Consumption of Energy-Dense, Nutrient-Poor Foods by the US Population: Effect on Nutrient Profiles

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Key words: diet quality, empty calories, food groups, NHANES II, nutrient adequacy, nutrient density, "other" foods

Objective: To examine the association of consumption of foods from the fats, sweets, and the alcohol group ("other" group) with nutrient profiles.

Methods: Using data from the NHANES II survey of 1976–80, we categorized the foods reported to be consumed by adults (n = 11,528) into six groups: meat, dairy, grain, fruit, vegetable, and "other."

Results: Nearly one-third of total daily energy intake was contributed by foods from the "other" category. As the proportion of daily energy intake from "other" foods increased, total daily energy intake also increased, as did the percent energy from carbohydrate and alcohol. However, percent energy from fat and protein, intake of all examined micronutrients (except vitamin E), nutrient density, and the proportion of the population meeting the RDA of various nutrients declined with increasing intake of "other" foods. Respondents were more likely to report no servings as well as less than the recommended servings of foods from the major food groups with increasing intake of "other" foods.

Conclusion: The data suggest that consumption of foods from the "other" group displaced nutrient-dense foods from the diets of NHANES II respondents.

INTRODUCTION

Recommendations for moderating the intake of fats, sweets and alcohol have been a part of federal nutrition guidance given the US public since 1979 [1–8]. However, to our knowledge, the association of consumption of foods collectively categorized in the fats, sweets, and alcohol group ("other" group) to nutrient adequacy has never been systematically examined. Currently, the only available information on the relative contribution of fats, sweets, and alcohol to daily energy and nutrient intake in the US population is limited to summary estimates from the Nationwide Food Consumption Surveys (NFCS) of the US Department of Agriculture (USDA) [9–11]. Also, some investigators have studied the relation of alcohol intake [12,13], added sugar intake [14], or total daily fat intake [15], to nutrient adequacy.

This study examined 1) the proportion of daily energy and macronutrients contributed by the fats, sweets, and alcohol group ("other" group) in the US population; 2) the association of nutrient adequacy with the level of consumption of foods from the "other" group; and 3) the association of consumption of foods from the dairy, meat, grain, fruit, and vegetable groups with the level of consumption of foods from the "other" group.

METHODS

The second National Health and Nutrition Examination Survey (NHANES II) was conducted from 1976–80 on a nationwide probability sample of the civilian, non-institutionalized population of the United States by the National Center for Health Statistics (NCHS). Details of survey design and data collection have been described elsewhere [16]. In this survey, a single 24-hour dietary recall was administered to each participant by a trained dietary interviewer using three-dimensional food models to aid estimation of food portion sizes. For the purpose of analyses in this study, a subset composed of 24-hour recalls

Abbreviations: NCHS = National Center for Health Statistics, NHANES II = The Second National Health and Nutrition Examination Survey, NFCS = Nationwide Food Consumption Survey

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from all black and white individuals 19–74 years of age (n = 11967) was created. From this subset, we excluded 24-hour recalls considered to be unsatisfactory, incomplete, imputed, or obtained from surrogates (n = 310). Also excluded were recalls of 129 women reported to be pregnant or lactating at the time of the survey. The final analytic sample included 11528 individuals.

To evaluate each 24-hour recall for food group intake, we assigned the 2244 foods reported consumed by adults in the NHANES II to one of six food groups: dairy, meat, grain, fruit, vegetable, and "other." Methods used for categorizing foods into the various groups [17,18] consider the nutrient composition and customary uses of foods in the diet [1,6]. To summarize, the dairy group was comprised of all milk and milk products, including ice cream, but excluded butter and cream. The meat group included both animal and plant protein sources such as beef, poultry, fish, dried beans, nuts, and seeds. The grain group included all grain products such as rice, bread and pasta, but excluded cakes, pies, cookies and pastries. The fruit group included all fresh, canned, frozen, and dried fruits, as well as fruit juices, but excluded fruit drinks. The vegetable group included all raw, cooked, frozen, and canned vegetables. Food mixtures that contained foods from more than one food group (e.g., casseroles, stews, lasagna) were assigned to each relevant food group.

Foods excluded from the five groups on the basis of their nutrient density and uses in the diet were grouped separately and are referred as the "other" (fats, sweets, and alcohol) group. The "other" group included sugar and other caloric sweeteners, visible fats, carbonated and alcoholic beverages, fruit drinks, candy, and baked products with a high sugar and fat content such as cakes, cookies, and pies. In the analyses reported here, this group represents foods of relatively low-nutrient but high-energy density.

For each 24-hour recall, the total daily energy intake and the proportion of total daily energy intake contributed by the "other" group was calculated. Based on tertile cuts of percent of total daily energy intake from the "other" group, three categories representing three levels (low, medium, and high) of consumption of foods from the "other" group were established.

The proportion of total daily energy, fat, carbohydrate, and protein intake contributed by foods from the "other" group was calculated for each tertile of consumption of energy from "other" foods. Daily intakes of dietary fiber, and percent energy from protein, carbohydrate, fat, and alcohol were calculated for each 24-hour recall, by each tertile of consumption of "other" foods. We also evaluated the intakes of vitamins A, B_6, C, E and folate, and the minerals iron, zinc, calcium, and potassium relative to the sex-age-specific Recommended Dietary Allowance (RDA) [19]. These food components and nutrients were selected for this study because they were identified as current or potential public health issues by the Expert Panel on Nutrition Monitoring [20].

The nutrient content data base for foods reported to be consumed by NHANES II subjects does not contain information on vitamin B_6, folate, vitamin E, and dietary fiber. Therefore, data bases were created for each of these nutrients using data from the most recent USDA data base and from other sources [21–24]. There were no missing nutrient values for foods in the NHANES II nutrient data base. For a limited number of foods, imputed nutrient values were assigned based on values for similar foods [21–24].

Statistical Analyses

Descriptive statistics for nutrient intake and food group intake were obtained by tertile of consumption of "other" foods, age, gender, and race. Statistical analyses were performed using SAS [25], and were weighted using sample weights assigned to each individual by the NCHS to enable inference to the total US white and black noninstitutionalized population. Statistical software packages SUDAAN [26], SESUDAAN [27], and SURREGR [28], appropriate for analyses of complex sample surveys, were used to obtain estimates of variance and to perform regression analyses. The estimates of nutrient and food group intake were adjusted for age, sex, and race, using methods described previously [29]. Differences in nutrient intake among tertiles of consumption of energy from "other" foods were tested by regression analysis. The model contained nutrient intake as a dependent variable and the tertiles of daily energy intake from "other" foods, age, gender, and race as independent variables.

RESULTS

Proportion of Daily Energy and Macronutrients from the "Other" Group

Respondents consuming <21.5, 21.5–35.4, and >35.4% of daily energy from "other" foods were categorized in the first, second, and third tertiles of consumption of "other" foods, respectively. Table 1 presents the proportion ± SE of daily energy and macronutrients contributed by foods from the "other" group on the survey day. Among the entire population, these foods contributed 30% of the daily energy, 29% of the fat, 33% of the carbohydrate, and 7% of the daily protein. Respondents in the first (lowest) tertile of consumption of "other" foods consumed a mean of 13%, while those in the third (highest) tertile obtained a mean of 47% of energy from this group. Women consumed a somewhat higher proportion of their daily fat intake from the "other" group relative to men. Exclusion

Table 1. Percentage ± SE (Adjusted for Race and Age) of Total Daily Energy and Macronutrients from "Other[a]" Foods, by Sex, by Tertile of Consumption of "Other" Foods

Tertile of % of daily energy from "other" foods	N	Proportion of daily nutrients from "Other" foods			
		Energy	Fat	Carbohydrate	Protein
All tertiles					
All	11528	30 ± 0.2	29 ± 0.3	33 ± 0.4	7 ± 0.1
Men	5509	31 ± 0.4	27 ± 0.4	35 ± 0.5	7 ± 0.2
Women	6019	30 ± 0.3	31 ± 0.4	32 ± 0.5	7 ± 0.2
First tertile (<21.5% of total daily energy from "other" foods)					
All	3842	13 ± 0.1	15 ± 0.3	15 ± 0.3	2 ± 0.1
Men	1707	13 ± 0.2	14 ± 0.4	16 ± 0.4	2 ± 0.1
Women	2135	13 ± 0.2	16 ± 0.4	13 ± 0.4	2 ± 0.1
Second tertile (21.5–35.4% of daily energy from "other" foods)					
All	3843	28 ± 0.1	28 ± 0.4	33 ± 0.3	5 ± 0.1
Men	1932	28 ± 0.1	26 ± 0.5	33 ± 0.5	5 ± 0.1
Women	1911	28 ± 0.1	29 ± 0.5	32 ± 0.4	6 ± 0.2
Third tertile (>35.4% of daily energy from "other" foods)					
All	3843	47 ± 0.2	42 ± 0.4	51 ± 0.4	12 ± 0.3
Men	1870	47 ± 0.3	39 ± 0.5	51 ± 0.6	12 ± 0.3
Women	1973	48 ± 0.2	46 ± 0.6	51 ± 0.5	13 ± 0.3

[a] "Other" group: fats, sweets, and alcohol group (included all visible fats, caloric sweeteners, carbonated and alcoholic beverages, and desserts and snacks with a high fat and sugar content).

Differences among tertiles, in the proportion of daily energy and macronutrients contributed by "other" foods were significant at $p < 0.0000$. Each regression model contained the nutrient as a dependent and tertiles, age, and race as independent variables.

of respondents answering positively to being on a special diet (n = 1896) did not alter the results presented in Table 1 (data not shown).

Nutrient Intake Profiles

Table 2 presents the mean ± SEM of the daily intake of energy, alcohol, fiber, and selected nutrients, adjusted for age, sex, and race, by tertile of consumption of energy from the "other" foods. With increasing consumption of "other" foods, the mean daily intake of energy and percent energy from alcohol and carbohydrates increased, but percent energy from fat and protein declined ($p < 0.0000$). The mean intake of dietary fiber, all vitamins (except vitamin E), and minerals decreased with increasing percent of energy from "other" foods ($p < 0.0000$).

The nutrient density of all examined nutrients except vitamin E decreased with increasing consumption of foods from the "other" groups ($p < 0.0000$) (data not shown).

Table 3 presents the age-, sex-, and race-adjusted estimates of the proportion ± SE of the sample population consuming <100% of the 1989 RDA for nutrients examined, by each tertile of energy from the "other" foods. The proportion of the population meeting the RDA for these nutrients decreased with increasing consumption of energy from "other" foods ($p < 0.0000$).

Food Group Consumption

With increasing consumption of percent of energy from the "other" group, the proportion of the population failing to report any foods from the meat, dairy, grain, fruit, and vegetable groups on the survey day increased ($p < 0.0000$) (Table 4). The proportion of respondents reporting consumption of at least the recommended number of servings from the major food groups decreased (Table 5) ($p < 0.0000$) with increasing percent of energy from the "other" foods.

Demographic Profile

Sociodemographic and other lifestyle characteristics of respondents classified in the various tertiles of intake of energy from the "other" foods are presented in Table 6. The proportion of respondents reporting the highest level of consumption of foods from the "other" group declined with increasing age. Proportion of current smokers, and alcohol drinkers increased with increasing level of consumption of "other" foods. The proportion of respondents with a high BMI (BMI ≥ 27.8 for men and ≥ 27.3 for women [30]), and answering yes to being on a special diet, decreased with increasing level of consumption of "other" foods.

DISCUSSION

This study examined the contribution of foods constituting the fats, sweets, and alcohol group to daily energy and macronutrient intake and its impact on nutritional profiles. Respondents reported a wide range in the level of consumption of energy from foods in the "other" group, with an average of nearly one-third of total daily energy intake coming from these relatively nutrient-poor foods (Table 1). For high consumers (3rd tertile) of "other" foods, almost 50% of total daily energy intake was contributed by these foods. Other analogous estimates of contribution of "other" foods to the US diet are not available for comparison. However, any future comparisons of NHANES II estimates with those derived from other studies must consider the dependence of such estimates upon assumptions made in classifying foods into groups.

It is not surprising that nutrient density of the diets declined with increasing consumption of foods from the "other" group (data not shown). It is notable, however, that stratification for level of consumption of nutrient-poor, energy-dense foods led to a shift in the commonly

Table 2. Mean ± SEM (Adjusted for Age, Sex, and Race) of Daily Nutrient Intake, by Tertile[a] of Consumption of Energy from the "Other[b]" Group

Nutrient	Tertile of % energy from "other" foods			
	All	First	Second	Third
Energy (kcal)	1987 ± 17	1856 ± 22	2011 ± 103	2081 ± 87
Carbohydrate (% energy)	44 ± 0.1	43 ± 0.3	44 ± 0.2	45 ± 0.2
Fat (% energy)	36 ± 0.1	37 ± 0.2	37 ± 0.2	33 ± 0.2
Protein (% energy)	16 ± 0.1	19 ± 0.1	16 ± 0.1	13 ± 0.1
Alcohol (% energy)	4 ± 0.1	1 ± 0.1	3 ± 0.1	9 ± 0.4
Fiber (g)	11 ± 0.1	13 ± 0.3	11 ± 0.2	10 ± 0.2
Vitamin A (IU[c])	5374 ± 59	6026 ± 142	5291 ± 109	4869 ± 185
Vitamin E (TE)	8 ± 0.1	8 ± 0.2	9 ± 0.2	8 ± 0.2
Vitamin C (mg)	100 ± 1	114 ± 1.8	102 ± 2.0	86 ± 2.2
Vitamin B_6 (mg)	1.5 ± 0.01	1.6 ± 0.02	1.5 ± 0.02	1.3 ± 0.02
Folate (μg)	244 ± 3	270 ± 5	248 ± 5	216 ± 4
Zinc (mg)	12 ± 0.2	14 ± 0.4	12 ± 0.2	11 ± 0.3
Calcium (mg)	750 ± 11	860 ± 15	787 ± 13	617 ± 11
Iron (mg)	13 ± 0.1	15 ± 0.2	14 ± 0.2	12 ± 0.1
Potassium (mg)	2498 ± 24	2729 ± 31	2554 ± 22	2237 ± 27

[a] First tertile = <21.5% of daily energy from "other" foods.
Second tertile = 21.5 – 35.4% of daily energy from "other" foods.
Third tertile = >35.4% of daily energy from "other" foods.
[b] "Other" group: fats, sweets, and alcohol group (included all visible fats, caloric sweeteners, carbonated and alcoholic beverages, and desserts and snacks with a high fat and sugar content). Differences among tertiles, in the intake of energy, percent energy from macronutrients and alcohol, and micronutrients, were significant at $p < 0.0000$; the multivariate regression model included the tertiles, age, sex, and race as independent variables.
[c] Retinol equivalent estimates are not available for NHANES II data.

Table 3. Percentage ± SE (Adjusted for Age, Sex, and Race) of the Population Reporting <100% of the RDA[a] of Selected Nutrients, by Tertile[b] of Consumption of Energy from the "Other[c]" Group

Nutrient	Tertile of % energy from "other" foods			
	All	First	Second	Third
Protein	35 ± 1	31 ± 1	32 ± 1	43 ± 1
Vitamin A	64 ± 1	58 ± 1	63 ± 1	69 ± 1
Vitamin E	70 ± 1	75 ± 1	69 ± 1	68 ± 1
Vitamin C	46 ± 1	39 ± 1	44 ± 1	53 ± 1
Vitamin B_6	74 ± 1	69 ± 1	73 ± 1	79 ± 1
Folate	48 ± 1	43 ± 1	46 ± 1	55 ± 1
Zinc	72 ± 1	64 ± 1	71 ± 1	80 ± 1
Calcium	69 ± 1	61 ± 1	65 ± 1	79 ± 1
Iron	49 ± 1	45 ± 1	45 ± 1	55 ± 1
Potassium	40 ± 1	33 ± 1	38 ± 1	48 ± 1

[a] RDA = age, and sex specific 1989 RDA. Protein RDA = 0.8 g/kg body weight. Potassium RDA = As there is no RDA for potassium, the standard used for this analysis was 2000 mg.
[b] First tertile = <21.5% of daily energy from "other" foods. Second tertile = 21.5 – 35.4% of daily energy from "other" foods. Third tertile = >35.4% of daily energy from "other" foods.
[c] "Other" group: fats, sweets, and alcohol group (included all visible fats, caloric sweeteners, carbonated and alcoholic beverages, and desserts and snacks with a high fat and sugar content). Differences among tertiles, in the proportion of the population meeting 100% of the RDA of protein and micronutrients were significant at $p < 0.000$. Each regression model contained nutrient as a dependent variable and the tertiles, age, sex, and race as independent variables.

observed relationship of energy and nutrient intake. Energy intake is usually positively associated with intake level of most nutrients [31,32]. In our analysis, increasing consumption of energy from the "other" group was associated with an increase in total energy intake but decline in nutrient intake (Table 2). The mean total energy intake in the highest tertile was approximately 112% of that in the first tertile; however, the mean proportion of daily energy from "other" foods in the highest tertile was over 360% of that in the lowest tertile.

Our results suggest that increasing consumption of energy from the fats, sweets, and alcohol group on survey day occurred at the expense of nutrient-dense foods from the diet. Consumption of foods from the fat, sweet, and alcohol group, along with a sound foundation diet, should expectedly lead to a decline in nutrient density of the diet due to dilution of nutrient intake. This, however, should not be associated with a decrease in absolute nutrient intake or an increase in the proportion of respondents consuming less than the RDA, as was the case in the current analyses. Lewis et al [14] also reported intake of lower percentage of the RDA of various nutrients by respondents reporting a high proportion of daily energy as

Table 4. Percentage ± SE (Adjusted for Age, Sex, and Race) of the Population Consuming No Servings from the Meat, Dairy, Fruit, and Vegetable Groups, by Tertile[a] of Consumption of Energy from the "Other[b]" Group

Food group	First tertile	Second tertile	Third tertile
Meat	4.8 ± 0.4	4.9 ± 0.4	8.9 ± 0.5
Dairy	17.9 ± 0.8	20.9 ± 0.8	33.6 ± 0.8
Grain	5.2 ± 0.4	3.5 ± 0.4	6.7 ± 0.6
Fruit	38.2 ± 1.3	44.2 ± 1.3	55.7 ± 1.0
Vegetable	17.5 ± 0.7	16.3 ± 0.8	19.8 ± 0.8

[a] First tertile = <21.5% of daily energy from "other" foods. Second tertile = 21.5 – 35.4% of daily energy from "other" foods. Third tertile = >35.4% of daily energy from "other" foods.
[b] "Other" group: fats, sweets, and alcohol group (included all visible fats, caloric sweeteners, carbonated and alcoholic beverages, and desserts and snacks with a high fat and sugar content). Differences among tertiles, in the proportion not reporting each food group were significant at $p < 0.0000$; the multivariate regression model contained the tertiles, age, sex, and race as independent variables.

Table 5. Percentage ± SE (Adjusted for Age, Sex, Race) of the Population Consuming at Least 2 Servings Each of Meat, Dairy, Fruit, and Vegetable, and Four Servings of Grain Groups, by Tertile[a] of Consumption of Energy from the "Other[b]" Group

Food group	First tertile	Second tertile	Third tertile
Meat	74.4 ± 1.0	73.2 ± 0.7	65.1 ± 0.8
Dairy	58.8 ± 1.3	54.6 ± 1.0	38.0 ± 1.0
Grain	33.7 ± 1.0	33.5 ± 1.0	21.1 ± 0.9
Fruit	37.1 ± 1.2	30.6 ± 0.9	21.0 ± 0.8
Vegetable	61.2 ± 1.0	61.9 ± 1.0	58.6 ± 1.0

[a] First tertile = <21.5% of daily energy from "other" foods. Second tertile = 21.5 – 35.4% of daily energy from "other" foods. Third tertile = >35.4% of daily energy from "other" foods.

[b] "Other" group: fats, sweets, and alcohol group (included all visible fats, caloric sweeteners, carbonated and alcoholic beverages, and desserts and snacks with a high fat and sugar content). Differences among tertiles, in the proportion reporting at least the recommended servings of each food group were significant at $p < 0.0000$; the multivariate regression model contained the tertiles, age, sex, and race as independent variables.

added sugar.

With increasing intake of foods from the "other" group, respondents were more likely to report diets that excluded one or more of the major food groups (Table 4). Additionally, the proportion of respondents reporting consumption of at least the recommended numbers of servings of foods from the major food groups declined with increasing intake of nutrient-poor foods (Table 5). These observations provide further evidence for displacement or low consumption of nutrient-dense foods due to increasing consumption of relatively energy-dense, nutrient-poor foods from the fats, sweets and alcohol group. Because we limit our conclusions to groups rather than individual respondents in the survey, the 24-hour dietary recall used for collecting dietary information is not a limitation of this study [33].

Methods used in this paper for examining the association of "other" foods with nutrient adequacy may be useful for future investigations of this nature. Our analysis is based on dietary data collected in 1976–80, and provides a baseline for evaluating trends in contribution of "other" foods to the American diet. Due to increasing public awareness of diet and health issues, and increasing availability of foods with modified sugar and fat content in the American food supply, a decline in intake of foods from the "other" group might be expected. However, as demonstrated by an examination of dietary patterns of American women from 1977–1985 [34], not all trends in food intake are consistent with this expectation. Relative to 1977, women did report increasing use of lower-fat meats and milk in 1985, however, the proportion of women using high-fat desserts and high-fat salty snacks (foods in the "other" group) also increased [34]. American women aged 19–50 years in the USDA's 1977–78 NFCS survey consumed approximately 14% of daily energy from the fats, sweets, and alcohol group (estimated from NFCS data [9]); in 1985, this proportion was nearly 19% [10], and in 1986, >17% [11]. (The USDA fats, sweets, and alcohol group does not include desserts and snacks with a high fat and sugar content and therefore is not directly comparable

Table 6. Sociodemographic and Lifestyle Characteristics of Respondents, by Tertile[a] of Consumption of Energy from the "Other[b]" Group

	% energy from "other" foods by tertile			
	All	First	Second	Third
Gender				
Males	48	44	50	49
Females	52	56	50	51
Ethnicity				
White	89	89	89	88
Black	11	11	11	12
Age group (years)				
19–34 y	32	27	32	37
35–50 y	20	18	21	22
61–65 y	29	31	29	26
>65 y	19	23	18	15
Level of education (years)				
1–8	20	24	19	17
9–12	50	48	49	53
13–16	24	22	25	24
>16	6	6	7	6
Income status (poverty index ratio)				
<1	17	20	16	15
≥1	83	80	84	85
Smoking Status				
Never	41	47	41	37
Former	24	24	24	22
Current	35	29	34	41
Vitamin/mineral supplement use				
No	63	62	62	66
Yes, reg	24	25	25	21
Yes, irreg	13	13	13	13
Any drinking?				
No	33	39	32	27
Yes	67	61	68	73
Self-described level of usual physical activity				
Very active	35	33	36	35
Moderate	51	52	51	52
Inactive	14	15	13	13
High BMI[c] (≥27.8 in men; ≥27.3 in women)				
Yes	25	30	25	23
On a special diet?				
Yes	15	22	13	10

[a] First tertile = <21.5% of daily energy from "other" foods. Second tertile = 21.5 – <35.4% of daily energy from "other" foods. Third tertile = >35.4% of daily energy from "other" foods.

[b] "Other" group: fats, sweets, and alcohol group (included all visible fats, caloric sweeteners, carbonated and alcoholic beverages, and desserts and snacks with a high fat and sugar content).

[c] BMI = body mass index [wt (kg)/ht (m^2)].

to the "other" group in our analysis.)

In conclusion, our results suggest that in self-selected American diets, use of foods from the fats, sweets, and alcohol group was associated with decreased consumption of nutrient-dense foods and, as a result, a decline in nutrient adequacy of the diet. Our results in no way imply that there is no place for foods from the "other" group in a well balanced diet. However, frequent consumption of these foods without attention to judicious selection of relatively nutritious foods is likely to be an index of increased nutritional risk.

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