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Common ways Americans are incorporating fruits and vegetables into their diet: intake patterns by meal, source, and form, National Health and Nutrition Examination Survey, 2007–2010

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Abstract

Objective—We explored how Americans aged 2 years and older who consumed the recommended amount of fruits and vegetables on a given day incorporated fruits and vegetables into their diet compared to those who did not consume recommended amounts.

Design—We used one day of dietary recall data from the 2007–2010 National Health and Nutrition Examination Survey (NHANES) to examine cross sectional differences in mean intake of fruits and vegetables in cup equivalents by meal, source, and form between the two groups.

Setting—United States

Subjects—17,571 2007–10 NHANES participants aged 2 years and older with 1 day of reliable 24-hour recall data

Results—On a given day, the proportion of fruits and vegetables consumed at different meals were similar between those who consumed recommended amounts and those who did not. Among adults, 59 – 64% of their intake of fruit was consumed at breakfast or as a snack and almost 90% of came from retail outlets regardless of whether they consumed the recommended amount or not. Adults who consumed the recommended amount of fruit ate more fruit in raw form and with no additions than those who did not. Among children and adults, 52–57% of vegetables were consumed at dinner by both groups. Retail outlets were the main source of vegetables consumed (62%–68%).

Conclusion—Our findings indicate that habits of when, where and how consumers eat fruits and vegetables might not need to change but increasing the amount consumed would help those not currently meeting the recommendation.

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Keywords

fruit; vegetables; recommended amounts; dietary patterns

Introduction

Most Americans do not eat enough fruits and vegetables ⁽¹⁾ in spite of the demonstrated benefits of consuming adequate amounts⁽²⁾. The *Dietary Guidelines for Americans, 2010* encourage Americans to increase intake of fruits and vegetables to add important nutrients that are frequently lacking from their diets, reduce the risk of many leading causes of death and illness, and aid in healthy weight management by substituting them for higher calorie foods⁽²⁾. However, in 2007–2010, among individuals aged 1 year and older, approximately 13% met their age and sex-specific U.S. Department of Agriculture (USDA) Food Patterns vegetable intake recommendations and 25% met fruit recommendations⁽³⁾.

To date, little research has been done using nationally representative data on how people incorporate fruits and vegetables into their day^(4–6), especially among those who consume amounts recommended by the USDA Food Patterns versus those who do not. Given this, we explored how U.S. children (aged 2–18 years) and adults (aged 19 years and over) who consumed recommended amounts of fruits and vegetables on a given day incorporated fruits and vegetables into their diets compared to those who did not using nationally representative data from 2007 – 2010. We identified where (source), when (meal), and in what form(s) individuals consumed their fruits and vegetables among those who consumed recommended amounts on a given day versus those who did not.

Methods

We used data from the 2007–2010 National Health and Nutrition Examination Survey (NHANES) to estimate fruit and vegetable intake among individuals aged 2 years and older. NHANES is a nationally representative survey of the non-institutionalized population that is conducted in 2-year phases using a stratified multi-stage probability design. Details on the survey and sampling are described elsewhere⁽⁷⁾. Respondents participated in a household questionnaire and a physical examination, including a 24-hour dietary recall, at the Mobile Examination Center (MEC). Trained interviewers collected 24-hour dietary recalls using the USDA automated multiple-pass method by proxy for those aged 1–5 years, with proxy assistance for those aged 6–11 years, and directly from participants aged 12 years. A total of 20,686 individuals were interviewed and 20,015 completed a physical examination in the MEC. MEC response rates were 75.4% and 77.3% for NHANES 2007–2008 and 2009–2010, respectively. There were 17,571 individuals aged 2 years and older with 1 day of reliable 24-hour recall data who participated in NHANES 2007–10 and were included in analyses. All participants in NHANES provided written informed consent.

For all foods or beverages participants reported, we used USDA's Food Patterns Equivalent Database (2007–2008 and 2009–2010) to disaggregate each food or beverage item into its individual food components^(8, 9). The total amount of fruits and vegetables for each individual, in cup equivalents, were summed across all foods and beverages that were

reported. Cup-equivalents of fruits and vegetables consumed were calculated separately by the meal, source, and form of each food item. Categories of meal, source, and form were derived from survey responses. Of the 20 different types of eating occasions⁽¹⁰⁾, we classified foods and beverages into 5 meal categories: breakfast, lunch, dinner, snack, and other eating occasions such as brunch and drinking occasions. Of the 23 different source options⁽¹⁰⁾, we collapsed foods and beverages into four mutually exclusive categories: 1) Retail (e.g., retail stores, mail order purchases); 2) Restaurants (e.g., restaurants, bars, street vendors, and sport, recreation or entertainment facilities); 3) Cafeterias (e.g., school and other institutional cafeterias, residential dining facilities, vending machines, common snack tray, childcare center, family/adult day care center); and 4) Other (e.g., soup kitchens or food pantries, Meals On Wheels, other community food programs, home grown or gifted, and any other reported source). Lastly, of the 16 different types of food and beverage combinations,⁽¹⁰⁾ we collapsed foods and beverages into four mutually exclusive form categories: 1) raw/alone (e.g. whole or cut up apple or carrots); 2) a salad or sandwich ingredient; 3) an ingredient in a fruit or vegetable mixed dish (e.g. salsa, hummus, tomato sauce on pizza or spaghetti); and 4) all other forms.

Individuals were classified as consuming the recommended amounts based on the total cup-equivalents of fruits and vegetables consumed on the recall day, respectively. Recommended amounts (Table 1) ranged from 1 to 2 cup-equivalents of fruit and 1 to 3 cup-equivalents of vegetables, were age- and sex-specific, and appropriate for individuals with less than 30 minutes of daily physical activity.^(11, 12) Ratio of means were calculated to compare the relative proportion of fruits and vegetables consumed at different meals, from different sources, and in different forms among those who consumed recommended amounts versus those who did not. Ratio of means were estimated by dividing each group's mean amount of fruit and vegetable intake from different meals, sources, and forms by the group's mean total fruit and vegetable intake. Ratio of mean estimates and p-values for differences in the ratio of means using t-tests for linear contrasts were calculated using PROC RATIO in SAS 9.3.2 and SAS Callable SUDAAN 10.1 to account for the complex sampling design. Analyses were conducted separately for those 2–18 years and those aged 19 years and over. Due to the number of statistical tests performed, a Bonferroni adjustment was used to set the significance level at 0.001.

Results

Children who consumed the recommended amounts of fruits or vegetables ate or drank about an additional cup each of fruits and vegetables compared to those children who did not consume the recommended amounts (Table 2). Adults who consumed the recommended amounts ate or drank an additional 2.5 cups of fruits and 2.6 cups of vegetables compared to those who did not consume recommended amounts.

Meals

In general, the proportion of fruits and vegetables consumed at different meals were similar between those who consumed recommended amounts and those who did not. For example, among adults, 59 – 64% of fruit was consumed during breakfast or as a snack regardless of

whether or not these individuals met fruit recommendations on the day of recall. However, adults who did not consume recommended amounts of fruit reported consuming a larger share during breakfast (34% versus 25%, p -value < 0.0001). Among all children, the largest share of fruit was consumed as a snack (31%–37%), followed by lunch (22% – 27%), and then breakfast (18% – 23%); however, children who consumed recommended amounts were not significantly different in their intake patterns from those who did not consume recommended amounts. For both adults and children, dinner was the meal in which the greatest proportion of vegetables were consumed (ranged from 52% – 57%), regardless of whether they consumed recommended amounts or not.

Source

Among all adults, almost 90% of fruit was obtained from retail stores (86%–88%). Most fruit for children came from retail stores as well (72% – 80%); however, cafeterias accounted for 16% of fruit intake for children who did not consume recommended amounts compared to 9% of fruit for children who met recommendations (p -value < 0.0001). Overall, retail stores and restaurants were the most commonly reported source for vegetables among both adults and children (retail: 60%–68% and restaurant: 20%–29%). A higher proportion of vegetables came from restaurants for adults who did not consume recommended amounts compared to adults who did meet recommendations (29% versus 21% respectively, p -value < 0.0001).

Form

A higher proportion of fruit was eaten raw and alone (e.g., a raw, whole or sliced apple) among adults and children who consumed recommended amounts compared to those who did not (p -values < 0.001). Both adults and children consumed the majority of their vegetables in forms other than raw and alone, as part of a salad or sandwich, or in a fruit/vegetable mixed dish, regardless of meeting the recommendations. However, adults who did not consume recommended amounts also reported consuming less vegetables as part of a salad or sandwich (19% versus 25% respectively, p -value < 0.0001) than those who consumed recommended amounts.

Discussion

In general, the proportion of fruits and vegetables consumed at different meals, from different sources, and in different forms were similar between those who consumed recommended amounts and those who did not. Individuals who reported consuming recommended amounts of fruits and vegetables incorporated them into their diets in similar ways to those who did not. Compared to those who did not report consuming recommended amounts, those who did reported consuming an additional two cup-equivalents of both fruit and vegetables which equated to six times as much fruit and three times as many vegetables.

The findings from this study are consistent with prior work^(4–6). For example, a NHANES 2007–2010 analyses indicated that about 90% of fruit and 70% of vegetables are consumed at home⁽⁴⁾. A survey of 2,000 households in the U.S. indicated that two thirds of vegetables were eaten at dinner and fruits were consumed at all eating occasions but especially

breakfast (44%) and lunch (24%)⁽⁵⁾. Similarly, most fruit and vegetables were consumed at home and a large proportion was consumed fresh. A small-scale study among fourth to sixth graders also found higher fruit intake was associated with starting the day with juice or fruit⁽⁶⁾. While the above studies have examined how small populations or subpopulations obtain fruits and vegetables and when they eat them⁽⁴⁻⁶⁾, this study differs from others in that we used updated nationally representative data to explore how intakes of fruit and vegetables on a given day differed between those who consumed recommended amounts and those who did not.

Limitations of this study include reliance on the Food Patterns Equivalents Databases to estimate cup equivalents of fruits and vegetables for each food reported. The Food Patterns Equivalents Databases disaggregates foods reported, including composite foods and mixtures, into their nutritionally relevant components and translates these amounts into cup equivalents consistent with federal food guidance. Although, the databases are uniquely designed to examine diets reported via 24-hour recall methodology in NHANES, assumptions are made regarding the consistency of recipes and cooking methods to disaggregate foods into appropriate components. A second limitation of the analysis is that we did not examine whether usual intake of fruits and vegetables exceeded recommendations. One 24-hour dietary recall does not capture day-to-day variation in diets and thus does not represent usual dietary intake but is accurate for estimating differences in mean intakes as we did in these analyses⁽¹³⁾. Third, individuals may not report their food consumption accurately by weight status^(13, 14) and possibly between meals⁽¹⁵⁾. NHANES may underreport mean energy intake by 11% compared to total energy expenditure estimated using doubly labeled water⁽¹⁶⁾. Normal weight adults underreported mean energy intake by <3%⁽¹⁶⁾. Fruit intake estimates especially may be higher than reported given that approximately a third of fruit intake occurs as snacks. Next, while most Americans should consume more fruits and vegetables to meet recommendations, increased intake should be balanced within calorie needs. Fruit and vegetable intake recommendations account for calorie needs, however, individual needs may differ from those in the USDA Food Patterns. Finally, we examined patterns among children and adults overall even though fruit and vegetable intake varies within these broad age groups⁽³⁾. In general, we observed no significant differences when we stratified by age in children (see Appendix Table) but further research may be needed to explore patterns by age.

Eating patterns by meal, source, and form for those who consumed recommend amounts of fruits and vegetables on a given day versus those who did not were very similar and mainly differed in the amount consumed. Overall, this indicates that people may not need to shift their current habits substantially in regards to when, from where, and how they eat in order to meet recommendations. Increasing the amount of fruit consumed by 1 cup equivalent equates to eating a banana or a small apple⁽¹¹⁾. Increasing the amount of vegetables consumed by 1 cup equates to eating 12 baby carrots or a large tomato⁽¹²⁾. Small shifts in everyday eating patterns like these could help the majority of the U.S. population who are not consuming enough fruits and vegetables reduce their risk of many leading causes of illness and death, add important nutrients to their diet, and help with weight control⁽²⁾.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

USDA Food Patterns recommended intakes of fruits and vegetables by age and sex *

Age and Sex Group	Cup equivalents [†]	
	Fruit [‡]	Vegetable [§]
Children		
2–3 years	1.0	1.0
4–8 years	1–1.5	1.5
Females		
9–13 years	1.5	2.0
14–18 years	1.5	2.5
19–30 years	2.0	2.5
31–50 years	1.5	2.5
51+ years	1.5	2.0
Males		
9–13 years	1.5	2.5
14–18 years	2.0	3.0
19–30 years	2.0	3.0
31–50 years	2.0	3.0
51+ years	2.0	2.5

USDA, United States Department of Agriculture

* These amounts are appropriate for individuals who get less than 30 minutes per day of moderate physical activity, beyond normal daily activities. Those who are more physically active may be able to consume more while staying within calorie needs.

[†] One cup equivalent is approximately equal to 1 small apple (149 g), 8 large strawberries (144 g), 12 baby carrots (120 g), or 1 large tomato (182 g).

[‡] How Much Fruit Is Needed Daily? [United States Department of Agriculture]. 2016. Available at: <http://www.choosemyplate.gov/Fruits>. Accessed February 4, 2016.

[§] How many vegetables are needed? [United States Department of Agriculture]. 2016. Available at: <http://www.choosemyplate.gov/vegetables>. Accessed February 4, 2016.

Amounts of fruit and vegetables consumed by source, form, and meal versus total intake (ratio of means) among those who met USDA Food Patterns fruit intake recommendations on a given day of recall versus those who did not meet target, National Health and Nutrition Examination Survey 2007–2010

Table 2

Fruit	2–18 years: Met target			>= 19 years: Met target		
	Yes	No	P-value*	Yes	No	P-value
No. of respondents	3,244	2,846		2,563	8,918	
Cup equivalents consumed	1.7	0.4	<.0001	3.0	0.5	<.0001
Meal						
Breakfast	18%	23%	0.0116	25%	34%	<.0001
Lunch	22%	27%	0.0095	16%	14%	0.0509
Dinner	16%	13%	0.0412	16%	16%	0.8862
Snack	37%	31%	0.0224	34%	30%	0.0021
Other	8%	6%	0.2192	9%	6%	0.0037
Source [†]						
Retail store/source	80%	72%	<.0001	88%	86%	0.1956
Restaurant	3%	5%	0.0567	4%	6%	0.0004
Cafeteria	9%	16%	<.0001	2%	2%	0.8192
Other	7%	7%	0.9453	7%	6%	0.3759
Form [‡]						
Raw, alone	84%	75%	<.0001	82%	70%	<.0001
Salad or sandwich	1%	1%	0.1375	1%	2%	0.1032
Fruit/vegetable mixed dish	3%	3%	0.9817	3%	3%	0.6321
Other	13%	21%	<.0001	13%	24%	<.0001
Vegetable						
No. of respondents	1,648	4,442		1,975	9,506	
Cup equivalents consumed	1.7	0.7	<.0001	3.8	1.2	<.0001
Meal						
Breakfast	5%	4%	0.0698	7%	5%	0.0575
Lunch	29%	31%	0.3129	28%	31%	0.0501
Dinner	52%	54%	0.2198	57%	56%	0.7914

Fruit	2–18 years: Met target		>= 19 years: Met target		P-value
	Yes	No	Yes	No	
Snack	14%	11%	6%	7%	0.4002
Other	1%	1%	2%	1%	0.0444
Source [‡]					
Retail store/source	63%	60%	68%	62%	0.0003
Restaurant	20%	25%	21%	29%	<.0001
Cafeteria	8%	9%	2%	2%	0.6792
Other	10%	6%	9%	7%	0.0019
Form [‡]					
Raw, alone	6%	3%	5%	3%	0.0006
Salad or sandwich	13%	11%	25%	19%	<.0001
Fruit/vegetable mixed dish	12%	13%	14%	12%	0.0614
Other	69%	73%	57%	66%	<.0001

* P-values for differences in the ratio of means using t-tests for linear contrasts

[‡] Stores include retail stores and mail order purchases; Restaurants include restaurants, bars, street vendors, and sport, recreation or entertainment facilities; Cafeterias include cafeterias, residential dining facilities, vending machines, common snack tray, childcare center, family/adult day care center; Other sources include food assistance programs, home grown or gifted, and any other reported sources.

[‡] Form categories included: 1) raw and not an ingredient; 2) an ingredient in a salad or sandwich; 3) an ingredient in a fruit or vegetable based dish; and 4) an ingredient in other types of mixed dish. Ingredient in fruit and vegetable dish includes salsa, bean dips, guacamole, and other dried bean vegetable, and fruit-based mixed dishes.

Appendix Table

Amounts of fruit and vegetables consumed by source, form, and meal versus total intake (ratio of means) among 2–5, 6–11, and 12–18 year olds who met USDA Food Patterns fruit intake recommendations on a given day of recall versus those who did not meet target, National Health and Nutrition Examination Survey 2007–2010

Fruit	Met target							
	2–5 years				6–11 years			
	Yes	No	P-value*		Yes	No	P-value*	
No. of respondents	956	737			810	1465		
Cup equivalents consumed	2.3	0.4	<.0001		2.3	0.4	<.0001	
Meal								
Breakfast	19%	23%	0.1971		17%	21%	0.1522	
Lunch	21%	22%	0.4709		23%	32%	0.0036	
Dinner	14%	13%	0.5527		18%	13%	0.0439	
Snack	38%	36%	0.4539		36%	29%	0.0203	
Other	8%	6%	0.2994		6%	6%	0.9520	
Source [‡]								
Retail store/source	84%	81%	0.3487		74%	67%	0.0188	
Restaurant	3%	5%	0.2233		4%	4%	0.9777	
Cafeteria	8%	6%	0.2426		14%	22%	0.0228	
Other	5%	8%	0.0463		8%	8%	0.9031	
Form [‡]								
Raw, alone	81%	73%	0.0155		82%	74%	0.0056	
Salad or sandwich	1%	1%	0.9513		1%	2%	0.1098	
Fruit/vegetable mixed dish	3%	1%	0.0814		4%	3%	0.7066	
Other	15%	25%	0.0059		13%	20%	0.0034	
Vegetable								
No. of respondents	451	1,242			468	1,807		
Cup equivalents consumed	1.6	0.4	<.0001		1.9	0.6	<.0001	
Meal								

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