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Snacking Behaviors, Diet Quality, and BMI in a Community Sample of Working Adults

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Abstract

Background—Snacking behaviors have been linked with higher energy intake and excess weight. However results have been inconsistent. Moreover, few data are available on the extent to which snacking affects diet quality.

Objective—This study describes snacking behaviors, including total snacking energy, frequency, time of day, and percentage of snacking energy intake by food groups, and their associations with diet quality and BMI.

Design—Snacking behaviors and dietary intake were examined cross-sectionally among 233 adults participating in a community-based worksite nutrition intervention from September 2010–February 2013. Three telephone-administered 24-hour dietary recalls were collected (two weekday; one weekend day). Diet quality was characterized by the Healthy Eating Index (HEI)-2010 and BMI was computed using measured height and weight.

Setting—The setting was a large metropolitan medical complex in Minneapolis, Minnesota.

Main outcome measures—Outcome measures included diet quality and BMI.

Statistical analyses—General linear regression models were used to examine associations between each of the snacking behaviors as independent variables, and diet quality and BMI as dependent variables.

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Conflict of Interest

No potential conflict of interest is reported by the authors.

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Results—Percent of snacking energy from fruit & juice ($\beta=0.13$, $P=0.001$) and nuts ($\beta=0.16$, $P=0.008$) were significantly positively associated with diet quality. Percent of snacking energy from desserts and sweets ($\beta=-0.16$, $P<0.001$) and sugar-sweetened beverages ($\beta=-0.22$, $P=0.024$) were significantly inversely associated. Percent of snacking energy from vegetables ($\beta=-0.18$, $P=0.044$) was significantly associated with lower BMI. Percent snacking energy from desserts and sweets was significantly associated with a higher BMI ($\beta=0.04$, $P=0.017$).

Conclusions—Snack food choices, but not total energy from snacks, frequency or time of day, were significantly associated with diet quality and BMI.

Keywords

Snacking; eating behavior; diet quality; Healthy Eating Index; BMI; adults

Introduction

Snacking behavior, or eating occasions that are outside of main meals, has increased in the United States over the past few decades and has been linked with higher energy intake and weight gain¹⁻³. However, study findings have been inconsistent and the relationship between snacking, diet quality and excess weight gain is still unclear^{2,4,5}.

Particular aspects of snacking behavior have been hypothesized to be associated with both positive and negative outcomes regarding energy balance and BMI. For example, some have hypothesized that frequent snacking may promote more consistent feelings of satiety throughout the day and therefore lead to less overeating and improved daily energy balance⁶. Alternatively, frequent snacking throughout the day may contribute to excess energy intake unless less energy is consumed at meals⁷. Another hypothesis is that evening snacking may be more harmful to energy balance, perhaps due to excess calorie consumption or the choice of less healthful snack foods⁸.

Snack foods have typically been characterized as poor in nutritional quality, with most food items consisting of primarily fat and carbohydrates^{2,9}. However, data on snack food choices and possible associations with diet quality in adults are limited^{5,9}. Snacking in itself may not be harmful to a person's dietary quality and may increase the opportunity for the inclusion of healthy, low-energy food choices and a wider variety of foods in the diet⁴. In a recent study, five snacking patterns (miscellaneous snacks, vegetables/legumes, crackers/salty snacks, other grains, and whole fruit) were associated with better diet quality scores compared to participants with no reported snacking⁵.

This study aimed to: 1) examine patterns of snacking behavior (including frequency of snacking, snack energy intake, and percent of snack energy from different foods); and 2) examine the association between snacking behaviors, diet quality and BMI. It was hypothesized that greater energy intake from snacking and more frequent snacking would be associated with poorer diet quality and higher BMI. In addition, less healthful snack food choices such as chips, cakes, and sugar-sweetened beverages were hypothesized to be associated lower dietary quality and higher BMI.

Methods

Subjects

Data are from baseline measures of 233 adults recruited to participate in a worksite nutrition intervention conducted at a major urban medical center from September 2010 through February 2013¹⁰. The study was approved by the University of Minnesota Institutional Review Board. Data were collected by trained research staff at a University research building located about a mile from the medical complex. Eligible participants were scheduled for an individual baseline data collection visit at which the study was reviewed, eligibility confirmed, and informed consent was obtained. Eligibility criteria included the following: 1) age 18–60 years; 2) nonsmoker; 3) fluent in English; 4) not taking medications that affect appetite or body weight; 5) working at the medical complex full time, including during the lunch hours; 6) not currently on a diet to lose weight; 7) no history of a diagnosed eating disorder; 8) not moving from the area during the next six months; 9) not currently taking part in another research study; and 10) not currently pregnant, nursing or pregnant in the last 12 months.

The details of the intervention have been published¹⁰. The study purpose was to examine the effects of weekday exposure to one of three different lunch energy sizes on energy intake and body weight in a free living sample of adults over 6 months. The study purpose was described as a feasibility study for the provision of box lunches to employees at the worksite. Efforts were made to recruit a diverse sample in terms of sex, income, education and job type.

Dietary Measures

Dietary intake was measured using three telephone-administered 24-hour dietary recalls collected at baseline (a total of three recalls). Dietary recalls were conducted by trained and certified staff on non-consecutive days (two weekdays and one weekend day; all three within a time window of 21 days maximum) over the telephone using *Nutrition Data System for Research (NDSR) software version 2013 (Nutrition Coordinating Center, NCC), University of Minnesota, Minneapolis, Minnesota*. The NCC interviewers were trained to probe in detail about portion sizes and to ask the participants to use portion size examples to accurately report on the foods they ate. Food group components and select dietary data were extracted from NDSR output to create both the diet quality and snacking behavior variables.

Diet Quality—The 2010 USDA Healthy Eating Index (HEI-2010)^{11,12} was used to measure dietary quality based on mean values of food and nutrient intakes from an average of the three dietary recalls. The HEI quantifies diet quality in terms of the 2010 Dietary Guidelines for Americans^{11,13}. The HEI-2010 consists of the sum of 12 components: nine adequacy components and three moderation components, and ranges from 0 and 100 with a higher score indicative of a diet more consistent with the Dietary Guidelines for Americans. Food components examined included total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, fatty acids, refined grains, sodium, and empty calories. Empty calories as defined by the HEI-2010

includes calories from solid fats, alcohol (beyond a threshold >13g/1000 kcal), and added sugars^{11,12}.

Snacking Behaviors—Snacking behaviors were defined as meal entries designated as a “snack” using the NDSR interview system. “Snack” within the NDSR data profile represents any eating occurrence not designated by the participant as breakfast, brunch, lunch, dinner, beverage only, or other meal. The average frequency of snacking and the time of day for each snacking episode were determined for each participant based on the average of the three 24 hour recalls. Both average frequency of snacking and average total snacking energy were treated as continuous variables. Time of day was categorized into four time periods: morning (5:00–11:59 am), early afternoon (12:00–2:59 pm), late afternoon (3:00–5:59 pm), and evening (6:00 pm–5:00 am) using the date and time of each snacking episode recorded in the NDSR data profiles.

Percent of snack energy intake from food groups was determined by calculating the amount of snacking energy from each food group and dividing each value by the total daily energy from snacking. Food groups were determined by aggregating 135 specific food item groupings used by the NDSR system.

Body Weight and BMI

Body weight and height was collected during the initial baseline assessment. Participants were instructed not to eat any food or drink caloric beverages for 3 hours prior to the appointment. Body weight was measured to the nearest 0.1 kg using a calibrated electronic scale (Befour Inc, Saukville, WI) with participants wearing light clothing and no shoes. Height was measured to the nearest 0.1 cm with a wall-mounted stadiometer. All measures were performed in duplicate. If the two measures differed by greater than or equal to 1 cm or 0.5 kg, a third measurement was taken. The mean values of the two measures in closest agreement were used in analyses. Body mass index (BMI) was calculated as weight/height² (kg/m²).

Covariates

Covariates included demographic information, objectively measured physical activity data, and total daily energy intake. Demographic information was self-reported and included age, sex, race and ethnicity, educational level, household income, job type, and marital status. Physical activity was measured using a commercially available ActiGraph GT1M accelerometer (ActiGraph, Pensacola, FL) to determine the daily minutes of moderate-to-vigorous physical activity. Minimum wear time criteria were four days for a minimum of nine hours per day¹⁴.

Statistical Analyses

Separate linear regression models were used to examine associations between each of the snacking behaviors as the independent variables, and diet quality and BMI as dependent variables. Thus, each dependent outcome, diet quality or BMI, was modeled as a function of each snacking behavior i.e. total snacking energy, snacking frequency, time of day, or percent of snacking energy intake from each food group. Each model was adjusted for age,

sex, race/ethnicity, education level, income, job type, marital/partner status, physical activity, and total daily energy intake. Total daily energy intake was included in models so that the effect of snacking on diet quality and BMI independent of total energy intake could be examined. Also, and perhaps more importantly, energy was included to minimize potential bias from differential underreporting of energy intake by weight status. Statistical significance was set at $P < 0.05$. All analyses were performed using SAS (version 9.3, 2012, SAS Institute, Inc., Cary, NC).

Results

Participant Descriptive Characteristics

On average, participants were 43 years of age, two-thirds were female, and the majority were Non-Hispanic White (Table 1). Nearly 52% were college graduates and 77% earned greater than \$40,000 per year in annual income. Fifty-nine percent were married or living with a partner. The average moderate to vigorous physical activity was 27.5 minutes per day and the average daily total energy intake was 2,012 kcal per day. Seventy-four percent were overweight or obese ($> 25 \text{ kg/m}^2$), with an average BMI of 29.8 kg/m^2 . The average HEI-2010 score was 58.2 on a scale of 0 to 100.

Snacking Behaviors

On average, participants reported 2.1 snacking episodes per day and the mean energy intake from snacking was 404 kcal per day (Table 1). Nearly 85% of participants reported at least one snacking episode per day. Most snacks were consumed during the early or late afternoon. Snack choices consisted primarily of desserts and sweets (including cakes, cookies, pies, candy, sugar and sweets) (20.8%) and chips, crackers, ready-to-eat cereals, popcorn, and other related products (16.5%). A graphical representation is displayed in Figure 1.

Table 2 shows the results of linear regression models that examined the association between snacking behavior and diet quality or BMI. After adjusting for all covariates, there were no significant associations observed between total snacking energy, frequency of snacking, or time of day with either of the two outcomes, diet quality or BMI. However, percent of snacking energy from different food groups was significantly associated with diet quality and BMI. Percent of snacking energy from the fruit & juice group ($\beta = 0.13$, $P = 0.001$) and nuts ($\beta = 0.16$, $P = 0.008$) were significantly positively associated with diet quality. Thus, for each 10 percent increase in total snacking energy from fruit & juices or nuts, HEI-2010 score was significantly improved by 1.3 points and 1.6 points, respectively. Percent of snacking energy from desserts and sweets ($\beta = -0.16$, $P < 0.001$) and sugar-sweetened beverages ($\beta = -0.22$, $P = 0.024$) was significantly inversely associated with diet quality. Finally, percent of snacking energy from vegetables was significantly associated with lower BMI ($\beta = -0.18$, $P = 0.044$) and percent snacking energy from desserts and sweets was significantly associated with higher BMI ($\beta = 0.04$, $P = 0.017$).

Discussion

The present results show that total snacking energy and frequency are not associated with diet quality or BMI. However, choice of specific snack foods is associated in expected directions with diet quality and body weight. These are unique findings and provide new insights into the role that snacking behavior may play in energy balance and a healthful diet.

To the best of our knowledge, only two previous studies have examined the role of snacking on overall diet quality in adults^{5,9}. Using NHANES data, Zizza et al. observed that snacking frequency was modestly positively associated with higher HEI-2005 scores among adults 20 years and older. Thus, diet quality as assessed by the 2005 HEI, was higher in adults that snacked more frequently per day. In the present study, snacking frequency was not significantly associated with diet quality, or excess body weight, even though the perception of an association persists in the literature¹⁵. In another study by Nicklas et al., specific snacking patterns were found to be significantly associated with better dietary quality compared to a diet with no snacks⁵. However, our study goes a step further by considering how the percent of energy contributed by each snacking group or pattern was associated with overall dietary quality.

Unlike previous research, frequency was not the only measure used to define snacking behavior in the present study. The present study examined total energy intake from snacking and percent of energy from different snacking foods with overall diet quality and BMI. Only the percent of snacking energy from different types of snack foods was significantly associated with either overall diet quality or BMI. These findings suggest that the quality of the snack food consumed is important, but not necessarily the frequency or absolute calories. Specifically, snack intake from desserts and sugar-sweetened beverages was associated with poorer diet quality, while snack intake from fruit & juice and nuts was associated with a higher diet quality. Snack intake in the form of vegetables was associated with a lower BMI. However, given the small percentage of vegetable snacking within our study (1.4%) it could just be the case that of those participants that consumed vegetables as snack also happen to be the leaner individuals.

To date, there is no clear theory about how snacking behaviors are associated with diet quality and BMI. However, the present study addresses several important limitations in the snacking behavior research literature. First, the current literature does not include any standardized, universal accepted definition of snacking^{4,16}. Many researchers have used the time of day of food consumption, defining a “snack” as everything consumed between the main meals (i.e. breakfast, lunch, or dinner)¹⁶. However, others have identified snacks by their nutrient content and actual foods that are consumed⁴. In addition, snacking behavior has been thought to be a positive and negative facilitating mechanism for energy balance and body weight⁷. However a consistent theory has not been articulated to resolve these inconsistent predictions. Evidence supports both hypotheses: that snacking several times every day and selecting nutrient-rich foods can be beneficial to overall diet quality and weight status, especially in select populations (i.e. lean, healthy, young adults), as well as that consuming snack foods, especially those with high fat, sugar, or salt content, has a deleterious influence on diet quality and weight¹. While the present cross-sectional study

cannot draw any firm conclusions about causality, the findings from the present study support the hypothesis that healthful snack choices can contribute to energy balance and a healthful diet. Moreover, snacking is not necessarily an unhealthy behavior¹⁷, but may be unhealthy if high calories, nutrient-poor foods such as chips, cakes, desserts, and/or sugar-sweetened beverages are selected.

Strengths of the present study are notable. Data collected for this study used gold-standard methods for dietary assessment, BMI, and physical activity. Using the dietary data, detailed features of snacking behavior including frequency, time of day, and specific foods consumed were selected. Additionally, overall diet quality was characterized using the latest 2010 Healthy Eating Index. The HEI has become a useful tool for researchers to assess individuals' diet quality based on their compliance with dietary recommendation from the Dietary Guidelines of Americans (DGA)^{11,12}. Thus, this study assessed snacking behavior using both snacking frequency and specific food groups in relationship to overall diet quality and BMI. It is only the third study to examine the association between snacking behaviors and overall diet quality in adults. Lastly, this study used a free-living, worksite sample of adults compared to laboratory or a specialized sample such as college students.

There are several limitations to this study. First, a snacking episode was defined as any eating occasion not identified as a main meal. This method for defining snacking was chosen based on the NDSR data collection protocol and there may be measurement error associated with the snacking definition. However, this approach provides a consistent method of defining snacking behavior across studies that use NDSR dietary assessment protocols. Secondly, there is likely underreporting of dietary intake with the magnitude of underreporting greater in overweight and obese participants. This is a well-documented methodological limitation of most self-report dietary assessment methods^{18,19}. Moreover, it's possible intake could be misreported, particularly for snacking²⁰. However, this study used the 24-hour recall method which is considered a gold standard method for capturing dietary intake in free living populations. Finally, a small sample size was available compared to larger, national surveys of dietary intake. The sample may not be generalizable to all populations and sub-groups. The study was conducted in a healthcare worksite and the participants were predominantly female, White, and educated. Thus, their behaviors may not reflect the general population. However, the recruited sample did try to include significant proportions of men, non-White racial/ethnic groups and different job types.

Conclusion

Frequency of snacking (and total energy from snacking) were not significantly associated with overall diet quality or BMI in this community sample of working adults. However, the proportion of energy from various types of foods consumed as snacks was significantly associated with these outcomes.

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Figure 1.
Mean % of snacking energy intake from food groups in 233 adults participating in a work-site intervention at baseline

Table 1

Descriptive characteristics of a small sample of working adults participating in a work-site invention at baseline (n=233)

Demographics		
Age (in years), mean $\pm$ SD		42.6 $\pm$ 11.2
Sex, %		
Male		32.6
Female		67.4
Race/Ethnicity, %		
Non-Hispanic White		65.7
Non-Hispanic Black		14.5
Hispanic		10.3
Asian		7.7
Native American		0.9
More than one race		0.9
Education, %		
High School/GED/Vocational		15
Some College		33.5
College Graduate and Beyond		51.5
Job Type, %		
Admin/Executive		10.7
Clerical/Admin/Tech		37.3
Patient Care		35.2
Service/Labor		4.7
Other		9
Missing		3
Income (per year), %		
\$40,000		22.8
>\$40,000 and \$80,000		41.2
>\$80,000		36
Married/Living with Partner, %		
Yes		58.8
No		41.2
Moderate to Vigorous Physical Activity (minutes per day), mean $\pm$ SD		27.5 $\pm$ 17.2
Total Daily Energy Intake (kcal per day), mean $\pm$ SD		2,012.4 $\pm$ 678.5
Diet Quality		
HEI-2010 ^a (Score range, 0 to 100), mean $\pm$ SD		58.2 $\pm$ 12.2
BMI		
BMI (kg/m ²), mean $\pm$ SD		29.8 $\pm$ 6.4
Daily Snacking Behaviors		
Total Snacking Energy Intake (kcal per day), mean $\pm$ SD		404.2 $\pm$ 275.7
Frequency of Snacking (times per day), mean $\pm$ SD		2.1 $\pm$ 1

Average Time of Day of Snack Meals, n (%)

Morning (5:00 – 11:59 am)	28 (12.4)
Early Afternoon (12:00 – 2:59 pm)	83 (36.9)
Late Afternoon (3:00 – 5:59 pm)	72 (32)
Evening (6:00 pm – 5:00 am)	42 (18.7)

% of Snacking Energy Intake from Food Groups, mean $\pm$ SD

Fruit & Juice	11.1 $\pm$ 20.2
Vegetables	1.4 $\pm$ 4.1
Protein (including beef, pork, poultry, and related products)	3 $\pm$ 8.5
Grains and related products	8.1 $\pm$ 13.2
Chips, crackers, ready-to-eat cereals, popcorn, and related products	16.5 $\pm$ 22.6
Desserts and sweets (including cakes, cookies, pies, candy, sugar and sweets)	20.8 $\pm$ 22.9
Nuts	5.1 $\pm$ 13.1
Dairy (including milk, ice cream, yogurt and related products)	15 $\pm$ 18.9
Sugar-sweetened beverages	2.5 $\pm$ 8
Other foods (fats and oils, eggs and related products, condiments, spices, soups, gravy, and sauces, commercial entrees, supplements, and other beverages)	10.5 $\pm$ 14.2

^aHEI-2010, Healthy Eating Index-2010

Table 2

Associations between the snacking behaviors of a sample of adults participating in a work-site intervention and diet quality and BMI at baseline (n=233)

	Diet Quality based on HEI-2010 ^a		BMI (kg/m ²)	
	β (SE) ^b	P value	β (SE) ^b	P value
Daily Snacking Behaviors				
Total Snacking Energy Intake (kcal per day)	−0.0009 (0.004)	0.797	−0.0003 (0.002)	0.861
Frequency of Snacking (times per day)	1.4 (0.92)	0.129	−0.63 (0.43)	0.151
Average Time of Day of Snack Meals				
Morning (5:00 – 11:59 am)	ref		ref	
Early Afternoon (12:00 – 2:59 pm)	−1.76 (2.73)	0.521	−0.91 (1.3)	0.481
Late Afternoon (3:00 – 5:59 pm)	−0.57 (2.78)	0.838	−0.3 (1.32)	0.821
Evening (6:00 pm – 5:00 am)	−0.66 (3.01)	0.826	0.27 (1.43)	0.851
% of Snacking Energy Intake from Food Groups				
Fruit & Juice	0.13 (0.04)	0.001	−0.02 (0.02)	0.364
Vegetables	−0.11 (0.19)	0.583	−0.18 (0.09)	0.044
Protein (including beef, pork, poultry, and related products)	−0.06 (0.09)	0.5	−0.07 (0.04)	0.103
Grains and related products	0.01 (0.06)	0.856	0.002 (0.03)	0.946
Chips, crackers, ready-to-eat cereals, popcorn, and related products	0.05 (0.03)	0.147	0.002 (0.02)	0.892
Desserts and sweets (including cakes, cookies, pies, candy, sugar and sweets)	−0.16 (0.03)	<0.001	0.04 (0.02)	0.017
Nuts	0.16 (0.06)	0.008	−0.05 (0.03)	0.076
Dairy (including milk, ice cream, yogurt and related products)	−0.03 (0.04)	0.517	0.07 (0.02)	0.75
Sugar-sweetened beverages	−0.22 (0.10)	0.024	−0.005 (0.05)	0.912
Other foods (fats and oils, eggs and related products, condiments, spices, soups, gravy, and sauces, commercial entrees, supplements, and other beverages)	−0.02 (0.06)	0.673	−0.01 (0.03)	0.665

^aHEI-2010, Healthy Eating Index-2010

^bAssociations assessed using simple linear regression models. All models adjusted for age, sex, race/ethnicity, education, job type, income, partner, physical activity, and total daily energy intake.