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Diets of drinkers on drinking and nondrinking days: NHANES 2003–2008[1–3]

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ABSTRACT

Background: Alcohol may affect dietary intake. However, little is known about diets on drinking days in the US population.

Objective: We determined whether the diets of drinkers differ on drinking compared with nondrinking days.

Design: Data were from the 2003–2008 NHANES Mobile Examination Center interview. We identified 1864 current drinkers (1126 men and 738 women) who completed two 24-h dietary recalls, one of which was on a drinking day and the other of which was on a nondrinking day. Sex-specific repeated-measures analyses that were adjusted for dietary recall order and recall day of the week were used to compare within-individual differences in energy, nutrient, and food-group intakes. Analyses were weighted to produce representative estimates.

Results: On their drinking (compared with nondrinking) days, men consumed an excess 168 nonalcohol kcal ($P < 0.01$), which was reflected in higher intakes of nutrients including total protein ($P < 0.001$), total fat ($P < 0.01$), saturated fat ($P < 0.01$), monounsaturated fat ($P < 0.01$), potassium ($P < 0.001$), and sodium ($P < 0.05$). Men also had higher intakes of food groups including meat ($P < 0.001$), white potatoes ($P < 0.05$), and discretionary oil and solid fat ($P < 0.05$) and lower intakes of total fruit ($P < 0.05$) and milk ($P < 0.05$). Women did not consume excess nonalcohol kilocalories but had higher intakes of total fat ($P < 0.05$), monounsaturated fat ($P < 0.05$), polyunsaturated fat ($P < 0.05$), potassium ($P < 0.01$), and discretionary oil and solid fat ($P < 0.05$) and lower intakes of milk ($P < 0.01$) and milk products ($P < 0.01$).

Conclusions: These mostly moderate drinkers had poorer diets on drinking days. Same-day associations between alcohol and diet could be useful targets for public health efforts to improve dietary intake. *Am J Clin Nutr* doi: 10.3945/ajcn.112.050161.

INTRODUCTION

Alcohol, which is a macronutrient that supplies 7 kcal/g, is consumed by 70% of US adults (1) and contributes 4.8% of the population's total energy intake (2). The high prevalence of obesity in the United States (3) has led to concern about the potential effect of alcohol on dietary intake. However, little is known about diets of drinkers on days that they drink because suitable population-level epidemiologic data have not been available to explore the relation.

Whether alcohol is associated with same-day diet is an important and considerably different question than that posed by previous epidemiologic studies (4–14) and a clinical trial (15) that investigated whether usual alcohol consumption averaged over days to a year was associated with diet. Same-day effects of alcohol on diet are biologically plausible. Alcohol acutely suppresses fatty acid oxidation, increases short-term thermogenesis, and affects food-related hormones and neurotransmitters including leptin, serotonin, and neuropeptide Y (16). In terms of public health messages, same-day associations between alcohol and diet could be useful targets for efforts to improve dietary intake.

Several human experimental studies have reported that moderate alcohol consumption increased same-day nonalcohol energy intake (4, 16–22). These studies typically administered an alcohol preload before or with lunch. Food intake was immediately stimulated, and the effect lasted ∼1–2 h. In 2 studies (17, 18), energy intake was not sufficiently reduced during the remainder of the day to completely compensate for the excess alcohol and food consumed; however, in one study (17), excess energy intake was compensated for by a reduced intake on the subsequent day. These experimental studies provided little information about the association of alcohol with nutrient or food-group intakes because food choices were limited, and it was not their purpose.

It would be possible to compare dietary intake on drinking compared with nondrinking days within individuals in the US population if an epidemiologic study included repeated measures of alcohol and diet. The advantage of repeated measures is that each person acts as his or her own control (ie, each person is matched to himself or herself), which removes confounding as a result of individual-level characteristics both observable (eg, demographics and lifestyle) and unobservable (eg, genetics and environment). The 2003–2008 NHANES included two 24-h

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recalls that were obtained generally 3–10 d apart and provided an opportunity for such an analysis. We used these recalls to examine diets of 1864 current drinkers who consumed alcohol on one of the 24-h recalls but not the other.

SUBJECTS AND METHODS

Survey

Our study used combined data from NHANES conducted in 2003–2004, 2005–2006, and 2007–2008. NHANES, which is conducted by the CDC's National Center for Health Statistics, is a continuing cross-sectional nationally representative survey of the health and nutrition of the US noninstitutionalized civilian population (23). NHANES uses a complex, stratified, multistage probability sample design. The survey includes an in-person visit to a mobile exam center (MEC) where participants receive a health examination and are asked interviewer-administered questions on several topics including alcohol use and dietary intake. Unweighted response rates for the MEC sample were 76% in 2003–2004 (24); 77% in 2005–2006 (25); and 75% in 2007–2008 (26).

Alcohol consumption assessment

During the MEC visit, adults aged ≥20 y are asked about usual alcohol consumption over their lifetime as follows: "In any one year, have you had at least 12 drinks of any type of alcoholic beverage?"; "In your entire life, have you had at least 12 drinks of any type of alcoholic beverage?"; "In the past 12 months, how often did you drink any type of alcoholic beverage?"; and "In the past 12 months, on those days that you drank alcoholic beverages, on the average how many drinks did you have?" (27). Individuals were considered current drinkers if they consumed ≥12 drinks in their entire life and drank on ≥1 d in the past year. In women, light drinking was defined as ≤3 drinks/wk, moderate drinking was defined as >3–7 drinks/wk, and heavier drinking was defined as >7 drinks/wk; in men, corresponding ranges were ≤3, >3–14, and >14 drinks/wk, respectively.

Dietary assessment

The MEC visit includes an interviewer-administered dietary recall that uses the USDA Automated Multiple-Pass Method (28) to estimate all foods and beverages (including alcohol) consumed during the 24-h period before the interview (midnight to midnight) (29). On completion of the recall, participants are scheduled for a second recall to be administered by telephone 3–10 d later on a different day of the week. Intakes available from recalls include total energy, total protein, total carbohydrate, total fat, saturated, monounsaturated, and polyunsaturated fats, dietary fiber, calcium, potassium, sodium, and alcohol. We estimated energy from alcohol as

$$\text{Alcohol (g)} \times 6.93 \qquad (1)$$

We estimated nonalcohol energy in alcoholic beverages as follows: we identified all alcoholic beverages by using USDA food codes 931XXXXX to 935XXXXX [except 93401300 (wine used in cooking)], determined the total energy contribution of each, and subtracted energy from alcohol.

The 24-h recall data were used to estimate intakes of MyPyramid food groups by merging the data with the USDA MyPyramid Equivalents Database, which specifies food groups on the basis of US Dietary Guidelines (30, 31). The MyPyramid Equivalents Database contains 32 major food groups (eg, total grain and total vegetables) and subgroups (eg, whole grains); we reduced the number to 21 by retaining all major groups and combining several subgroups on the basis of their nutritional characteristics.

Dietary outcomes

Our dependent variables of interest were intakes of total energy, nonalcohol energy, macronutrients [total protein, total carbohydrate, total fat, and subtypes (saturated, monounsaturated, and polyunsaturated fats)], dietary fiber, and calcium as well as intakes of potassium and sodium. When energy intakes were calculated, we used the following definitions:

$$\text{Alcohol} = \text{ethanol} \qquad (2)$$

$$\begin{aligned}\text{Alcoholic beverages} &= \text{ethanol} + \text{naturally occurring} \\ &\text{macronutrients in the beverage (eg, carbohydrates in beer)} \\ &+ \text{mixers}\end{aligned} \qquad (3)$$

$$\begin{aligned}\text{Total nonalcohol energy} &= \text{total energy} \\ &- \text{energy from ethanol}\end{aligned} \qquad (4)$$

Study design and sample

The study used a repeated-measures analysis to estimate within-individual changes in dietary and nutrient intakes of current drinkers who consumed alcohol on one dietary recall day (drinking day) but not the other (nondrinking day).

To obtain an appropriate sample, we first identified all respondents who completed MEC interviews in NHANES 2003–2004, 2005–2006, and 2007–2008. Of 29,355 respondents who completed interviews, we excluded 14,133 individuals who were <20 y of age followed by 116 individuals who were breastfeeding, 591 individuals who were pregnant, 809 individuals whose diet recalls on both days were not reliable or not available, 1454 individuals with only a single dietary recall, and 4848 individuals who were not current drinkers in the past year or whose drinking status was unknown. We excluded 924 men and 374 women who consumed alcoholic beverages on both dietary recall days and 2028 men and 2214 women who did not consume alcoholic beverages on either dietary recall day. The remaining 1126 men and 738 women consumed alcoholic beverages on one dietary recall day but not the other; these individuals comprised our analytic sample.

In our analyses, covariates were dietary recall order [ie, whether the first (in-person interview) or second (telephone) recall was a nondrinking day or drinking day] and recall day of the week. The season was considered by using 6-mo segments, which was the only variable available in the dataset.

Statistical analysis

Statistical analyses were weighted by 2-d dietary recall sample weights. All analyses were sex specific. For demographic, lifestyle, and dietary recall characteristics, unadjusted percentage distributions with 95% CIs were calculated. For dietary intake analyses, multiple linear regression models estimated within-individual differences in energy, nutrient, and food-group intakes between drinking and nondrinking days by regressing each day dietary variable on dummy variables for the recall day of the week, a dummy variable for recall order (day 1 recall compared with day 2 recall), and a separate fixed effect for each person in the sample, which controlled for person-level characteristics such as demographic, lifestyle, and genetic characteristics. The season of MEC exam was not informative and, therefore, not included in models. Interactions between variables were estimated and tested by including product terms between variables in regression models. Interactions with BMI (in kg/m^2) and marital status were considered; few interactions were shown, and no interactions were particularly strong. The survey-adjusted Wald's F test was used to test hypotheses. All analyses were performed with Stata version 12 statistical software that took into account survey stratification and clustering in the computation of SEs. For significance testing, α was <0.05 (2 tailed).

RESULTS

Of 1864 participants (1126 men and 738 women) who consumed alcoholic beverages on one recall day but not the other, the majority were non-Hispanic white, had at least some college education, were married or cohabiting, and had moderate or higher income (**Table 1**). The majority of participants had never smoked or had quit. Most participants were light or moderate drinkers. Approximately 70% of men and 51% of women had BMI ≥25.

Alcohol consumption was more likely to be reported on the first (in-person) than second (telephone) interview (**Table 2**).

TABLE 1
Weighted demographic and lifestyle characteristics of current drinkers matched on completion of two 24-h dietary recalls on 1 d without alcohol (nondrinking day) and 1 d with alcohol (drinking day): NHANES 2003–2008[1]

	Men (n = 1126; median age: 41 y)		Women (n = 738; median age: 43 y)	
	n	Percentage (95% CI)	n	Percentage (95% CI)
Race-ethnicity				
Non-Hispanic white	568	73.5 (69.2, 77.3)	417	77.4 (72.5, 81.5)
Non-Hispanic black	250	10.6 (8.6, 13.1)	137	9.5 (7.1, 12.6)
Mexican American	222	9.1 (7.0, 11.7)	105	5.1 (3.5, 7.5)
Other	86	6.8 (4.7, 9.7)	79	8.0 (5.5, 11.7)
Education				
<12 y	278	14.4 (12.2, 16.9)	104	8.3 (6.4, 10.9)
High school graduate, GED[2], or equivalent	262	22.1 (19.0, 25.5)	163	19.6 (15.6, 24.3)
Some college	327	31.9 (28.0, 36.0)	250	34.7 (29.3, 40.4)
≥College	258	31.6 (26.6, 37.1)	221	37.4 (31.5, 43.7)
Marital status				
Married/cohabiting	741	63.9 (59.3, 68.3)	426	60.9 (56.2, 65.4)
Not married	384	36.0 (31.6, 40.7)	312	39.1 (34.6, 43.8)
Poverty:income ratio				
<1.85 (poverty/low income)	355	22.5 (19.2, 26.3)	193	18.8 (15.3, 22.9)
1.85–3.50 (moderate income)	281	22.3 (18.5, 26.6)	177	22.9 (18.5, 27.9)
>3.50 (higher income)	420	50.0 (44.6, 55.5)	320	53.1 (47.5, 58.7)
Smoking status				
Current smoker	335	29.9 (25.9, 34.4)	189	24.8 (21.2, 28.7)
Former smoker	315	27.0 (23.2, 31.1)	178	25.3 (21.7, 29.3)
Never smoker	474	43.1 (38.8, 47.4)	371	49.9 (45.9, 53.9)
Usual alcohol consumption (past year)				
Light	508	41.9 (37.5, 46.5)	499	63.1 (58.3, 67.6)
Moderate	496	48.9 (44.6, 53.2)	157	23.4 (19.2, 28.3)
Heavier	122	9.2 (7.2, 11.7)	81	13.4 (9.7, 18.1)
BMI (kg/m^2)				
≤24.99	340	29.9 (25.7, 34.4)	301	48.3 (42.9, 53.6)
25.0–29.99	452	39.9 (35.0, 44.9)	222	28.0 (23.9, 32.5)
≥30	324	29.6 (25.5, 34.2)	212	23.1 (19.2, 27.5)

[1] Current drinkers consumed ≥12 drinks in their entire life and consumed alcohol on ≥1 d in the past year. Pregnant or lactating women were excluded. n may not add to total because of missing observations.

[2] GED, General Educational Development.

Drinking occurred more often on weekends (Friday, Saturday, and Sunday) than on weekdays. We did not study intakes by the type of alcoholic beverage because of relatively small numbers but note that, in men, beer alone was consumed by 699 participants (62%), wine alone was consumed by 153 participants (14%), distilled spirits alone were consumed by 119 participants (11%), and mixed drinks alone were consumed by 44 participants (4%); 111 participants (10%) consumed more than one type of alcoholic beverage. The respective figures for women were as follows: beer, 236 participants (32%); wine, 253 participants (34%); distilled spirits, 99 participants (13%); mixed drinks, 93 participants (13%); and more than one type, 57 participants (8%).

Energy

Men had significantly higher total energy intakes (433-kcal excess; $P < 0.001$) on drinking than on nondrinking days (**Table 3**). The alcohol in alcoholic beverages contributed 264 of 433 kcal (61%) of the excess. The remaining 168 of 433 kcal (39% of the excess) ($P < 0.01$) was contributed by nonalcohol components of alcoholic beverages (macronutrients naturally present in straight drinks and in mixers) and by other foods and beverages.

Women also had significantly higher total energy intakes (299-kcal excess; $P < 0.001$) on drinking days. Energy from the alcohol in alcoholic beverages contributed 206 kcal (69%) of the excess. Women did not have significantly higher intakes of total nonalcohol energy.

Nutrients

Men had significantly higher intakes of total protein ($P < 0.001$), total fat ($P < 0.01$), saturated fat ($P < 0.01$), monounsaturated fat ($P < 0.01$), potassium ($P < 0.001$), and sodium ($P < 0.05$) on drinking days (Table 3). Women had significantly higher intakes of total fat ($P < 0.05$), monounsaturated fat ($P < 0.05$), polyunsaturated fat ($P < 0.05$), and potassium ($P < 0.01$) on drinking days.

Food groups

Men consumed significantly more white potatoes ($P < 0.05$); more foods from the meat, poultry, and fish group ($P < 0.001$) [specifically meat (beef, pork, veal, lamb, and game); $P < 0.001$]; more combined discretionary oil and solid fat ($P < 0.05$); and significantly less fruit ($P < 0.05$) and milk ($P < 0.05$) on days that they drank (**Table 4**). Women consumed significantly more combined discretionary oil and solid fat ($P < 0.05$) and significantly less total milk products ($P < 0.05$) and milk ($P < 0.01$) on days that they drank.

Supplemental analyses

To understand whether observed differences in energy intakes on drinking compared with nondrinking days in current drinkers were related to within-individual day-to-day variability in dietary intakes, we examined the day-to-day variability in persons who drank on both dietary recall days or on neither day (*see* Tables 1–5 under "Supplemental data" in the online issue). The covariate was the recall day of the week. Differences in total energy intake between the 2 recalls, although not statistically tested, appeared to be less extreme in men and women who drank on neither day (men: 3.7%; women: 1.7%) or on both days (men: 6.8%; women: 9.2%) than in our analytic sample who drank on one day but not the other (men: 18.2%; women: 17.4%).

Our analyses of the analytic sample controlled for the effects of both dietary recall order (ie, whether drinking occurred on the first or second recall) and recall day of the week. We present stratified analyses by recall order in subsamples, which suggested that, for men (but not women), having had the first recall on a drinking day was associated with increased intakes of total nonalcohol energy, whereas having had the first recall on a nondrinking day was not (*see* Tables 6 and 7 under "Supplemental data" in the online issue). We also present stratified

TABLE 2
Characteristics of dietary recall days of current drinkers matched on completion of two 24-h dietary recalls on 1 d without alcohol (nondrinking day) and 1 d with alcohol (drinking day): NHANES 2003–2008[1]

	Men (n = 1126)		Women (n = 738)	
24-h dietary recall	Nondrinking day	Drinking day	Nondrinking day	Drinking day
Order [n (%)]				
First day	338 (37.4)	788 (62.6)	234 (37.2)	504 (62.8)
Second day	788 (62.6)	338 (37.4)	504 (62.8)	234 (37.2)
Day of the week [n (%)]				
Monday	224 (18.1)	99 (12.6)	151 (20.5)	57 (10.4)
Tuesday	223 (19.8)	95 (11.6)	151 (19.2)	71 (12.2)
Wednesday	230 (19.2)	98 (11.8)	143 (19.0)	58 (9.9)
Thursday	99 (8.4)	87 (9.4)	73 (10.7)	59 (9.6)
Friday	95 (8.1)	248 (16.4)	80 (7.6)	145 (15.2)
Saturday	77 (5.6)	257 (16.1)	40 (4.3)	186 (19.4)
Sunday	178 (20.9)	242 (22.2)	100 (18.7)	162 (23.3)
Season [n (%)]				
1 November–30 April	504 (41.2)	504 (41.2)	305 (39.7)	305 (39.7)
1 May–31 October	622 (58.8)	622 (58.8)	433 (60.3)	433 (60.3)

[1] Current drinkers consumed ≥12 drinks in their entire life and consumed alcohol on ≥1 d in the past year. Pregnant or lactating women were excluded.

TABLE 3
Weighted adjusted matched analysis of nutrient intakes in current drinkers matched on completion of two 24-h dietary recalls on 1 d without alcohol (nondrinking day) and 1 d with alcohol (drinking day): NHANES 2003–2008[1]

	Men (n = 1126)					Women (n = 738)				
	Nondrinking day	Drinking day	Drinking compared with nondrinking day			Nondrinking day	Drinking day	Drinking compared with nondrinking day		
	Mean (95% CI)		Change (95% CI)	Percentage[2]	P	Mean (95% CI)		Change (95% CI)	Percentage[2]	P
Energy (kcal)										
Total	2381 (2300, 2462)	2814 (2715, 2912)	433 (312, 553)	18.2	***	1715 (1655, 1775)	2014 (1926, 2101)	299 (202, 395)	17.4	***
Total nonalcohol[3]	2373 (2293, 2453)	2541 (2449, 2634)	168 (51, 286)	7.1	**	1711 (1650, 1772)	1803 (1720, 1886)	92 (−0.0, 184)	5.4	
Alcoholic beverages										
Total (kcal)	12 (6, 17)	375 (344, 405)	363 (333, 393)	—		7 (1, 13)	273 (248, 298)	266 (239, 293)	—	
Alcohol (kcal)[4]	8 (4, 12)	272 (249, 295)	264 (241, 287)	—		4 (−1, 8)	210 (191, 230)	206 (186, 228)	—	
Nonalcohol (kcal)[5]	4 (2, 5)	103 (94, 111)	99 (91, 107)	—		3 (1, 4)	62 (55, 70)	59 (52, 67)	—	
Nutrients										
Total protein (g)	95.7 (91.7, 99.7)	105.9 (101.6, 110.1)	10.2 (4.3, 16.0)	10.6	***	69.6 (66.9, 72.3)	71.7 (68.8, 74.7)	2.1 (−1.7, 5.9)	3.0	
Total carbohydrate (g)	295.3 (283.1, 307.6)	308.3 (297.0, 319.7)	13.0 (−2.1, 28.1)	4.4		210.3 (200.5, 220.0)	218.2 (208.2, 228.1)	7.9 (−4.5, 20.4)	3.8	
Total fat (g)	92.9 (89.1, 96.6)	101.2 (96.1, 106.4)	8.3 (2.2, 14.5)	9.0	**	68.5 (65.4, 71.6)	74.4 (69.5, 79.4)	5.9 (0.8, 11.1)	8.7	*
Saturated fat (g)	31.0 (29.6, 32.5)	34.0 (32.1, 36.0)	3.0 (0.9, 5.2)	9.7	**	22.6 (21.6, 23.7)	24.3 (22.6, 26.0)	1.7 (−0.3, 3.5)	7.2	
Monounsaturated fat (g)	34.5 (33.0, 36.1)	38.0 (36.1, 39.9)	3.5 (1.0, 6.0)	10.1	**	25.2 (23.9, 26.4)	27.2 (25.4, 29.0)	2.0 (0.1, 4.0)	8.1	*
Polyunsaturated fat (g)	19.2 (18.4, 20.1)	20.4 (19.1, 21.8)	1.2 (−0.4, 2.8)	6.3		15.0 (13.9, 16.1)	16.7 (15.2, 18.2)	1.7 (0.3, 3.0)	11.0	*
Dietary fiber (g)	17.2 (16.4, 18.0)	17.6 (16.5, 18.7)	0.4 (−0.7, 1.5)	2.3		14.4 (13.5, 15.2)	14.7 (13.7, 15.8)	0.3 (−0.8, 1.6)	2.5	
Calcium (mg)	1009 (954, 1063)	1036 (968, 1104)	27 (−40, 94)	2.7		821 (778, 864)	794 (749, 839)	−27 (−85, 31)	−3.3	
Potassium (mg)	2949 (2829, 3069)	3229 (3107, 3351)	280 (150, 411)	9.5	***	2331 (2227, 2435)	2498 (2406, 2590)	167 (58, 276)	7.2	**
Sodium (mg)[6]	4010 (3845, 4175)	4246 (4071, 4422)	236 (33, 440)	5.9	*	3045 (2902, 3188)	3157 (2964, 3349)	112 (−134, 357)	3.7	

[1] Adjusted for the day of the week of each recall and day effect (first compared with second day of recall). Current drinkers consumed ≥12 drinks in their entire life and consumed alcohol on ≥1 d in the past year. Pregnant or lactating women were excluded. *,**,***P values are for tests of change (2-sided t tests): *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

[2] Percentage difference = [(drinking day − nondrinking day) ÷ nondrinking day] × 100.

[3] All kilocalories except from alcohol (ethanol).

[4] Kilocalories from alcohol (ethanol) only.

[5] Kilocalories from nonalcoholic components of straight alcoholic beverages and mixers.

[6] Excludes salt added at the table.

TABLE 4
Weighted adjusted analysis of food intake in current drinkers matched on completion of two 24-h dietary recalls on 1 d without alcohol (nondrinking day) and 1 d with alcohol (drinking day): NHANES 2003–2008[1]

	Men (n = 1126)					Women (n = 738)				
	Nondrinking day	Drinking day	Drinking compared with nondrinking day			Nondrinking day	Drinking day	Drinking compared with nondrinking day		
Foods[3]	Mean (95% CI)		Change (95% CI)	Percentage[2]	P	Mean (95% CI)		Change (95% CI)	Percentage[2]	P
Total grain (oz equivalents)	7.61 (7.18, 8.03)	7.74 (7.26, 8.21)	0.13 (−0.49, 0.75)	1.7		5.77 (5.36, 6.18)	5.56 (5.22, 5.91)	−0.21 (−0.76, 0.34)	−3.6	
Whole grain	0.72 (0.61, 0.84)	0.68 (0.56, 0.80)	−0.04 (−0.19, 0.11)	−5.8		0.76 (0.66, 0.86)	0.69 (0.57, 0.81)	−0.07 (−0.20, 0.06)	−9.0	
Non–whole/refined grain	6.89 (6.49, 7.28)	7.06 (6.58, 7.53)	0.17 (−0.44, 0.79)	2.5		5.01 (4.58, 5.44)	4.86 (4.54, 5.19)	−0.15 (−0.68, 0.39)	−2.9	
Total vegetables (cup equivalents)	1.75 (1.63, 1.88)	1.89 (1.75, 2.02)	0.13 (−0.04, 0.31)	7.5		1.52 (1.40, 1.63)	1.71 (1.52, 1.89)	0.19 (−0.01, 0.38)	12.3	
Dark-green and orange vegetables and tomatoes	0.63 (0.55, 0.70)	0.63 (0.55, 0.71)	0.00 (−0.10, 0.10)	0.0		0.57 (0.50, 0.64)	0.65 (0.54, 0.76)	0.08 (−0.04, 0.20)	14.0	
White potatoes	0.43 (0.38, 0.49)	0.51 (0.45, 0.58)	0.08 (0.01, 0.15)	18.8	*	0.28 (0.24, 0.32)	0.33 (0.27, 0.38)	0.05 (−0.03, 0.12)	15.9	
Other vegetables	0.69 (0.62, 0.77)	0.74 (0.66, 0.82)	0.05 (−0.06, 0.16)	7.2		0.66 (0.59, 0.74)	0.72 (0.63, 0.82)	0.06 (−0.06, 0.18)	9.3	
Total fruits (cup equivalents)	1.15 (1.00, 1.31)	0.97 (0.84, 1.09)	−0.19 (−0.35, −0.03)	−16.1	*	1.03 (0.87, 1.18)	0.94 (0.82, 1.05)	−0.09 (−0.30, 0.12)	−8.5	
Total milk (milk, yogurt, and cheese) (cup equivalents)	1.76 (1.58, 1.94)	1.72 (1.53, 1.92)	−0.03 (−0.24, 0.17)	−1.9		1.43 (1.29, 1.58)	1.26 (1.14, 1.38)	−0.17 (−0.34, −0.00)	−12.1	*
Milk	0.92 (0.78, 1.05)	0.80 (0.68, 0.92)	−0.11 (−0.21, −0.02)	−12.3	*	0.73 (0.62, 0.85)	0.57 (0.49, 0.66)	−0.16 (−0.27, −0.05)	−21.9	**
Yogurt and cheese	0.83 (0.72, 0.95)	0.91 (0.80, 1.03)	0.08 (−0.08, 0.24)	9.7		0.69 (0.61, 0.78)	0.68 (0.59, 0.76)	−0.02 (−0.12, 0.09)	−2.2	
Meat, poultry, and fish (oz cooked lean meat)	5.93 (5.52, 6.33)	6.80 (6.42, 7.18)	0.88 (0.39, 1.37)	14.8	***	3.84 (3.52, 4.17)	4.11 (3.79, 4.44)	0.27 (−0.20, 0.73)	7.0	
Meat (beef, pork, veal, lamb, and game) (oz cooked lean meat)	2.34 (2.07, 2.61)	3.07 (2.74, 3.40)	0.73 (0.34, 1.11)	31.0	***	1.33 (1.05, 1.61)	1.69 (1.39, 1.98)	0.36 (−0.07, 0.79)	27.1	
Frankfurters, sausage, and luncheon meats made from meat or poultry (oz cooked lean meat)	1.15 (0.98, 1.32)	1.06 (0.88, 1.24)	−0.09 (−0.27, 0.09)	−7.6		0.7 (0.55, 0.85)	0.63 (0.47, 0.78)	−0.07 (−0.28, 0.13)	−10.3	
Poultry (chicken, turkey, and other) (oz cooked lean meat)	1.51 (1.24, 1.78)	1.85 (1.58, 2.12)	0.34 (−0.00, 0.69)	22.8		1.2 (0.98, 1.41)	1.29 (1.08, 1.49)	0.09 (−0.18, 0.37)	7.6	
Fish and shellfish (oz cooked lean meat)	0.92 (0.68, 1.15)	0.81 (0.63, 1.00)	−0.11 (−0.39, 0.18)	−11.6		0.61 (0.48, 0.74)	0.51 (0.36, 0.65)	−0.11 (−0.31, 0.10)	−17.3	
Eggs (oz equivalents of lean meat)	0.56 (0.47, 0.65)	0.57 (0.48, 0.67)	0.02 (−0.08, 0.11)	2.7		0.41 (0.33, 0.49)	0.36 (0.28, 0.44)	−0.05 (−0.16, 0.06)	−12.2	
Cooked dry beans and peas, nuts and seeds, and meat alternatives (oz equivalents of lean meat)	0.77 (0.63, 0.91)	1.03 (0.69, 1.36)	0.26 (−0.09, 0.61)	33.9		0.74 (0.53, 0.94)	0.82 (0.62, 1.01)	0.08 (−0.21, 0.38)	11.3	
Discretionary oil and solid fat (g)	73.19 (69.97, 76.42)	78.98 (74.65, 83.30)	5.78 (0.62, 10.94)	7.9	*	54.16 (51.20, 57.12)	58.82 (54.55, 63.09)	4.66 (0.16, 9.15)	8.6	*
Added sugars (teaspoon equivalents)	21.82 (20.24, 23.39)	20.80 (19.33, 22.27)	−1.01 (−2.73, 0.71)	−4.6		13.19 (11.93, 14.45)	13.48 (12.12, 14.85)	0.30 (−1.21, 1.80)	2.2	
Alcoholic beverages (alcoholic drinks) (*n*)	0.13 (0.07, 0.19)	2.97 (2.71, 3.23)	2.84 (2.57, 3.11)	—		0.06 (0.01, 0.11)	2.20 (2.01, 2.39)	2.14 (1.93, 2.35)	—	

[1] Adjusted for the day of the week of each recall and day effect (first compared with second day of recall). Current drinkers consumed ≥12 drinks in their entire life and consumed alcohol on ≥1 d in the past year. Pregnant or lactating women were excluded. *,**,****P* values are for tests of change (2-sided *t*-tests): $^*P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

[2] Percentage difference = [(drinking day − nondrinking day) ÷ nondrinking day] × 100.

[3] Cup equivalents for the fruit and vegetable groups equal the amount of food equivalent to 1 cup cut-up fruit or vegetables; cup equivalents for the milk group equal the amount of food equivalent to 1 cup milk. Ounce equivalents for the grain group equal the amount of food equivalent to a 1-oz slice of bread or 1 oz dry cereal; ounce equivalents for the meat and beans group equal the amount of food equivalent to 1 oz cooked lean meat, poultry, or fish. 1 cup = 237 mL; 1 oz = 28 g; 1 teaspoon = 5 g.

analyses by weekend (Friday–Sunday) and weekday in subsamples, which suggested that, in both men and women, weekend drinking was associated with increased intakes of total nonalcohol energy, whereas weekday drinking was not (*see* Tables 8 and 9 under "Supplemental data" in the online issue).

DISCUSSION

In our national sample of current drinkers, men consumed excess nonalcohol energy on drinking days relative to nondrinking days, but women did not. Both sexes had less-healthy diets on drinking days; however, men's diets appeared to be poorer than women's diets.

Our finding that men consumed excess nonalcohol energy on drinking days is consistent with results from several experimental studies (4, 17–22). Our finding that women did not consume excess nonalcohol energy on drinking days could have been due to a number of factors including their lower total energy intake, lower consumption of alcohol, or greater dietary vigilance. Also, the experimental studies were mostly conducted in men, although one study that included women (21) reported a positive effect in both sexes.

We showed that nutrient intakes differed on drinking and nondrinking days. The most striking findings were ∼9–10% higher drinking day intakes of total protein, total fat, saturated fat, and protein in men and ∼7–8% higher drinking day intakes of total fat, monounsaturated fat, and potassium and an 11% higher intake of polyunsaturated fat in women. Higher intakes of total fat and saturated fat are of particular concern in terms of dietary recommendations.

Our examination of food-group intakes showed changes in foods reported on drinking days. Men consumed more from the meat, poultry, and fish group, particularly more meat. Men also consumed more discretionary oil and solid fat and white potatoes and less fruit. Although men consumed less milk, their total milk-group (milk, yogurt, and cheese) intake was unchanged, which suggested the substitution of milk for other dairy products on drinking days. Food selections of women on drinking days were also remarkable for more discretionary oil and solid fat and fewer products from the milk, yogurt, and cheese group, particularly milk. We note that women's reduced consumption of milk should have been reflected in lower intakes of calcium, but this was not the case. This finding may be explained by the low amounts of milk (<1 cup) women consumed on both drinking and nondrinking days. Although food-group data are derived and, therefore, less precise than nutrient data, they have public health benefits regarding potential messages to moderate drinkers about eating behaviors on drinking days. Our sample consisted almost entirely of moderate drinkers.

Our study used a matched design, and the results were not directly comparable to those of other epidemiologic studies. We examined diets of individual drinkers on a single day on which they drank compared with a single day on which they did not. It was a within-individual study that used repeated measures with detailed 24-h data for each day. In contrast, previous epidemiologic studies (4–14) and a clinical trial (15) generally obtained estimates whereby alcohol and/or diet were averaged over a period of time, which reflected usual intakes. The majority of studies showed no association between alcohol consumption and higher absolute intakes of total nonalcohol energy with the exception of a U-shaped association in women in one study (5) and a linear trend across drinking levels in men in another study (10). The general lack of association was likely because of compensation over the long term (4).

Strengths of our study were that we examined within-individual dietary differences on a drinking compared with nondrinking day. Our repeated-measures design virtually eliminated individual-level confounding, which is a problematic issue in most epidemiologic studies. It was necessary to control only for the effects of the dietary recall administration (order and day of the week). Our study used a large national sample that was primarily comprised of light to moderate drinkers, who constitute the majority of drinkers, which increased its generalizability.

Limitations included that drinking was more likely to be reported on the first dietary recall and on weekends. The first recall was more likely to occur on a weekend, possibly because individuals considered MEC visits most convenient at that time. However, all analyses were controlled for the order of dietary recall. All analyses were also controlled for the day of the week. Nevertheless, we could not dismiss the possibility of residual confounding. We note that our purpose was to describe cross-sectional associations between alcohol and dietary intakes on the day in which alcohol was consumed. We make no claims about cause and effect. Future studies might consider approaches to untangle the complex effects of alcohol on drinking day dietary intake from correlations on the basis of weekend and weekday drinking (32), social activity (33), or other relevant factors. We compressed the USDA MyPyramid food groups from 32 to 21 to increase the statistical power. This alteration may have limited our ability to determine certain differences (eg, between types of fats). Our study did not address dietary intake according to drinking levels because of its matched design.

In conclusion, we showed that diets of current drinkers were poorer on a day they consumed alcohol than on a day they did not. Targeting drinking days to improve dietary intake may prove a useful public health strategy.

The authors' responsibilities were as follows—RAB, CMC, and BIG: analyzed data; RAB: wrote the manuscript and had primary responsibility for the final content of the manuscript; and all authors: designed the research, provided critical input in the writing of the manuscript, and read and approved the final manuscript. An abstract submitted to the 2012 Research Society on Alcoholism meeting was selectively published in Alcoholism Clinical and Experimental Research. None of the authors had a conflict of interest.

REFERENCES

1. Substance Abuse and Mental Health Services Administration. Results from the 2010 National Survey on Drug Use and Health, detailed tables. Version current 2011. Available from: http://www.samhsa.gov/data/NSDUH/2011SummNatFindDetTables/NSDUH-DetTabsPDFWHTML2011/2k11DetailedTabs/Web/HTML/NSDUH-DetTabsSect2peTabs1to42-2011.htm#Tab2.41B (cited 18 December 2012).
2. National Cancer Institute, National Institutes of Health. Mean intake of energy and percentage contribution of various foods among US adults, by race/ethnicity and family incomes, NHANES 2005–06. Version current 21 May 2010. Available from: http://riskfactor.cancer.gov/diet/foodsources/energy/table6a.html (cited 1 August 2012).
3. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. JAMA 2012;307:491–7.
4. Yeomans MR. Alcohol, appetite and energy balance: is alcohol intake a risk factor for obesity? Physiol Behav 2010;100:82–9.

5. Colditz GA, Giovannucci E, Rimm EB, Stampfer MJ, Rosner B, Speizer FE, Gordis E, Willett WC. Alcohol intake in relation to diet and obesity in women and men. Am J Clin Nutr 1991;54:49–55.
6. Fisher M, Gordon T. The relation of drinking and smoking habits to diet: the Lipid Research Clinics Prevalence Study. Am J Clin Nutr 1985;41:623–30.
7. Gruchow HW, Sobocinski KA, Barboriak JJ, Scheller JG. Alcohol consumption, nutrient intake and relative body weight among US adults. Am J Clin Nutr 1985;42:289–95.
8. Jones BR, Barrett-Connor E, Criqui MH, Holdbrook MJ. A community study of calorie and nutrient intake in drinkers and nondrinkers of alcohol. Am J Clin Nutr 1982;35:135–9.
9. Le Marchand L, Kolonel LN, Hankin JH, Yoshizawa CN. Relationship of alcohol consumption to diet: a population-based study in Hawaii. Am J Clin Nutr 1989;49:567–72.
10. Liangpunsakul S. Relationship between alcohol intake and dietary pattern: findings from NHANES III. World J Gastroenterol 2010;16: 4055–60.
11. McCann SE, Sempos C, Freudenheim JL, Muti P, Russell M, Nochajski TH, Ram M, Hovey K, Trevisan M. Alcoholic beverage preference and characteristics of drinkers and nondrinkers in western New York (United States). Nutr Metab Cardiovasc Dis 2003;13:2–11.
12. Rose D, Murphy SP, Hudes M, Viteri FE. Food energy remains constant with increasing alcohol intake. J Am Diet Assoc 1995;95: 698–700.
13. Barefoot JC, Gronbaek M, Feaganes JR, McPherson RS, Williams RB, Siegler IC. Alcoholic beverage preference, diet, and health habits in the UNC Alumni Heart Study. Am J Clin Nutr 2002;76:466–72.
14. Breslow RA, Guenther PM, Juan W, Graubard BI. Alcoholic beverage consumption, nutrient intakes, and diet quality in the US adult population, 1999-2006. J Am Diet Assoc 2010;110:551–62.
15. Cordain L, Bryan ED, Melby CL, Smith MJ. Influence of moderate daily wine consumption on body weight regulation and metabolism in healthy free-living males. J Am Coll Nutr 1997;16:134–9.
16. Yeomans MR, Caton S, Hetherington MM. Alcohol and food intake. Curr Opin Clin Nutr Metab Care 2003;6:639–44.
17. Caton SJ, Bate L, Hetherington MM. Acute effects of an alcoholic drink on food intake: aperitif versus co-ingestion. Physiol Behav 2007; 90:368–75.
18. Caton SJ, Ball M, Ahern A, Hetherington MM. Dose-dependent effects of alcohol on appetite and food intake. Physiol Behav 2004;81:51–8.
19. Hetherington MM, Cameron F, Wallis DJ, Pirie LM. Stimulation of appetite by alcohol. Physiol Behav 2001;74:283–9.
20. Tremblay A, St Pierre S. The hyperphagic effect of a high-fat diet and alcohol intake persists after control for energy density. Am J Clin Nutr 1996;63:479–82.
21. Westerterp-Plantenga MS, Verwegen CR. The appetizing effect of an aperitif in overweight and normal-weight humans. Am J Clin Nutr 1999;69:205–12.
22. Yeomans MR, Hails NJ, Nesic JS. Alcohol and the appetizer effect. Behav Pharmacol 1999;10:151–61.
23. National Center for Health Statistics. National Health and Nutrition Examination Survey. Version current 30 November 2012. Available from: http://www.cdc.gov/nchs/nhanes.htm (cited 18 December 2012).
24. National Center for Health Statistics. Unweighted response rates for NHANES 2003-2004 by age and gender. Version current unknown. Available from: http://www.cdc.gov/nchs/data/nhanes/response_rates_cps/RRT0304MF.pdf (cited 16 August 2012).
25. National Center for Health Statistics. Unweighted response rates for NHANES 2005-2006 by age and gender. Version current unknown. Available from: http://www.cdc.gov/nchs/data/nhanes/response_rates_cps/RRT0506MF.pdf (cited 16 August 2012).
26. National Center for Health Statistics. Unweighted response rates for NHANES 2007-2008 by age and gender. Version current unknown. Available from: http://www.cdc.gov/nchs/data/nhanes/response_rates_cps/RRT0708MF.pdf (cited 16 August 2012).
27. National Center for Health Statistics. Computer assisted personal interview (CAPI) questionnaire: alcohol use. Version current 14 May 2010. Available from: http://www.cdc.gov/nchs/nhanes/nhanes2007-2008/questexam07_08.htm (cited 16 August 2012).
28. Moshfegh AJ, Rhodes DG, Baer DJ, Murayi T, Clemens JC, Rumpler WV, Paul DR, Sebastian RS, Kuczynski KJ, Ingwersen LA, et al. The US Department of Agriculture Automated Multiple-Pass Method reduces bias in the collection of energy intakes. Am J Clin Nutr 2008;88: 324–32.
29. National Center for Health Statistics. Dietary interviewer procedure manual - in person. Version current 6 September 2012. Available from: http://www.cdc.gov/nchs/nhanes/nhanes2007-2008/diet07_08.htm (cited 18 December 2012).
30. Agricultural Research Service, US Department of Agriculture. MyPyramid equivalents database. Version current 29 September 2010. Available from: http://www.ars.usda.gov/Services/docs.htm?docid=17558 (cited 16 August 2012).
31. Nutrition Guidance and Analysis Division, Center for Nutrition Policy and Promotion. CNPP addendum to MPED 2.0A. Available from: http://www.cnpp.usda.gov/OtherProjects.htm (cited 6 October 2011).
32. Haines PS, Hama MY, Guilkey DK, Popkin BM. Weekend eating in the United States is linked with greater energy, fat, and alcohol intake. Obes Res 2003;11:945–9.
33. de Castro JM, Brewer EM, Elmore DK, Orozco S. Social facilitation of the spontaneous meal size of humans occurs regardless of time, place, alcohol or snacks. Appetite 1990;15:89–101.