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Effect of Snacking Frequency on Adolescents' Dietary Intakes and Meeting National Recommendations

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Abstract

Purpose: To determine how snacking level impacts intake of nutrients and food groups and assists in meeting recommendations outlined in the U.S. Department of Agriculture's MyPyramid Food Guidance System.

Methods: Dietary data based on 24-hour recall from 4357 adolescents 12–19 years of age participating in the National Health and Nutrition Examination Survey 2001–2004 (NHANES) were analyzed. Regression analyses were applied to examine the effect of snacking on nutrient and food group intake and to determine its effect on the likelihood of meeting MyPyramid recommendations.

Results: Food energy, carbohydrate, total sugars, and vitamin C intake were positively associated, whereas protein and fat intake were negatively associated, with snacking frequency. Fruit intake increased, whereas solid fat intake decreased, as snacking incidence rose. Increasing snacking frequency was also associated with a greater likelihood of meeting milk and oil recommendations for boys and meeting fruit recommendations for both genders. Non-Hispanic black adolescents were less likely to meet their milk recommendations at low and high snacking levels and more likely to meet their fruit recommendations at high levels only. Foods consumed as snacks provided 12–39% of the day's total number of portions of the five MyPyramid food groups, 35% of total discretionary calorie intake, and 43% of total added sugar intake.

Conclusions: Snacking frequency affects intake of macronutrients and a few micronutrients and promotes consumption of fruits. Top food choices for snacks provide an excess of discretionary calories in the form of added sugars and fats. Modification of these choices would assist adolescents in consuming diets more consistent with national recommendations. © 2008 Society for Adolescent Medicine. All rights reserved.

Keywords: Snacking; Adolescents; Nutrient intake; Food intake; MyPyramid Food Guidance System

It is generally accepted that dietary patterns established during childhood and adolescence continue into adulthood and have implications for the development of chronic disease, both at present and in the future [1,2]. Increased meal frequency, particularly in the form of snacking, is one aspect that has received considerable attention—mainly because of its assumed role in the rise in obesity prevalence observed in both children and adults [3,4].

Snacking incidence in all age groups including adolescents has increased over the last 25 years [5–7]. The percentage of the population reporting consumption of three or more snacks per day has increased fourfold according to some estimates [8]. Snacks, therefore, now account for a substantially larger percentage of total daily energy and macronutrient intake than they did in the late 1970s [6,8]. What is unclear is how this phenomenon impacts the overall quality of the diet. Research investigating associations between snacking and nutrient intakes have yielded conflicting

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results. Although some studies have shown snacking to be beneficial in meeting nutrient needs, others have shown it to lower the nutrient density of the total diet [9,10]. Findings concerning its effect are useful to professionals for understanding how snacking influences total nutrient intake. Because the general population receives nutrition recommendations in terms of foods and not nutrients, however, it is equally valuable to evaluate the impact of snacking in the framework of accepted food guidance. Dietary patterns that follow this guidance have been associated with a lower risk of mortality later in life [11].

The MyPyramid Food Guidance System, recently developed by the U.S. Department of Agriculture (USDA), provides a food-based avenue to evaluate the total diet [12]. The goal of MyPyramid is to implement the key recommendations of the 2005 Dietary Guidelines for Americans [12]. Daily food intake patterns provided as part of MyPyramid identify the types and amounts of foods to eat each day to meet nutrient needs and put limits on food components typically consumed in excess in the American diet [12]. With MyPyramid, emphasis is on the appropriateness of the whole diet rather than on a single food or nutrient. To date no assessment of the effect of snacking by adolescents on food group intake using MyPyramid has been conducted.

Considering these shortfalls in the current knowledge, the goals of this study were to determine how adolescents' snacking influences their total intake of nutrients and food groups, and to assess the effect of snacking on the likelihood of meeting recommendations outlined in the USDA's MyPyramid Food Guidance System. In addition adolescents' top food choices as snacks were identified so that applicable suggestions for improvement could be made.

Methods

Sample

The study sample is from What We Eat in America, the dietary interview component of the National Health and Nutrition Examination Survey (WWEIA-NHANES) that was conducted in 2001–2004 by USDA and the U.S. Department of Health and Human Services. The NHANES was designed to yield a sample representative of the noninstitutionalized population of the United States. As a focal area of the most recent NHANES is adolescent health, persons 12–19 years of age were oversampled to produce reliable estimates [13,14].

A total of 4459 adolescents aged 12–19 years provided complete and reliable dietary intake data. Pregnant adolescent girls (n = 102) were excluded from this analysis, yielding a final sample of 4357 adolescents (2244 male and 2113 female).

One 24-hour dietary recall was collected in person by a trained interviewer using the USDA Automated Multiple-Pass Method (AMPM). This method uses a multiple-pass approach designed to enhance complete and accurate food recall and to reduce respondent burden [15]. Details of the AMPM are available elsewhere [16].

The name of each eating occasion was self-reported from a defined list, and distinguished from other occasions with a unique time and location where the foods and/or beverages were consumed. For this analysis, occasions termed "snack," "beverage," "extended consumption" and the Spanish terms "merienda," "entre comida," "bebida," "botana," and "bocadillo" were all classified as snacking occasions.

Calculation of nutrient intake

The source of the nutrient values was the Food and Nutrient Database for Dietary Studies (FNDDS) [17,18]. Nutrient values in FNDDS were derived using the most current food composition data from the USDA National Nutrient Database for Standard Reference that was available at the time of survey data collection [19,20]. Nutrient intakes for individuals were calculated by using the gram amounts of food consumed and the nutrient values for the food as listed in the FNDDS expressed per 100 g of food. Contributions made by supplemental vitamin or minerals were not included in nutrient calculations.

Conversion of intake data into food group amounts

The MyPyramid Food Guidance System defines 12 dietary patterns at energy levels ranging from 1000–3200 kilocalories, from which the appropriate pattern for an individual can be selected. Each dietary pattern specifies recommended amounts (cup or ounce equivalents) to eat from five basic food groups (grains, fruits, vegetables, milk, and meat/beans) and oils. Limits are also set on discretionary calories from solid fats (which are usually high in saturated and/or trans fats and found in butter, margarine, full-fat animal products, and many processed foods), added sugars; and alcohol [12].

Because foods in WWEIA-NHANES were reported as consumed, and because most foods are mixtures to a greater or lesser degree, a mechanism was needed to disaggregate foods into their ingredients and to assign the components to the appropriate MyPyramid food groups. The MyPyramid Equivalents Database for USDA Food Codes, 1994–2002, version 1.0, was used for this purpose [21]. With it, intake data from this study was converted into MyPyramid portions to estimate the mean intake of the five basic food groups, discretionary calories, solid fats, oils, and added sugars, and to determine the percentage of adolescent boys and girls meeting MyPyramid recommendations by snacking frequency.

To assign a set of MyPyramid recommendations (i.e., dietary pattern) to each individual in this study, that individual's food energy goal had to be determined. The dietary patterns recommended for teenagers range from 1600–3200 kcal/day depending on gender, age, and activity level. Activity level was not assessed in WWEIA-NHANES, so the dietary pattern for each individual was selected based on the kilocalories reported, which were assumed to match energy needs. "Bands" of 200 kcal were formed, with each kilocalorie recommendation level set as the midpoint. Actual kilocalorie intakes that fell within a band were assigned the dietary pattern corresponding to that kilocalorie level.

To quantify the impact of snack food choices on total intake, the proportion of MyPyramid portions eaten at snacking occasions was calculated. To characterize what types of foods these were, the top contributors to each of the five food groups and other MyPyramid components were identified.

Statistical analyses

Analyses were carried out using SAS, release 9.1.3 (SAS Institute, Cary, NC) and SUDAAN, release 9.0 (Research Triangle Institute, Research Triangle Park, NC). SUDAAN increases the validity of inferred results, as the variance estimates generated are corrected to account for the multistage stratified cluster probability design of the NHANES survey [22]. Sample weights provided with the data release designed to account for unequal probability of selection, noncoverage, and nonresponse were applied to all analyses.

Linear regression was used to provide estimates of mean intake of each nutrient and food group at different snacking levels (no snacks, one snack, two snacks, three snacks, and four or more snacks) and to test for a relationship between snacking frequency and nutrient and food intake. Gender-specific analyses were performed because preliminary analyses found significant differences in food and nutrient intake for boys and girls. Other explanatory variables, including age, race, ethnicity, poverty status, body mass index, vigorous and moderate activity in the last 30 days, and intake of three main meals, were controlled in the analyses. Energy intake was also controlled for, as it is strongly correlated with food and nutrient intake. Intake of food energy, protein, carbohydrate, total sugars, total fat, fiber, and cholesterol were analyzed, as well as those nutrients for which intakes had previously been identified as inadequate for at least 15% of adolescent girls or boys: vitamin A, vitamin C, vitamin E, vitamin B_6, folate, calcium, iron, magnesium, and phosphorus [23]. Food intake was characterized as intake of the five basic MyPyramid food groups and the other components of the MyPyramid Food Guidance System. The significance of the independent contribution of snacking to prediction of the intake of the nutrient/food was assessed by means of a t test on each β-coefficient.

Similarly logistic regression was used to generate estimates of the percentage of adolescents meeting MyPyramid recommendations by snacking level and to test for a relationship between snacking frequency and the likelihood of meeting MyPyramid recommendations. Nonsnackers were used as the reference group. Adjustment for the same variables accounted for in the linear regression analyses were made, with the exception of daily energy intake, which was excluded because the MyPyramid recommendations change relative to caloric intake.

Separate logistic regression analyses were conducted to identify which subgroups of adolescents were most at risk for not meeting their MyPyramid recommendations based on snacking category. Intakes were dichotomized into low ($\leq$1/day) and high ($>$1/day) snacking categories, and the likelihood of meeting recommendations for adolescents by race/ethnicity, income, and weight status were calculated.

A significance level of $p \leq .01$ was applied in all analyses.

Results

Nutrient intake by snacking level

Mean nutrient intake by snacking category and the significance level of the β-coefficients for snacking frequency are listed for boys and girls in Table 1. As snacking frequency increased, intake of food energy increased also. The majority of these additional kilocalories were consumed as carbohydrate. Energy-adjusted intakes for both genders reflected an increase in carbohydrate as snacking frequency increased, and this was paralleled by an increase in total sugar intake. Conversely energy-adjusted protein and fat were significantly lower in the diets of boys and girls as snacking frequency increased.

Intakes of vitamin A, vitamin E, and magnesium intake significantly increased for boys, and vitamin C intake significantly increased for both boys and girls, with rising snacking level, spiking to a mean of 144 mg/day for the boys who snacked four or more times a day, an amount well above the RDA of 75 mg/day [25]. Intakes of vitamin B_6, folate, calcium, iron, and phosphorus were not significantly affected by snacking frequency.

MyPyramid food group intake and percentage meeting recommendations

Of the nine MyPyramid components studied, only intakes of fruit, solid fat, and added sugars were affected by snacking frequency (Table 2). Fruit intake increased and solid fat intake decreased with higher snacking frequency for both adolescent boys and girls. Intake of added sugars increased for girls only. It is evident that a large proportion of the observed increase in total sugars in the nutrient analyses was caused by increases in intake of fruits and added sugars that occurred with increased snacking.

Snacking frequency significantly improved the likelihood of meeting fruit recommendations for both genders and of meeting milk and oils recommendations for boys. The more girls snacked, the less likely they were to meet their discretionary calorie recommendations; however the

Table 1
Nutrient intakes of adolescents 12–19 years of age by snacking level, 2001–2004[a]

Gender group and nutrient	0 Snacks (n = 502)	1 Snack (n = 1111)	2 Snacks (n = 1126)	3 Snacks (n = 834)	4+ Snacks (n = 784)	p Value (t test)[b]
Boys						
Food energy (kcal)	2156 ± 116	2391 ± 50	2505 ± 45	2916 ± 70	3249 ± 62	<.001*
Protein (g)	103 ± 3	96 ± 2	96 ± 2	92 ± 2	86 ± 2	<.001*
Carbohydrate (g)	338 ± 8	349 ± 5	349 ± 4	364 ± 5	375 ± 5	<.001*
Total sugars (g)	165 ± 9	175 ± 4	181 ± 5	200 ± 6	207 ± 5	<.001*
Total fat (g)	100 ± 2	98 ± 2	98 ± 2	94 ± 2	93 ± 2	.007*
Fiber (g)	15.0 ± .5	14.4 ± .5	15.4 ± .4	15.4 ± .6	16.3 ± .6	.014
Cholesterol (mg)	332 ± 14	308 ± 11	319 ± 11	278 ± 18	282 ± 18	.049
Vitamin A (μg RAE)	640 ± 35	577 ± 21	593 ± 23	670 ± 31	701 ± 30	.006*
Vitamin C (mg)	85 ± 7	89 ± 6	88 ± 6	91 ± 6	144 ± 9	<.001*
Vitamin E (mg α–tocopherol)	6.5 ± .3	6.8 ± .2	7.1 ± .3	7.6 ± .7	8.2 ± .4	<.001*
Vitamin B_6 (mg)	2.2 ± .1	2.1 ± .1	2.1 ± .1	2.2 ± .1	2.1 ± .1	.737
Folate (μg DFE)	673 ± 32	672 ± 23	642 ± 18	645 ± 17	685 ± 40	.960
Calcium (mg)	1206 ± 50	1147 ± 35	1166 ± 36	1210 ± 54	1172 ± 28	.718
Iron (mg)	19.3 ± .5	18.7 ± .4	18.8 ± .5	18.6 ± .5	19.1 ± .6	.979
Magnesium (mg)	278 ± 6	268 ± 6	282 ± 6	295 ± 6	292 ± 7	.002*
Phosphorus (mg)	1638 ± 46	1558 ± 29	1596 ± 18	1595 ± 34	1517 ± 26	.146
Zinc (mg)	16.4 ± .6	14.8 ± .4	15.1 ± .4	14.5 ± .5	13.9 ± .6	.026
Girls						
Food energy (kcal)	1501 ± 41	1812 ± 44	1944 ± 32	2136 ± 56	2437 ± 51	<.001*
Protein (g)	70 ± 1	68 ± 1	68 ± 1	65 ± 1	62 ± 2	<.001*
Carbohydrate (g)	258 ± 4	263 ± 3	267 ± 4	276 ± 3	282 ± 3	<.001*
Total sugars (g)	123 ± 3	133 ± 2	135 ± 4	148 ± 4	160 ± 4	<.001*
Total fat (g)	77 ± 2	75 ± 1	74 ± 1	72 ± 1	70 ± 1	<.001*
Fiber (g)	11.6 ± .3	12.0 ± .3	12.0 ± .3	12.2 ± .4	12.9 ± .4	.051
Cholesterol (mg)	224 ± 7	228 ± 11	216 ± 10	201 ± 12	199 ± 11	.013
Vitamin A (μg RAE)	478 ± 37	474 ± 15	501 ± 29	481 ± 22	559 ± 51	.095
Vitamin C (mg)	70 ± 5	75 ± 4	73 ± 4	85 ± 5	92 ± 7	.003*
Vitamin E (mg α–tocopherol)	5.8 ± .3	5.7 ± .2	5.8 ± .2	6.1 ± .4	6.0 ± .2	.197
Vitamin B_6 (mg)	1.5 ± .1	1.5 ± .0[c]	1.5 ± .0[c]	1.5 ± .1	1.5 ± .1	.814
Folate (μg DFE)	535 ± 42	501 ± 19	518 ± 17	526 ± 26	504 ± 27	.925
Calcium (mg)	862 ± 24	853 ± 28	841 ± 25	846 ± 33	841 ± 36	.671
Iron (mg)	14.2 ± .6	13.7 ± .4	14.2 ± .4	14.1 ± .5	13.4 ± .5	.726
Magnesium (mg)	205 ± 6	207 ± 3	213 ± 4	216 ± 5	219 ± 7	.118
Phosphorus (mg)	1173 ± 25	1158 ± 21	1146 ± 23	1132 ± 27	1094 ± 26	.046
Zinc (mg)	10.6 ± .4	10.1 ± .2	10.3 ± .4	9.9 ± .4	9.4 ± .3	.073

Data are mean ± S.E.M.

[a] Adjusted for energy (kilocalorie) intake (excluding food energy calculation), age, race/ethnicity (non-Hispanic white, non-Hispanic black, Mexican-American, other), percentage of poverty threshold (defined by the U.S. Census Bureau), consumption of three main meals (yes/no), participation in vigorous and moderate activity in the last 30 days (yes/no), and weight status (underweight, normal weight, or at risk/overweight) as defined by guidelines from the Centers for Disease Control and Prevention [24].

[b] t Test: β-coefficient of snacking level (treated as a continuous variable) is not equal to zero.

[c] SEM < .05.

* Significant at $p \leq .01$, level set to account for the large number of statistical tests conducted.

percentage meeting their recommendation (i.e., not surpassing their discretionary calorie allowance) was extremely low for all adolescents, regardless of snacking frequency.

Black adolescents in both the low- and high-snacking categories, and adolescents of other races (e.g., Asian, Hispanic other than Mexican, mixed races) in the low-snacking category only, were less likely than white adolescents to meet their milk recommendations (Table 3). Conversely black adolescents who snacked more favored fruits and thus were more likely to meet their fruit recommendations. Income level and weight status were not predictive of meeting recommendations for any of the MyPyramid groups/components.

Food choices

Table 4 presents the percentage of total MyPyramid portions eaten at snacking occasions as well as the top five foods contributing to those portions for each MyPyramid food group and component. More than one-third of all fruit portions and oils, about one-quarter of all grain and milk portions, and lesser proportions of vegetables and meat/beans portions were consumed at snacking occasions. In addition snacks contributed

Table 2
Mean intake of MyPyramid food groups and percentage meeting recommendations by snacking level among adolescents 12–19 years of age, 2001–2004[a]

Gender group and MyPyramid component	0 Snacks	1 Snack	2 Snacks	3 Snacks	4+ Snacks	p Value (t test)[c]	
	Number of portions (% meeting recommendations)[b]					Portions	% Meeting recommendations
Boys							
Grains (oz equivalents)	9.1 (53)	9.4 (58)	8.8 (52)	8.4 (58)	8.8 (59)	.101	.286
Vegetables (cups)	1.5 (8)	1.5 (9)	1.4 (8)	1.4 (8)	1.3 (5)	.079	.090
Fruit (cups)	.7 (15)	.8 (14)	.9 (14)	.9 (13)	1.7 (28)	<.001*	.003*
Milk (cups)	2.6 (27)	2.4 (26)	2.5 (25)	2.6 (38)	2.5 (44)	.876	<.001*
Meat/beans (oz equivalents)	6.9 (51)	6.1 (44)	6.4 (47)	6.0 (38)	5.3 (40)	.013	.039
Oils (tsp)	3.4 (7)	4.3 (14)	4.6 (20)	4.9 (18)	4.7 (18)	.017	.006*
Solid fats (g)	66.0	61.5	59.4	55.7	54.9	<.001*	—
Discretionary Calories	1110 (2)	1112 (2)	1105 (1)	1122 (2)	1104 (1)	.928	.557
Added sugars (teaspoons)	30.1	32.2	33.1	36.2	35.7	.016	—
Girls							
Grains (oz equivalents)	7.1 (61)	6.8 (48)	6.9 (52)	6.7 (49)	6.4 (44)	.048	.028
Vegetables (cups)	1.2 (13)	1.2 (6)	1.2 (8)	1.1 (6)	1.1 (6)	.177	.377
Fruit (cups)	.6 (11)	.8 (19)	.8 (14)	1.0 (22)	1.3 (27)	<.001*	<.001*
Milk (cups)	1.8 (12)	1.8 (19)	1.8 (17)	1.7 (20)	1.7 (19)	.578	.107
Meat/beans (oz equivalents)	4.5 (37)	4.4 (34)	4.3 (30)	4.0 (29)	3.8 (25)	.011	.025
Oils (teaspoons)	3.1 (19)	3.4 (21)	4.0 (20)	3.9 (18)	5.3 (27)	.961	.226
Solid fats (g)	45.2	45.5	43.6	44.6	40.2	<.001*	
Discretionary calories	772 (5)	802 (3)	796 (1)	829 (1)	826 (<.5)	.076	.002*
Added sugars (tsp)	22.3	23.6	24.5	25.9	27.6	<.001*	

[a] Adjusted for age, race/ethnicity (non-Hispanic white, non-Hispanic black, Mexican-American, other), percentage of poverty threshold (defined by U.S. Census Bureau), consumption of three main meals (yes/no), participation in vigorous and moderate activity in the last 30 days (yes/no), and weight status (underweight, normal weight, or at risk/overweight) as defined by CDC guidelines [24]. Energy (kilocalorie) intake was adjusted in the portions calculations but not the percent meeting recommendations calculations.

[b] Standard errors available upon request.

[c] t Test: β-coefficient of snacking level (treated as a continuous variable) is not equal to zero.

* Significant at $p \leq .01$, level set to account for the large number of statistical tests conducted.

more than one-third of discretionary calories and added sugars, and approximately one-fourth of solid fats.

Results from the nutrient and food group analyses reflect the foods that adolescents select at snacks. Snacks provide a large part of the total fruit portions, and one of the top contributers (orange juice) is high in vitamin C. Although items high in fat and/or added sugars predominate, some snack foods make valuable contributions to dietary intake.

Table 3
Sociodemographic determinants of meeting MyPyramid recommendations: Results from logistic regression models for adolescents 12–19 years of age, National Health and Nutrition Examination Survey (NHANES) 2001–2004

Snacking category and sociodemographic variable[a]	MyPyramid group[b]			
	Fruit		Milk	
	Adjusted OR[c]	99% CI	Adjusted OR[c]	99% CI
Low snacking (≤1 snack/day)				
Non-Hispanic black[d]	NS	NS	.42	(.25,.72)
Other race[d,e]	NS	NS	.24	(.09,.64)
High snacking (≥2 snacks/day)				
Non-Hispanic black[d]	1.57	(1.06, 2.31)	.55	(.38,.81)

CI = confidence interval; OR = odds ratio.

[a] Variables tested but not significant predictors for any of the MyPyramid groups: Mexican American descent, percentage of poverty threshold (<185%, 185–350%, >350%), and weight status (≤85th percentile body masss index for age, >85th percentile body mass index for age).

[b] Among the variables tested, no significant predictors were found for the following MyPyramid groups/components: grains, vegetables, and meat/beans groups, oil and discretionary energy sources.

[c] Estimates mutually adjusted for the other sociodemographic variables tested as well as age, gender, consumption of three main meals (yes/no), and participation in vigorous and moderate activity in the last 30 days (yes/no).

[d] Non-Hispanic white individuals were the reference category.

[e] Includes Hispanic individuals not of Mexican descent.

Table 4
Foods Eaten at Snacks: Percent of Total and Five Largest Contributors to MyPyramid Food Groups Portions, for Adolescents 12–19 Years, 2001–2004

MyPyramid Group	Food subgroup	Percent of total food group portions consumed at snacks		Percent contribution to MyPyramid portions eaten at snacks	
				Boys	Girls
Grain		22			
	Tortilla and corn chips, twists, puffs			16	16
	White breads and rolls			14	14
	Cookies			10	11
	Pizza			9	
	Crackers			6	7
	Pretzels				7
			Total	55	55
Vegetables		15			
	Potato chips			38	38
	Pizza			11	
	French fries			8	7
	Catsup, salsa			6	6
	Lettuce, cucumbers, celery			3	10
	Carrots				7
			Total	66	68
Fruits		39			
	Orange juice			24	13
	Apples			22	20
	Noncitrus juices- apple, grape, 100% juice blends			10	14
	Fruitades and drinks (not 100% juice)			7	8
	Bananas			7	7
			Total	70	62
Milk		24			
	Milk			51	44
	Flavored milk, milk drinks			9	6
	Frozen dairy desserts			9	11
	Pizza			8	
	Natural cheeses			4	11
	Candies				5
			Total	81	77
Meat/beans		12			
	Hot dogs, luncheon meats			19	13
	Nuts and seeds			15	25
	Chicken			8	10
	Nut butters			8	
	Candies			6	9
	Meat, poultry or fish with gravy/sauce				5
			Total	56	62
Discretionary calories		35			
	Soft drinks			25	23
	Frozen dairy desserts			9	10
	Candies			9	13
	Cookies			7	7
	Fruit drinks and ades			7	8
			Total	57	61
Added sugars (tsp)		43			
	Soft drinks			41	36
	Fruit drinks and ades			12	12
	Candies			12	16
	Frozen dairy desserts			6	7
	Cake			6	6
			Total	77	77
Oils (g)		37			
	Tortilla and corn chips, twists, puffs			25	22
	Potato chips			17	17

(Continued on next page)

Table 4
Continued

MyPyramid Group	Food subgroup	Percent of total food group portions consumed at snacks	Percent contribution to MyPyramid portions eaten at snacks	
	Candies		12	16
	Popcorn		8	
	Nuts and seeds		7	10
	Regular salad dressings			9
		Total	69	74
Solid fats		24		
	Frozen dairy desserts		15	16
	Cookies		13	12
	Milk		11	8
	Cakes		7	6
	Pizza		7	
	Candies			7
		Total	53	49

Chips (corn and potato combined), for instance, are major contributors to oil intake, and more than one-third of oil is eaten at snacks. This MyPyramid group was added in 2005 partly because of the nutrients it provides (e.g., vitamin E) [12]. Not surprisingly snacking frequency was found to positively influence vitamin E intake. Other popular foods provided little benefit. Soft drinks, for instance, contributed only to discretionary calories and added sugars, which were MyPyramid components overconsumed in the diet.

Discussion

This study provides information on the association of nutrient and food group intake to the frequency of snacking by adolescents. Food group intake was compared with MyPyramid recommendations to determine whether snacking level was predictive of meeting recommendations. Subgroups most at risk for not meeting recommendations within snacking categories were also identified. To our knowledge this is the first study to evaluate the effect of snacking on intake by using the MyPyramid Food Guidance System. In addition this study provides new information on the foods that adolescents are eating at snacks that are the primary contributors to the MyPyramid food groups. Identifying the foods that are consumed at snacks provides practical information for professionals who counsel adolescents on how to make more healthful, yet acceptable, snack food choices.

Snacking frequency affected intake of all the macronutrients and a few micronutrients. As snacking level increased, total energy increased, and most of this increase was in the form of carbohydrate. Total sugars increased at an even faster rate, so that more snacking resulted in a higher proportion of carbohydrate intake in the form of sugar. Protein and fat intakes, in contrast, were lowered on an adjusted kilocalorie basis. Micronutrients significantly affected by more frequent snacking were vitamin A, vitamin E, and magnesium by adolescent boys and vitamin C by both boys and girls. These findings are contradictory to those from other studies that have found higher or lower intakes of many nutrients with an increase in the reported number of eating occasions or, more specifically, the number of snacks in a day [10,26]. These other studies focused on adults, and it may be that the food choices made at snacks (and thus their nutrient contribution) are different for adolescents. The increases that we did find may be explained by the high consumption of fortified products at snacks. Fruit drinks, for instance, are highly fortified with vitamin C. Extremely popular with adolescents, they were one of the leading contributors to added sugars for boys and girls and were among the top five sources of discretionary calories at snacks.

Key recommendations of the Dietary Guidelines 2005 include encouraging the consumption of fruits and milk or milk products, as they exhibit some of the largest discrepancies between current consumption and recommendations [11]. It is therefore a positive finding that snacking increased the mean number of fruit portions consumed by both boys and girls and that the percentage of adolescent girls meeting recommendations for the fruit group and adolescent boys meeting recommendations for the fruit and milk groups significantly increased because of snacking. Fruit portions more than doubled on an adjusted kilocalorie basis for boys and girls when comparing nonsnackers with those in the highest snacking category, and the percentage meeting recommendations increased proportionately as well. Fruit intake by black adolescents in particular was enhanced by increased snacking. Milk intake, although constant on an adjusted kilocalorie basis, actually increased with more frequent snacking because kilocalorie intake increased. Because milk recommendations are set at three cups daily for male and female adolescents 12 years or more of age, regardless of the caloric level and corresponding dietary pattern, a significantly larger percentage of boys met their milk group recommendations at the highest snacking level when compared with the nonsnackers. Even though adolescent girls at the highest snacking level also consumed significantly more kilocalories on average than nonsnacking girls, they were not more likely to meet their milk recommendations. The quantity of milk portions in the diets of girls is so low that even an increase in kilocalories (assuming the same dietary composition) did not improve the likelihood of meeting recommendations. Studies have shown that consumption of foods high in calcium, such as milk products, have steadily decreased over the past 10 years, especially among adolescent girls and young women [27]. Milk and other dairy products are a primary source of calcium, which is required in sufficient quantities for optimal bone health [28]. Reports of progress toward national health objectives indicate that only 19% of females 9–19 years of age met calcium recommendations as of 1994 [29]. To encourage meeting these recommendations and to reduce the risk of osteoporosis later in life, adolescent girls at all snacking levels would benefit from incorporating more milk products into their diet. Black adolescents were also less likely to meet their milk recommendations relative to white adolescents, but the implications of this finding are less clear.

The higher consumption of soft drinks as snacking frequency rose may account for the apparent attenuated increase in milk group portions by girls. Girls who snacked the most consumed more than twice the added sugars as the nonsnacking girls, and soft drinks and fruit drinks contributed nearly 50% of all of the added sugars consumed at snacks. Findings for the adolescent boys were similar. This circumstance has negative implications on diet quality. Consumption of sweetened beverages has been associated with a higher risk of childhood obesity [30,31]. More generally, high intake of added sugars has been linked with low intakes of several micronutrients and low intake of food groups [32,33]. Beverage choices made at snacks appear to be an important area to target to decrease consumption of soda and fruit drinks in favor of more nutritious options.

Snack choices by adolescents need improvement. Studies have shown that consumption of three main meals by adolescents has decreased over the past 25 years in favor of smaller, more frequent eating occasions such as snacks [34]. Because main meals tend to be more nutrient-dense than other types of eating occasions, positive changes in snack choices are needed to compensate [5,10]. Top contributors to snacks for all of the food groups except the fruit group are foods high in discretionary calories and fats. Potato chips, for instance, provided more than one-third of all vegetable servings consumed at snacks. Palatable, relatively inexpensive snack foods that are similar to those currently chosen but that are lower in discretionary calories and fat and are more nutrient dense need to be more available. Nonfat or low-fat milk and milk drinks, 100% juices, and bottled water are viable alternatives to soda and fruit drinks. Substitution of traditional items already popular among adolescents, such as pizza and corn chips, with items with healthful modifications (e.g., using lower-fat ingredients, more substitution of baked items for fried) is one area that should be explored further. With appropriate food selections, the observed "grazing" meal pattern that is so prevalent in this age group could be instrumental in enhancing the overall dietary intake.

There are some limitations to this study. Underreporting of dietary intakes is a widespread problem, and foods eaten at snacking occasions are more likely to be forgotten or excluded from recall than foods eaten at main meals [35]. For this reason snack occasions must be specifically addressed in the interviewing process through questions and memory aids [36]. The AMPM method that was used to collect these data has been designed to address these concerns [16]. This method has been shown to work well in populations typically prone to underreporting, including women and overweight adults [37]. Another limitation was the mechanism by which dietary patterns were assigned because of the absence of activity level data. Assuming that respondents' intakes reflected energy balance (within 200 kilocalories) was chosen instead of arbitrarily assigning an activity level. Finally comparison of this study with others assessing the impact of snacking is difficult, because definitions as to what constitutes a snack are not consistent [38]. Although in this research, occasion designations including snacks were made by the respondent, other studies have used time of day, types or amounts of food consumed, or interviewer assessment to determine what eating occasions would be classified as snacks [10,39].

Conclusion

Snacks constitute a large portion of adolescents' total dietary intake. Snacking enhances the intake of vitamin C, fruit and oils; increases the likelihood of meeting fruit recommendations; and decreases intake of solid fats on an adjusted kilocalorie basis. Less beneficial are the sizeable contributions made to intake of discretionary calories and added sugars. Understanding how aspects of dietary patterns such as snacking frequency are associated with food and nutrient intake provides valuable information for practitioners to use when designing effective nutrition education strategies to improve adolescents' diets.

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