE

Contribution of snacks to dietary intakes of young children in the United States

Lenka H. Shriver[1] | Barbara J. Marriage[2] | Tama D. Bloch[3] | Colleen K. Spees[4] | Samantha A. Ramsay[5] | Rosanna P. Watowicz[6] | Christopher A. Taylor[4]

[1] Department of Nutrition, University of North Carolina Greensboro, Greensboro, North Carolina, USA

[2] Regulatory Affairs, Abbott Nutrition, Columbus, Ohio, USA

[3] Abbott Nutrition R&D, Columbus, Ohio, USA

[4] Medical Dietetics, The Ohio State University, Columbus, Ohio, USA

[5] University of Idaho, Moscow, Idaho, USA

[6] Case Western Reserve University, Cleveland, Ohio, USA

Correspondence
Christopher A. Taylor, The Ohio State University, 306A Atwell Hall, 453 W 10th Ave, Columbus, OH 43210-1234, USA.
Email: taylor.1043@osu.edu

Funding information
Funded by an unrestricted grant from Abbott Nutrition

Abstract

Nutritional quality of children's diets is a public health priority in the fight against childhood obesity and chronic diseases. The main purpose of this study was to determine contribution of snacks to energy and nutrient intakes and to identify leading snack food sources of energy, total fat, and added sugars amongst young children in the United States. Using the 2005–2012 NHANES data, dietary intakes of 2- to 5-year-old children were analysed from a parent-reported 24-hour dietary recall (n = 3,429). Snacking occasions were aggregated to determine the proportion of total food/beverage intake obtained from snacks, estimate energy, and nutrient intakes, and identify the leading snack food sources of energy, added sugars, and total fat. Nearly all children consumed a snack on the reported day (62% morning, 84% afternoon, and 72% evening). Snacks accounted for 28% of total energy intake, 32% of carbohydrates, 39% of added sugars, and 26% of total fat and dietary fiber intakes for the day. Snacking occasions accounted for 46.6% of all beverages consumed on the reported day. Snacks and sweets food category (i.e., cookies and pastries) were the leading sources of energy (44%), total fat (52%), and added sugars (53%) consumed during snacking occasions. Sweetened beverages (e.g., fruit and sport drinks) contributed 1-quarter of all added sugars obtained from snacks. Snacks contribute considerable amount of energy and nutrients to young children's diets, with a heavy reliance on energy-dense foods and beverages. Targeted interventions are needed to improve the nutritional quality of snacks consumed by young children.

KEYWORDS

children, dietary intake, NHANES, snacking, what we eat in America

1 | INTRODUCTION

Eating habits and taste preferences that are developed during early childhood track over time and influence an individuals' diet quality in the later years (Birch & Fisher, 1998). Given the increased prevalence of childhood obesity over the last several decades, with only the most recent estimates indicating decreased obesity rates amongst 2–5 year olds, optimizing children's dietary intakes early in life continue to be a public health priority in the United States (Ogden, Carroll, Kit, & Flegal, 2014). A number of nutrition-related behaviors likely contributed to the rising energy imbalance problems amongst American children since the 1970s, including larger portion sizes (Piernas & Popkin, 2011), fewer family meals (Neumark-Sztainer, Wall, Fulkerson, & Larson, 2013), eating more meals/snacks away from home (Poti & Popkin, 2011), and more frequent consumption of energy-dense snacks (Larson & Story, 2013; Piernas & Popkin, 2010).

Snacking with nutrient dense foods between meals is recommended by many nutrition professionals as part of healthy weight management and obesity prevention programs (Keast, Nicklas, & O'Neil, 2010; Larson & Story, 2013; Ma et al., 2003). The recommendation to include snacks extends to children as well, with current American Academy of Pediatrics recommends that children consume three meals and two snacks per day (American Academy of Pediatrics, Committee on Nutrition, 2013). Studies in adults have shown beneficial effects of more frequent eating occasions on appetite control, satiety, and energy intake throughout the day (Leidy & Campbell, 2011; Smeets & Westerterp-Plantenga, 2008). Snacking also has shown to have a favourable impact on obesity risk and/or

overall diet quality in youth (Evans, Jacques, Dallal, Sacheck, & Must, 2014; Keast et al., 2010). For instance, Keast et al. (2010) found that 12- to 18-year-old "snackers" were less likely to be overweight or obese and suffer from abdominal obesity than their "nonsnacking" peers. Similarly, snacking has been linked to better overall diet quality amongst school-aged children as well as older women (Evans et al., 2014; Kong et al., 2011). In a 12-month randomised controlled intervention by Kong et al. (2011), mid-morning snackers lost significantly more weight than those who did not snack and also indicated greater intakes of dietary fiber, fruits, and vegetables. The study suggested that snacking might be a source of dietary fiber, fruits, and vegetables.

Experts agree that the impact of snacking on children's weight status depends largely on the quality of the snack foods and beverages consumed by children. Further, the composition of snacks ultimately determines the impact of snacking on weight and nutritional status of children (Larson & Story, 2013; Shroff et al., 2013). Although the 2010 and 2015–2020 Dietary Guidelines for Americans in the United States do not include specific guidelines for snacking frequency, the latest recommendations continue to emphasise the importance of consuming fruit and vegetables, non-fat or low-fat dairy, and whole grains as part of a healthy diet. These recommendations also stress the need to minimise consumption of discretionary calories from sweetened foods and beverages as well as foods high in saturated and trans fats across the lifespan (Malik, Popkin, Bray, Després, & Hu, 2010; USDA & DHHS, 2010). Unfortunately, consuming nutrient-dense foods has become increasingly more difficult in today's obesogenic environment (Birch & Anzman, 2010; Roblin, 2007).

The number of snacking occasions and energy contribution of snacks has increased amongst children since 1970s (Popkin & Duffey, 2010). The greatest increases in snacking were observed amongst young children (Piernas & Popkin, 2010). Early childhood is a time period of dramatic physical growth and development in addition to cognitive development that requires optimal dietary intakes of energy as well as a variety of nutrients (Ogata & Hayes, 2014). Thus, it is essential to better understand snacking patterns amongst young children in the United States. The purpose of this study was to examine snacking patterns, determine overall contribution of children's snacks to energy and nutrient intakes, and to identify food categories and foods/beverages that represent leading sources of energy, total fat, and added sugars during snacking occasions amongst 2- to 5-year-old children in the United States.

Key messages

- Snacking contributes slightly over 28% of total energy to preschool-aged children in the United States, with afternoon snacks being the greatest contributor of energy, added sugars, and solid fats.
- Sweet bakery products and sweetened beverages provide the greatest amount of added sugars to children's diet, with sweet bakery products also representing the leading contributor to total energy and total dietary fat.
- Nutrition interventions should specifically target snacking occasions to include more nutrient-dense foods, such as non-fat dairy and fruit and vegetables to improve children's overall diet quality.
- "Mini-meals" that are nutrient dense rather than processed snack foods, baked sweets, and sweetened beverages should be offered to young children at snack times.

2 | METHODS

2.1 | Sample population

Dietary intake data from 2- to 5-year-old children from the 2005–2012 National Health and Nutrition Examination Surveys (NHANES 1999–2012) was analysed to evaluate the type of foods and food categories, and the contribution of key nutrients from snacking occasions to overall dietary intake of preschool-aged children in the United States. Data from public use files were obtained from the Center for Disease Control and Prevention National Center for Health Statistics and prepared for analysis. Data were collected from the noninstitutionalised population using a multistage stratified sampling technique to select participants (Centers for Disease Control and Prevention, 2009). In the overall NHANES data collection design, young children, adolescents, low-income persons, African Americans, and Mexican Americans were oversampled to support a greater statistical capability to assess difficult-to-reach populations (Centers for Disease Control and Prevention, 2009). For the current study, data from three 2-year NHANES data-collection cycles were aggregated to create a 6-year dataset (2005–2006, 2007–2008, 2009–2010, and 2011–2012). The National Center for Health Statistics' Research Ethics Review Board reviewed and approved all data collection protocols.

2.2 | Participants

Children aged 2–5 years with valid and reliable dietary intake data were included in the dataset to examine snacking patterns and snack food contributions to overall dietary intake in the sample (Anand, Raper, & Tong, 2006; Centers for Disease Control and Prevention, 2009). Personal and demographic characteristics, including age, gender, race/ethnicity, and household income, were obtained from the children's parents during in-person interviews. Dietary intakes were estimated from one 24-hr recall that was collected in the mobile examination center. The US Department of Agriculture's (USDA) Automated Multiple Pass Approach was employed to estimate children's dietary intakes (Moshfegh et al., 2008). Interviewers were trained to collect the specific foods and corresponding quantities and eating occasion (meals and snacks) for all foods and beverages consumed from midnight-to-midnight of the prior day. Due to the young age of children in our sample, adult proxies (i.e., parents in most cases) familiar with the

children's diet reported the child's dietary intakes. The procedures related to the dietary data collection during the NHANES cycles, including validity and reliability checks, are described in detail elsewhere (Centers for Disease Control and Prevention, 2009).

2.3 | Study variables: definition of snacking, snack foods, and snack food categories

Foods and beverages were categorised as snacks based on parental self-designation of the specific foods that were consumed as snacks by the child outside of the main meals that were described as breakfast, lunch, or dinner/supper. Details about each eating occasion were collected from adult proxies to identify the day of the week, time of day, the name of eating occasion (meal), the source of food, and whether the foods were eaten at home. The number of snacking occasions was determined by assessing differences in the reported time of day for each snacking occasion in the sample. The snacking occasions were recoded into three discrete snacking time periods: morning snacks (2:00–11:59 am), afternoon snacks (12:00–5:59 pm), and evening snacks (6:00–1:59 am). Children were stratified into snack consumers for the total day and the three snacking time periods when they reported foods as snacks.

For us to generate meaningful groupings of the foods and beverages reported as snacks, the individual foods reported were classified into food categories using the What We Eat in America (WWEIA) food categories (USDA, Agricultural Research Service, 2015). The What We Eat in America food categories with corresponding subcategories included grains (e.g., cooked grains; breads/rolls/tortillas; quick breads and bread products; ready-to-eat cereal; and cooked cereal); snacks and sweets (e.g., savory snacks, crackers, snack meals/bars, sweet bakery products, candy, and other desserts); fruit; vegetables; milk and dairy; protein foods (e.g., meats, poultry, and seafood); mixed dishes (e.g., grain-based like pizza, macaroni and cheese, and meat/poultry-based); beverages (e.g., 100% juices; diet beverages; sweetened beverages, includes soft drinks and sport drinks); fats and oils; condiments and sauces; and sugars.

To estimate the contribution of snacks to children's total intakes for the day, the sum of energy, total fat, added sugars, and nutrient intakes was aggregated across all snacks for the day, each snack time period as well as by each snacking food category. Estimation of nutrient intakes was computed based on the individual foods reported by parents using the Food and Nutrition Database for Dietary Surveillance Surveys (USDA, Agricultural Research Service, 2014; Montville et al., 2013) and the Food Patterns Equivalents Database (Bowman et al., 2013). The nutrients obtained per 100 kcal of snacks consumed by children were computed to estimate nutrient density of overall snacks and across each snacking time period for the overall sample.

2.4 | Statistical analysis

Snacking patterns in the sample were assessed utilising descriptive statistics (i.e., frequencies, means, and percentages). The proportion of children consuming a snack(s) was estimated for the day as well as across the three snacking time periods. Mean (95% CI) per capita intakes of volume (in grams), energy (kilocalories/kcal), and nutrient intakes (grams or milligrams) were computed across all snacking occasions and for each of three snacking time periods (morning, afternoon, and evening snacks). The mean proportion of the total day's dietary volume, energy, and nutrient intake obtained from snacks was estimated. The nutrient density (per 100 kcal) of snacks and the nutrient contributions of beverages and solid food consumed as snacks were also computed. Average nutrient content per snacking occasion was computed per child using the following formula.

$$\%\text{of total day nutrient intake from snacks} = \left(\frac{\sum(\textit{nutrient from snacking occasions})}{\sum(\textit{nutrient from all foods})}\right)$$

To assess which types of foods were contributing to most to snacking intakes, the proportions of energy, total fat, and added sugar from snacks obtained from the USDA food categories were used to determine the leading food sources of snack intakes using the following formula.

$$\%\text{of nutrient from snacks per food category} = \left(\frac{\sum(\textit{nutrient from each food category})}{\sum(\textit{nutrient from all foods from snacks})}\right)$$

Data were downloaded and imported into SPSS (version 24, IBM SPPS Inc, Chicago, IL) for tabulation. To account for the complex sampling design employed in data collection, SPSS Complex Samples (version 24, IBM SPSS Inc, Chicago, IL) was used for statistical analyses. The sample weights provided by CDC were used to generate population-based estimates, whereas SPSS Complex Samples produced sample-appropriate standard errors for minimising type 1 error. Data are presented as means (95% confidence interval) for nutrient intakes.

3 | RESULTS

Complete dietary intake data were obtained and included in the final analyses from a total of 3,429 children 2–5 years of age. Nearly all children (97.5%) consumed at least one snack on the reported day, with the greatest number of children consuming a snack in the afternoon (morning, 62%; afternoon, 84%; and evening, 72%). Children snacked approximately 3.3 times on the reported day (range of 0–13).

The detailed nutritional contribution of snacks to children's total dietary intakes is presented in Table 1. Reported snacks contributed more than one-quarter of total energy intake (28.4%), with children consuming approximately 450 kcal through snacks. Of the children's total nutrient intakes for the day of record, snacks contributed 32.0% of total carbohydrate (70 g), 26.1% of total fat (15.0 g), 27% of saturated fat (5.8 g), 25.7% of dietary fiber (2.9 g), and 32.8% of vitamin C (33.2 mg). Snacks accounted for nearly 40% (22 g) of total added sugars and 29.1% of solid fat (8.9 g) to children's total intake on the recalled day. Foods/beverages that were consumed for snacks did not contribute considerable amounts of protein, folate, or iron to children's total intakes for the day (≤20% of total intakes; Table 1). Examination of mean intakes by snacking time period revealed that afternoon snacks contained the greatest amounts of energy, carbohydrates, protein, fiber, potassium, and vitamin C but also the highest amounts of added sugars, total and solid fats, and sodium (Table 1). Nearly half (47%) of total beverages (excluded water but included sweetened drinks) consumed by children on the reported day were

TABLE 1 Total mean intakes (95% confidence intervals) from snack occasions and the proportion of the Total Day's intakes from snacks among 2–5 Year old children, 2005–2012 (n = 3,429)

	Total snacks		Snacking time Period[a]		
Intakes	Mean (95% CI)	% of total day's intake[b]	Morning Mean (95% CI)	Afternoon Mean (95% CI)	Evening Mean (95% CI)
Total volume (g)	675 (645, 705)	37.2	271 (250, 291)	245 (230, 261)	159 (148, 170)
Beverage intake (g)	522 (494, 551)	46.6	242 (221, 263)	167 (153, 181)	113 (104, 123)
Solid food intake (g)	152 (145, 160)	21.5	28.6 (25.5, 31.8)	78.3 (73, 83.5)	45.6 (41.2, 50)
Energy (kcals)	451 (433, 468)	28.4	105 (95, 114)	208 (197, 219)	138 (128, 149)
Protein (g)	11.0 (10.2, 11.8)	19.5	2.6 (2.2, 2.9)	4.6 (4.2, 5.1)	3.8 (3.4, 4.2)
Carbohydrate (g)	70.1 (67.4, 72.8)	32.0	17.3 (15.8, 18.9)	32.7 (31, 34.3)	20.1 (18.7, 21.6)
Added sugar (g)	22.0 (21.0, 23.1)	39.4	4.3 (3.8, 4.8)	10.5 (9.7, 11.4)	7.2 (6.5, 7.9)
Fiber (g)	2.9 (2.8, 3.1)	25.7	0.66 (0.61, 0.72)	1.4 (1.3, 1.6)	0.82 (0.74, 0.90)
Total fat (g)	15.0 (14.1, 15.9)	26.1	3.0 (2.7, 3.4)	7.0 (6.5, 7.5)	5.0 (4.5, 5.5)
Saturated fat (g)	5.8 (5.4, 6.3)	27.0	1.2 (1, 1.4)	2.5 (2.3, 2.7)	2.1 (1.9, 2.4)
Solid fats (g)	8.9 (8.3, 9.6)	29.1	1.8 (1.5, 2.0)	3.9 (3.6, 4.3)	3.2 (2.8, 3.6)
Vitamin C (mg)	33.2 (29.9, 36.4)	32.8	11.2 (8.9, 13.6)	15 (13.5, 16.5)	6.9 (6.0, 7.8)
Iron (mg)	2.3 (2.2, 2.4)	20.1	0.56 (0.49, 0.62)	1.1 (1.0, 1.2)	0.65 (0.57, 0.72)
Sodium (mg)	434 (407, 460)	19.2	95.3 (85.1, 105.5)	213 (192, 234)	125 (114, 137)
Potassium (mg)	569 (537, 600)	26.6	153 (136, 170)	237 (222, 252)	178 (163, 194)
Vitamin A (RAE)	128 (116, 139)	21.3	32.6 (26.9, 38.3)	46.9 (40.7, 53.1)	48.3 (42.4, 54.2)
Dietary Folate equivalents (ug)	79.6 (74.4, 84.9)	19.3	20.6 (18.1, 23.1)	35.5 (32.6, 38.4)	23.6 (19.1, 28)

[a]Morning snack: 2 am-11:59 am; Afternoon snack: noon-5:59 pm; Evening snack: 6 pm-1:59 am

[b]Percent of the total day was computed as the sum of the nutrient consumed from foods/beverages at snacking occasions divided by the total amount consumed across the full day of intake

consumed as part of a snack, with the highest consumption during the morning snacks (Table 1).

The nutrient density of snacks (nutrient/100 kcal) by snacking time period is presented in Table 2. Morning snacks were most nutrient-dense in regard to vitamin C, folate, and potassium and also lowest in added sugar. In contrast, evening snacks were higher in total, saturated, and solid fats per 100 kcal than snacks in the morning and afternoon (Table 2). The afternoon snacks contributed lower energy-adjusted amounts of protein, potassium, fiber, and vitamin A than snacks at other times of the day (Table 2).

Proportional contribution of food categories to total snack grams, energy, added sugars, and fat intakes is presented in Figure 1. The leading contributor of total snack energy (44%), total fat (52%), and added sugar (53%) obtained during snacking occasions was items from the Snacks and Sweets category. The items from the milk and dairy category represented the second leading source of energy and total fat from all snacks (Figure 1). Nonalcoholic beverages represented the second leading contributor of added sugars through snacks. Other food categories (e.g., fruit, vegetables, and protein foods) did not represent a significant proportion of snacks by volume, energy, or nutrients (Figure 1).

TABLE 2 Mean (95% CI) nutrient density (per 100 kcals) by snack time periods among 2–5 Year old children, 2005–2012 (n = 3,264)[a]

		Snacking time period		
Nutrient per 100 kcals	Total	Morning	Afternoon	Evening
Protein (g)	2.3 (2.2, 2.4)	2.3 (2.1, 2.4)	2.1 (2.0, 2.2)	2.7 (2.5, 2.8)
Carbohydrate (g)	16.2 (16.0, 16.5)	17.7 (17.2, 18.1)	16.8 (16.5, 17.1)	15.7 (15.4, 16.1)
Added sugar (g)	4.9 (4.7, 5.2)	4.0 (3.7, 4.3)	5.1 (4.8, 5.4)	5.2 (4.8, 5.6)
Fiber (g)	0.73 (0.69, 0.77)	0.87 (0.75, 1.00)	0.83 (0.77, 0.89)	0.70 (0.64, 0.76)
Total fat (g)	3.1 (3.0, 3.2)	2.5 (2.4, 2.7)	3.0 (2.9, 3.1)	3.2 (3.1, 3.3)
Saturated fat (g)	1.2 (1.1, 1.2)	0.95 (0.87, 1.03)	1.1 (1.0, 1.1)	1.4 (1.3, 1.4)
Solid fats (g)	1.8 (1.7, 1.9)	1.4 (1.3, 1.6)	1.6 (1.6, 1.7)	2.0 (1.9, 2.2)
Vitamin C (mg)	8.0 (7.5, 8.6)	14.2 (11.5, 16.8)	8.8 (7.8, 9.7)	7.3 (6.2, 8.3)
Iron (mg)	0.52 (0.49, 0.54)	0.61 (0.56, 0.67)	0.52 (0.48, 0.55)	0.49 (0.45, 0.54)
Sodium (mg)	96.2 (92.6, 99.7)	107 (80, 134)	94.3 (89.8, 98.8)	99.7 (80.3, 119.1)
Potassium (mg)	128 (124, 132)	154 (144, 164)	124 (118, 129)	144 (136, 152)
Vitamin A (RAE)	26.6 (25.1, 28.1)	30.7 (25.9, 35.6)	27.6 (19.6, 35.6)	36.9 (32.2, 41.6)
Dietary Folate equivalents (ug)	18.8 (16.6, 21.0)	24.2 (20.6, 27.8)	17.2 (15.8, 18.7)	17.2 (14.4, 20.0)

[a]Nutrient density was computed as the sum of each nutrient consumed during snacking occasions adjusted per 100 kcals of energy.

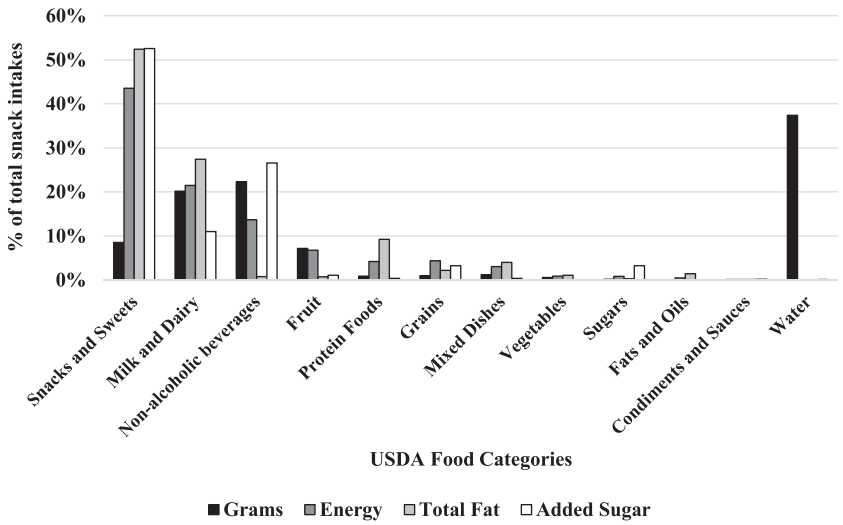

FIGURE 1 Proportional contribution of food sources to Total dietary intakes obtained from snacks among 2–5 Year old children, 2005–2012 (n = 3,318)

The food subcategories were examined further to identify more specific foods/beverages that contributed significant amounts of energy, total fat, and added sugars from snacks and also to explore the specific sources across the three snacking time period (Table 3). Sweet bakery products (i.e., cakes, cookies, and pastries) within the Snacks and Sweets and milk from the Milk food categories were the top two leading sources of energy and total fat during snacking occasions. Sweetened beverages (i.e., soda and fruit drinks) and sweet bakery products were the top two leading sources of added sugars in children's snacks (Table 3).

4 | DISCUSSION

The purpose of this study was to examine snacking patterns, determine nutritional contribution of snacks to total dietary intake, and to identify food categories–foods that represent leading sources of energy, total fat, and added sugars in snacks of 2- to 5-year-old children in the United States. From the nationally representative sample of 3,429 children, snacks contributed considerable amounts of energy and selected nutrients to young children's diets. This study identified potential targets for dietary interventions with 2- to 5-year-old children and also highlights the need to redefine snacking amongst families with young children. Increased efforts to limit "empty calorie foods," such as sweetened beverages and pastries, and to effectively promote nutrient-dense foods at snack times are warranted to improve children's diet quality and thus establish healthy eating habits from early childhood (Bellisle, 2014).

Meal patterns have changed significantly amongst both adults and children in the United States since 1970s (Popkin & Duffey, 2010; Poti & Popkin, 2011). The rise in overall energy intakes across age groups has been accompanied by increased frequency of eating occasions per day (Jahns, Siega-Riz, & Popkin, 2001; Popkin & Duffey, 2010; Poti & Popkin, 2011). The greatest increase in snacking frequency was observed amongst 2- to 6-year-old children who consumed 1.4 more snacks in 2006 compared to the 1970s (Piernas & Popkin, 2010). In the current study, 2- to 5-year-old children consumed 450 kcal via approximately 3 snacks, which represented 28% of their total energy intake for the day. Although changes in snacking trends between 2005 and 2012 were not examined within the current study, our findings suggest that the quality of foods/beverages consumed as snacks influences children's total daily energy and nutrient intakes and thus may have potential impact on their long-term nutritional and weight status (de Graaf, 2006).

Sweetened beverages and sweet bakery products consumed as snacks by children in our sample provided a relatively large proportion of total added sugars to children's diets. Added sugars from the reported snacks exceeded one-third of children's total energy, which is well above the amount that can be reasonably incorporated into a healthy diet according to the current dietary guidelines (USDA & DHHS, 2015). This is largely due to the fact that added sugars are typically found in foods–beverages with relatively high energy density but little nutritional value (USDA & DHHS, 2015). In our sample, the top source of both energy and added sugars were items from the snacks and sweets and nonalcoholic beverages food categories, which included 100% fruit juice, but also soda, fruit juice, and other sugar-sweetened drinks. These findings are similar to previous results observed among 2- to 6-year-old children, where desserts and sweetened beverages provided the greatest amount of calories to children's energy consumption (Piernas & Popkin, 2010). Furthermore, because sweets and snacks include items such as cakes, chips, pies, and ice cream, it is not surprising that this snacking food category also contributed large amounts of dietary fat to children's diets in our sample. The findings indicate that sweets and savory snacks, such as cakes, candy, and snack mixes, have remained popular snack choices of young children between 2005 and 2012 and continue to negatively influence children's diet quality through empty calories. The consumption of energy-dense foods at snack times have been associated with greater daily energy intakes, lower overall diet quality, and increased risk of obesity amongst youth (de Graaf, 2006). The abundance of energy-dense foods in children's food environment may make it difficult for parents to offer healthier snack choices to their children (Evans et al., 2014; Larson & Story, 2013; Shroff et al., 2013).

A strong body of research has linked consumption of sugar-sweetened beverages to excessive energy intakes and increased risk of obesity among both children and adults (Malik, Schulze, & Hu, 2006;

TABLE 3 Top food categories contributing to Total energy, Total fat and added sugars intakes within each snacking time period and for all snacks by US children age 2–5 Years, 2005–2012, (n = 3,429)[a]

	Food category	Morning snack	Food category	Afternoon snack	Food category	Evening snack	Food category	All snacks
Energy	Milk	15%	Sweet bakery products	15%	Milk	16%	Sweet bakery products	15%
	100% juice	14%	Savory snacks	10%	Sweet bakery products	14%	Milk	11%
	Sweet bakery products	13%	Candy	8%	Other desserts	10%	Savory snacks	9%
	Crackers	7%	Fruits	8%	Savory snacks	9%	100% juice	7%
	Fruits	7%	Crackers	7%	Candy	7%	Candy	7%
	Sweetened beverages	7%	Sweetened beverages	7%	Flavored milk	5%	Fruits	7%
	Flavored milk	6%	Other desserts	7%	Fruits	5%	Other desserts	7%
	Savory snacks	5%	Milk	6%	Sweetened beverages	5%	Sweetened beverages	6%
	Candy	5%	100% juice	6%	100% juice	4%	Crackers	6%
	Cheese	3%	Cheese	4%	Cheese	4%	Flavored milk	4%
Total fat	Milk	22%	Sweet bakery products	18%	Milk	19%	Sweet bakery products	18%
	Sweet bakery products	19%	Savory snacks	17%	Sweet bakery products	17%	Milk	14%
	Crackers	12%	Crackers	10%	Savory snacks	14%	Savory snacks	14%
	Savory snacks	8%	Cheese	9%	Other desserts	11%	Cheese	8%
	Cheese	8%	Milk	8%	Cheese	8%	Crackers	8%
	Flavored milk	5%	Other desserts	6%	Candy	5%	Other desserts	7%
	Plant-based proteins	4%	Candy	5%	Flavored milk	4%	Candy	5%
	Candy	3%	Plant-based proteins	5%	Plant-based proteins	4%	Plant-based proteins	4%
	Snack/meal bars	2%	Cured meats/poultry	4%	Crackers	3%	Flavored milk	3%
	Quick breads and products	2%	Flavored milk	2%	Cured meats/poultry	2%	Cured meats/poultry	3%
Added sugars	Sweetened beverages	31%	Sweetened beverages	28%	Sweet bakery products	20%	Sweetened beverages	25%
	Sweet bakery products	20%	Sweet bakery products	21%	Other desserts	19%	Sweet bakery products	20%
	Flavored milk	10%	Other desserts	16%	Sweetened beverages	18%	Other desserts	15%
	Candy	9%	Candy	15%	Candy	16%	Candy	14%
	Other desserts	6%	Yogurt	4%	Flavored milk	7%	Flavored milk	6%
	Yogurt	4%	Flavored milk	3%	Jams, syrups, toppings	5%	Yogurt	4%
	Snack/meal bars	3%	Snack/meal bars	2%	Yogurt	4%	Jams, syrups, toppings	3%
	Jams, syrups, toppings	3%	Jams, syrups, toppings	1%	Ready-to-eat cereals	2%	Ready-to-eat cereals	2%
	Ready-to-eat cereals	3%	Coffee and tea	1%	Dairy Drinks & Substitutes	1%	Snack/meal bars	2%
	Quick breads and products	2%	Fruit	1%	Coffee and tea	1%	Coffee and tea	1%

[a]Percent computed as the sum of energy or nutrient from the USDA Food Category divided by the total energy or nutrient consumed during each snack time.

Zheng, Allman-Farinelli, Heitmann, & Rangan, 2015). The nonalcoholic beverages snacking food category contributed the second greatest amount of added sugars and third greatest amount of kilocalories to children's overall intakes. The micronutrient contribution of these beverages, especially at morning snacking time periods, is perhaps due to the fact that this category included 100% fruit juices, but also nutritionally poor options (e.g., soda and fortified fruit drinks) that are often fortified with vitamin C and other micronutrients. Nearly half of all the nonalcoholic beverages reported by children in our study were consumed during snack times, which supports findings from previous research that reported a significant increase in the consumption of beverages at snack times among children (Popkin & Duffey, 2010). In our sample, the combined categories of snacks and sweets and nonalcoholic beverages contributed nearly 60% of children's total energy intake from snacks. These findings are of concern in the light of emerging evidence linking consumption of added sugars from sugar-sweetened beverages and other processed foods to a variety of negative health outcomes, including greater risk of obesity, diabetes, and stroke (Zheng et al., 2015). Although dairy foods (e.g., milk and cheese) were the second leading source of energy from snacks in our study, fruit, vegetables, grains, and protein foods did not contribute greatly to snacking occasions in our sample.

The findings suggest that morning snacks are highest in nutrient-density among young children. This may be due to the frequent inclusion of 100% fruit juice in children's morning snacks, and other more nutrient dense foods–beverages, such as milk and fruit. In contrast, the afternoon snacks provided greatest amount of added sugars and energy in our sample and often included sweet bakery products, desserts, and sweetened beverages that contributed to the high levels of added sugars. These trends are consistent with dietary patterns of children in past studies and highlight the need to incorporate more nutrient-dense foods into children's afternoon snacks (Piernas & Popkin, 2010).

The current study has several strengths, such as the use of a large nationally representative sample of 2- to 5-year-old children, the use of the USDA's multiple-pass 24-hr dietary recall interview for dietary assessment, and the use of multiple data collection waves from the time period between 2005 and 2012 NHANES. There are also several limitations that influence the interpretation of our findings. First, the analyses of dietary data in this study are based on one parent-reported 24-hr dietary recall interview conducted during NHANES data collection, which may not reflect an individual's habitual dietary intake; however, the use of one-day recall is acceptable and appropriate in studies that analyse data from large and nationally representative samples of children such as in our study of more than 3,400 preschool-aged children (Murphy, 2003). As well, at the time of analysis, only complete dietary data through 2011–2012 were available. Future efforts should evaluate the presence of temporal changes over time in children's snacking patterns. The current study did not assess children's obesity risks in relation to snacking, but rather focused on the types of foods and their nutritional contribution to children's overall dietary intake. The definition of snacking utilised in the current study may differ from those used in some of the previous studies (Piernas & Popkin, 2010). As eating habits of individuals have changed over the past decades, it has been increasingly difficult to define snacking (Miller, Benelam, Stanner, & Buttriss, 2013). Thus, "snacking" in our study was carefully defined as snacking occasions and characterised by parental self-designation of specific foods–beverages that were consumed as snacks by the child outside of the main meals. Our analyses focused on the nutritional content of the foods and beverages consumed by children at snacking occasions. Further analyses should examine the degree and nature of the association between children's snacking, overall diet quality, and the weight status in this sample of 2- to 5-year-old children.

The study contributes significantly to the current literature on the nutritional contribution of snacks to total dietary intakes of preschool-aged children in the United States. Snacks and sweets and nonalcoholic beverages were the leading contributors of energy and added sugars among children from snacks in our sample. Snacks and sweets and milk and dairy also represented the top leading contributors of dietary fat from snacks. Afternoon snacks represented the largest contributors of empty calories (i.e., added sugars and solid fats) to children's diet. Thus, these findings clearly indicate that there is an urgent need for targeted nutrition interventions to improve the nutritional quality of foods and beverages that are offered and consumed as snacks by young children. It is essential to redefine "snack foods" for parents and others who are responsible for feeding young children, and to think of snacks as nutritious "mini" meals. Education for parents and caregivers are needed to teach the importance of providing nutritious snacks as well as provide strategies to help caregivers offer nutritious snacks versus empty calorie choices. High-nutrient dense snack options will optimise children's nutritional status and promote cognitive and physical development. Convenient and simple snack food choices that incorporate nutrient dense foods, including protein, fiber, fruits, and vegetables, should be encouraged for today's on-the-go families with young children. Further research is needed to identify specific parental, environmental, and personal factors that influence the current snacking trends and the types of foods and beverages that are consumed by preschool-aged children in the United States.

ACKNOWLEDGMENT

None.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

CONTRIBUTIONS

Lenka Shriver assisted in research questions, data interpretation, and wrote the manuscript. Barbara Marriage assisted in research questions, data interpretation, and critically reviewed and approved the manuscript. Tama Bloch assisted in research questions, data interpretation, and critically reviewed and approved the manuscript. Colleen Spees assisted in research questions, data interpretation, and critically reviewed and approved the manuscript. Samantha Ramsay assisted in research questions, data interpretation, and revised and approved the manuscript. Rosanna Watowicz assisted in research questions, data analysis and interpretation, and critically reviewed and approved the manuscript. Christopher Taylor—senior author—assisted in research questions, conducted data analysis and interpretation, and revised and approved the manuscript.

REFERENCES

American Academy of Pediatrics, Committee on Nutrition. (2013). Feeding the child. In R. E. Kleinman, & F. G. Greer (Eds.), *Pediatric nutrition handbook* (7th ed.). (pp. 143–173). Elk Grove Village, IL: American Academy of Pediatrics.

Anand, J., Raper, N., & Tong, A. (2006). Quality assurance during data processing of food and nutrient intakes. *Journal of Food Composition and Analysis*, *19*, S86–S90.

Bellisle, F. (2014). Meals and snacking, diet quality and energy balance. *Physiology and Behavior*, *134*, 38–43. doi:10.1016/j.physbeh.2014.03.010

Birch, L. L., & Anzman, S. L. (2010). Learning to eat in an obesogenic environment: A developmental systems perspective on childhood obesity. *Child Development Perspectives*, *4*(2), 138–143.

Birch, L. L., & Fisher, J. O. (1998). Development of eating behaviors among children and adolescents. *Pediatrics*, *101*(Supplement 2), 539–549. Retrieved from http://pediatrics.aappublications.org/content/101/Supplement_2/539\nhttp://pediatrics.aappublications.org/content/101/Supplement_2/539.full.pdf\nhttp://pediatrics.aappublications.org/content/101/Supplement_2/539.short\nhttp://www.ncbi.nlm.nih.gov/pubmed/1.

Bowman, S. A., Clemens, J. C., Thoerig, R. C., Friday, J. E., Shimizu, M., & Moshfegh, A. J. (2013). Food patterns equivalents database: Methodology and user guide [online]. Food Surveys Research Group, Beltsville Human Nutrition Research Center, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland. Retrieved from http://www.ars.usda.gov/ba/bhnrc/fsrg (accessed 4 October 2016).

Centers for Disease Control and Prevention. (2009). National Health and Nutrition Examination Survey, MEC in-person dietary interviewer's procedure manual. Retrieved from http://www.cdc.gov/nchs/data/nhanes/nhanes_09_10/DietaryInterviewers_Inperson.pdf. Published 2009. Accessed November 30, 2012

de Graaf, C. (2006). Effects of snacks on energy intake: An evolutionary perspective. *Appetite*, *47*, 18–23.

Evans, E. W., Jacques, P. F., Dallal, G. E., Sacheck, J., & Must, A. (2014). The role of eating frequency on total energy intake and diet quality in a low-income, racially diverse sample of schoolchildren. *Public Health Nutrition*, *18*(3), 1–8. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/24780506.

Jahns, L., Siega-Riz, A. M., & Popkin, B. M. (2001). The increasing prevalence of snacking among US children from 1977 to 1996. *Journal of Pediatrics*, *138*, 493–498.

Keast, D. R., Nicklas, T. A., & O'Neil, C. E. (2010). Snacking is associated with reduced risk of overweight and reduced abdominal obesity in adolescents: National Health and Nutrition Examination Survey (NHANES) 1999-2004. *The American Journal of Clinical Nutrition*, *92*(2), 428–435. Retrieved from http://ajcn.nutrition.org/content/92/2/428.long.

Kong, A., Beresford, S. A., Alfano, C. M., Foster-Schubert, K. E., Neuhouser, M. L., Johnson, D. B., … McTiernan, A. (2011). Associations between snacking and weight loss and nutrient intake among postmenopausal overweight to obese women in a dietary weight-loss intervention. *Journal of the American Dietetic Association*, *111*, 1898–1903.

Larson, N., & Story, M. (2013). A review of snacking patterns among children and adolescents: What are the implications of snacking for weight status? *Childhood Obesity (Print)*, *9*(2), 104–115. Retrieved from: http://www.ncbi.nlm.nih.gov/pubmed/23470091.

Leidy, H. J., & Campbell, W. W. (2011). The effect of eating frequency on appetite control and food intake: brief synopsis of controlled feeding studies. *The Journal of Nutrition*, *141*(1), 154–157.

Ma, Y., Bertone, E. R., Stanek, E. J. 3rd, Reed, G. W., Hebert, J. R., Cohen, N. L., … Ockene, I. S. (2003). Association between eating patterns and obesity in a free-living US adult population. *American Journal of Epidemiology*, *158*(1), 85–92.

Malik, V. S., Schulze, M. B., & Hu, F. B. (2006). Intake of sugar-sweetened beverages and weight gain: A systematic review. *American Journal of Clinical Nutrition*, *84*(2), 274–288.

Malik, V. S., Popkin, B. M., Bray, G. A., Després, J. P., & Hu, F. B. (2010). Sugar Sweetened Beverages, Obesity, Type 2 diabetes and cardiovascular disease risk. *Circulation*, *121*(11), 1356–1364.

Miller, R., Benelam, B., Stanner, S. A., & Buttriss, J. L. (2013). Is snacking good or bad for health: An overview. *Nutrition Bulletin*, *38*, 302–322.

Montville, J. B., Ahuja, J. K. C., Martin, C. L., Heendeniya, K. Y., Omolewa-Tomobi, G., Steinfeldt, L. C., … Moshfegh, A. (2013). USDA Food and Nutrient Database for Dietary Studies (FNDDS), 5.0. *Procedia Food Science*, *2*, 99–112. Retrieved from http://www.sciencedirect.com/science/article/pii/S2211601X13000175.

Moshfegh, A. J., Rhodes, D. G., Baer, D. J., Murayi, T., Clemens, J. C., Rumpler, W. V., … Cleveland, L. E. (2008). The US Department of Agriculture Automated Multiple-Pass Method reduces bias in the collection of energy intakes. *American Journal of Clinical Nutrition*, *88*(2), 324–332.

Murphy, S. P. (2003). Collection and analysis of intake data from the integrated survey. *The Journal of Nutrition*, *133*(2), 585S–589S. Retrieved from http://jn.nutrition.org/content/133/2/585S.short\nhttp://www.ncbi.nlm.nih.gov/pubmed/12566508.

Neumark-Sztainer, D., Wall, M., Fulkerson, J. A., & Larson, N. (2013). Changes in the frequency of family meals from 1999 to 2010 in the homes of adolescents: Trends by sociodemographic characteristics. *Journal of Adolescent Health*, *52*(2), 201–206. doi:10.1016/j.jadohealth.2012.06.004

Ogata, B. N., & Hayes, D. (2014). Position of the academy of nutrition and dietetics: Nutrition guidance for healthy children ages 2 to 11 years. *Journal of the Academy of Nutrition and Dietetics*, *114*(8), 1257–1276.

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2014). Prevalence of childhood and adult obesity in the United States, 2011-2012. *JAMA : The Journal of the American Medical Association*, *311*(8), 806–814. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/24570244\nhttp://jama.jamanetwork.com/article.aspx?articleid=1832542.

Piernas, C., & Popkin, B. M. (2010). Trends in snacking among U.S. children. *Health Affairs (Project Hope)*, *29*(3), 398–404 Retrieved from http://europepmc.org/articles/PMC2837536/?report=abstract.

Piernas, C., & Popkin, B. M. (2011). Food portion patterns and trends among U.S. children and the relationship to total eating occasion size, 1977–2006. *The Journal of Nutrition*, *141*, 1159–1164.

Popkin, B. M., & Duffey, K. J. (2010). Does hunger and satiety drive eating anymore? Increasing eating occasions and decreasing time between eating occasions in the United States. *The American Journal of Clinical Nutrition*, *91*(5), 1342–1347. Retrieved from http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2854907&tool=pmcentrez&rendertype=abstract.

Poti, J. M., & Popkin, B. M. (2011). Trends in energy intake among US children by eating location and food source, 1977-2006. *Journal of the American Dietetic Association*, *111*(8), 1156–1164.

Roblin, L. (2007). Childhood obesity: Food, nutrient, and eating-habit trends and influences. *Applied Physiology, Nutrition, and Metabolism*, *32*, 635–645.

Shroff, M. R., Perng, W., Baylin, A., Mora-Plazas, M., Marin, C., & Villamor, E. (2013). Adherence to a snacking dietary pattern and soda intake are related to the development of adiposity: A prospective study in school-age children. *Public Health Nutrition*, *17*(7), 1–7. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/23701749.

Smeets, A. J., & Westerterp-Plantenga, M. S. (2008). Acute effects on metabolism and appetite profile of one meal difference in the lower range of meal frequency. *The British Journal of Nutrition*, *99*(6), 1316–1321 Retrieved from http://journals.cambridge.org/abstract_S0007114507877646.

USDA & DHHS. (2010). Dietary guidelines for Americans, 2010. *7Th Edition*, p.76.

USDA & DHHS. (2015). Dietary guidelines for Americans, 2015–2020. *8Th Edition*.

USDA, Agricultural Research Service. (2014). USDA Food and Nutrient Database for Dietary Studies 2011-2012. Retrieved from http://www.ars.usda.gov/ba/bhnrc/fsrg. Accessed October 2, 2015.

USDA, Agricultural Research Service. (2015). What We Eat in America Food Categories 2011-2012. Available: www.ars.usda.gov/nea/bhnrc/fsrg. Accessed October 12, 2016.

Zheng, M., Allman-Farinelli, M., Heitmann, B. L., & Rangan, A. (2015). Substitution of sugar-sweetened beverages with other beverage alternatives: A review of long-term health outcomes. *Journal of the Academy of Nutrition and Dietetics*, *115*(5), 767–779. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S2212267215001124.

How to cite this article: Shriver LH, Marriage BJ, Bloch TD, et al. Contribution of snacks to dietary intakes of young children in the United States. *Matern Child Nutr*. 2018;14: e12454. https://doi.org/10.1111/mcn.12454