Food group intake patterns and associated nutrient profiles of the US population

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Abstract We developed a method for evaluating food group intake patterns using dietary recall data (n = 11,529) from the second National Health and Nutrition Examination Survey. We used this method to examine the relationship of these food group intake patterns to nutrient intake and to selected biochemical indexes of nutritional status. We evaluated each 24-hour dietary intake recall for the presence or omission of five broad food groups—dairy, meat, grain, fruit, and vegetable. The five most prevalent patterns and the proportion of the population reporting them was as follows: all food groups, 33.6%; no fruit, 23.9%; no dairy and fruit, 9.0%; no dairy, 8.0%; and no fruit and vegetable, 5.6%. In the most prevalent pattern, all food groups were consumed; this was the only pattern that provided mean amounts of all of the key vitamins and minerals at levels greater than or equal to the Recommended Dietary Allowances (RDAs). This pattern also was reported by the lowest proportion of individuals consuming less than 100% RDA of the key nutrients. Patterns in which both fruit and vegetables were consumed were associated with highest levels of serum vitamin C. The consistency of these results indicates that screening diets for food group consumption can quickly provide meaningful information about their quality. *J Am Diet Assoc. 1991; 91:1532-1537.*

Recent reports indicate that a large proportion of the US population does not consume foods from one or more of the major food groups on any given day (1-4). Nearly 46%, 24%, and 18% of respondents in the second National Health and Nutrition Examination Survey (NHANES II) reported that they had not consumed foods from the fruit, dairy, and vegetable groups, respectively, on the day of the recall (4). However, the proportion of the population that typically consumes various combinations of food groups is as yet unknown. As recognition of the role of diet in health promotion increases (5-7), information on food patterns and their nutritional consequences among specific population groups would be useful as a basis for designing nutrition interventions and nutrition education materials.

Previous studies have examined patterns of food consumption from the standpoint of food group usage (8), food grouping based on statistical cluster/factor analysis of dietary recall (9-11), or food frequency data (12,13). Our report describes a method for evaluating dietary patterns based on consumption of foods from traditional food groups.

Our study examines data from NHANES II to identify patterns of intake of traditional food groups consumed by a nationally representative sample; examine the nutrient content of diets associated with these food group intake patterns; and examine the relationship of these patterns to selected biochemical and anthropometric indexes of nutritional status.

Methods

NHANES II was conducted by the National Center for Health Statistics (NCHS) from 1976 to 1980 on a nationwide probability sample of the civilian, noninstitutionalized population of the United States. Details of survey design and data collection have been described (14). In the NHANES II survey, a trained dietary interviewer administered a single 24-hour dietary recall to each participant using three-dimensional food models to facilitate estimation of food portion sizes. For the purpose of our analyses, we created a subset composed of 24-hour recalls from all black and white individuals aged 19 to 74 years (n = 11,967). This subset excluded 24-hour recalls considered to be unsatisfactory, incomplete, imputed, or obtained from surrogates (n = 309). Also excluded were the recalls of 129 women reported to be pregnant or lactating at the time of the survey. The final analytic sample included 11,529 individuals.

To evaluate each 24-hour recall for food group intake patterns, we assigned all foods reported consumed by adults (2,244 foods) in the NHANES II to one of five food groups—dairy, meat, grain, fruit, and vegetable. Foods excluded from the five groups (eg, fat, sugar) were not examined in our analysis. Our decision to place fruits and vegetables in two separate groups reflects their differing uses in the diet and is consistent with the rationale for grouping foods in the "Better Eating for Better Health" guide (15). Foods were placed in the five groups on the basis of similarities in nutrient composition and uses in the diet. The procedures used for grouping foods have been described elsewhere (4).

To avoid giving credit for a food group when the amounts consumed were small (eg, a slice of tomato), we established a minimum intake level. For the meat, fruit, and vegetable groups, the minimum reported amount for inclusion was 30 g for all solid foods categorized in one

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Table 1. Ranking the 10 most prevalent patterns[a] (proportion ± standard error) of food group intake in the US population, by gender and race, second National Health and Nutrition Examination Survey, 1976-80 (14)

rank	*total (n=11,529)*		*white men (n=4,905)*		*white women (n=5,303)*		*black men (n=604)*		*black women (n=717)*	
	DMGFV[b]	*%*	*DMGFV*	*%*	*DMGFV*	*%*	*DMGFV*	*%*	*DMGFV*	*%*
1	11111	33.6±0.7	11111	35.7±1.0	11111	34.2±1.0	11111	21.6±1.7	11111	23.2±2.6
2	11101	23.9±0.7	11101	29.2±1.2	11101	20.3±0.9	11101	19.2±1.5	11101	15.5±2.2
3	01101	9.0±0.5	01101	8.2±0.6	01111	8.7±0.6	01101	16.7±2.0	01101	12.7±1.2
4	01111	8.0±0.3	01111	6.5±0.5	01101	8.5±0.6	01111	10.4±1.3	01111	12.6±1.4
5	11100	5.6±0.3	11100	6.3±0.4	11110	5.1±0.4	11100	9.1±1.9	01100	7.1±1.5
6	11110	5.2±0.3	11110	5.2±0.5	11100	4.6±0.4	01100	7.5±1.4	01110	5.9±1.0
7	01100	2.5±0.2	01100	1.9±0.2	10111	2.7±0.3	11110	5.1±1.2	11100	5.3±1.0
8	10111	1.5±0.2	11011	1.2±0.2	01100	2.0±0.2	01110	3.1±1.0	11110	4.4±0.9
9	01110	1.5±0.2	01110	1.0±0.2	10101	1.5±0.2	01001	0.8±0.4	01001	2.6±0.7
10	11011	1.2±0.2	10100	0.8±0.2	11011	1.5±0.3	01010	0.7±0.5	00101	1.6±0.4

[a]The first and second most prevalent patterns were the same for all four populations; the third through tenth most prevalent patterns differed by gender and race groups.

[b]DMGFV = dairy, meat, grain, fruit, and vegetable groups; 1 = food group(s) present; 0 = food group(s) absent. For example, DMGFV = 11111 denotes that all food groups (dairy, meat, grain, fruit, and vegetable) were consumed; DMGFV = 11100 indicates that three food groups (dairy, meat, and grain) were consumed and two food groups (fruit and vegetable) were not consumed.

group and 60 g for all liquids and mixed dishes. For the dairy and grain groups, the minimum amount was 15 g for all solids and 30 g for all liquids and mixed dishes. The rationale for selection of minimum amounts for the various food groups has been described (4).

For each 24-hour recall, we evaluated the presence or absence of each food group. With five food groups and their occurrence at two levels each (present or absent), it was possible to report 32 combinations of food groups consumed on the survey day. We defined these combinations as patterns of food group intake and refer to them as DMGFV (dairy, meat, grain, fruit, and vegetable), with the number 1 indicating presence and 0 indicating absence of the food group(s). Thus, DMGFV = 11110 indicates a pattern in which all groups except vegetable were consumed on the survey day.

We selected intakes of energy, cholesterol, dietary fiber and percent energy from protein, carbohydrates, and fat as indexes of nutrition quality. We also evaluated intakes of the 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) (16). We chose these food components and nutrients for this study because the Expert Panel on Nutrition Monitoring (17) has identified the level of intake of these nutrients as current or potential public health issues.

The nutrient content database for foods reported consumed in NHANES II does not contain information on vitamins B-6 and E, folate, dietary fiber, or zinc. Therefore, databases were created for each of these nutrients using the most recent US Department of Agriculture (USDA) data and other sources (18-21).

We also examined data on selected biochemical and anthropometric indexes of nutritional status—hemoglobin, hematocrit, serum albumin, serum vitamin C, serum zinc, and the Quetelet index (weight [kg]/height [m]^2) relative to the food group intake patterns.

Statistical analyses

Descriptive statistics for patterns of food group intake, nutrient intake, Quetelet index, and biochemical variables were obtained by age, sex, and race. Statistical analyses were performed using SAS (22) and were weighted using the 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 (23), SESUDAAN (24), and SURREGR (25), appropriate for analyses of complex sample surveys, were used to estimate variance and perform regression analyses.

Differences in nutrient intake levels and biochemical indexes of nutritional status among individuals who consume diets from the most frequently reported food group patterns were tested by linear regression, using the SURREGR procedure, with pattern, age, sex, and race in the model as independent variables. If the overall F test was significant, all possible pairwise comparisons of the 10 leading food group patterns were made using a Bonferroni adjustment (26) to control the type I error rate to a conservative level. Thus, two means were declared significantly different from each other at $P<.001$. It was necessary to use these statistical procedures to compare means because multiple comparison tests that take survey design characteristics into consideration are not currently available.

Results

Patterns of food group intake

Table 1 presents the 10 most frequently reported patterns of food group intake (ranked in descending order) in the NHANES II, by sex and race. These 10 patterns accounted for nearly 92% of the population surveyed. Although the most frequently reported pattern for all sex-race groups was the one in which respondents consumed foods from all five food groups (DMGFV = 11111), this pattern was

Table 2. Dietary nutrient intake associated with the 10 most prevalent patterns of food group intake in the US population, second National Health and Nutrition Examination Survey, 1976-1980 (14)

demographic data/ nutrient	*patterns of food group intake (ranked in order of prevalence)*									
	1 DMGFV[a] 11111 (n=3,964)	*2 DMGFV 11101 (n=2,524)*	*3 DMGFV 01101 (n=1,027)*	*4 DMGFV 01111 (n=970)*	*5 DMGFV 11100 (n=642)*	*6 DMGFV 11110 (n=619)*	*7 DMGFV 01100 (n=297)*	*8 DMGFV 10111 (n=218)*	*9 DMGFV 01110 (n=196)*	*10 DMGFV 11011 (n=132)*
% of population	33.6	23.9	9.0	8.0	5.6	5.2	2.5	1.5	1.5	1.2
white:black[b]	13:1	10:1	4:1	5:1	7:1	9:1	2:1	15:1	2:1	15:1
male:female[b]	0.9:1	1.4:1	0.9:1	0.7:1	1.3:1	0.9:1	0.9:1	0.2:1	0.6:1	0.7:1
energy (kcal)										
mean ± SEM[c]	2,179 ± 27	2,277 ± 32	1,855 ± 30	1,721 ± 28	1,912 ± 43	1,955 ± 49	1,510 ± 63	1,378 ± 58	1,511 ± 56	1,604 ± 82
median	1,838	1,996	1,554	1,483	1,616	1,663	1,274	1,186	1,287	1,403
protein (% kcal)										
mean ± SEM	17 ± 0.1	16 ± 0.1	16 ± 0.2	15 ± 0.2	16 ± 0.2	16 ± 0.2	15 ± 0.4	13 ± 0.3	15 ± 0.4	20 ± 1.0
median	16	16	14	14	16	15	14	12	14	19
carbohydrate (% kcal)										
mean ± SEM	45 ± 0.2	42 ± 0.3	42 ± 0.4	46 ± 0.5	42 ± 0.4	47 ± 0.4	45 ± 0.9	56 ± 1.0	47 ± 1.0	41 ± 1.0
median	46	42	42	47	42	47	43	57	48	41
fat (% kcal)										
mean ± SEM	36 ± 0.2	38 ± 0.2	37 ± 0.4	35 ± 0.4	38 ± 0.4	35 ± 0.4	35 ± 0.7	31 ± 0.9	34 ± 0.8	36 ± 1.0
median	36	39	37	35	39	36	35	30	35	36
cholesterol (mg)										
mean ± SEM	391 ± 8	407 ± 10	330 ± 9	333 ± 9	360 ± 14	359 ± 14	302 ± 15	111 ± 6	357 ± 23	313 ± 25
median	294	307	247	281	282	294	222	85	323	228
dietary fiber (g)										
mean ± SEM	14 ± 0.2	10 ± 0.2	9 ± 0.3	12 ± 0.3	8 ± 0.6	11 ± 0.4	7 ± 0.5	13 ± 0.6	9 ± 0.5	12 ± 0.8
median	12	8	7	10	4	8	4	11	7	10
vitamin A (% RDA[d])										
mean ± SEM	157 ± 3	117 ± 6	90 ± 5	131 ± 7	63 ± 6	89 ± 8	25 ± 2	156 ± 11	62 ± 8	173 ± 29
median	106	73	47	72	42	60	18	108	40	98
vitamin E (% RDA)										
mean ± SEM	111 ± 2	97 ± 2	80 ± 2	83 ± 2	71 ± 3	76 ± 3	46 ± 2	95 ± 9	60 ± 3	85 ± 6
median	83	76	65	71	51	61	39	62	50	64
vitamin C (% RDA)										
mean ± SEM	250 ± 4	102 ± 3	97 ± 5	227 ± 6	45 ± 4	189 ± 8	34 ± 8	230 ± 14	169 ± 14	260 ± 21
median	208	75	63	181	19	150	8	180	131	224
vitamin B-6 (% RDA)										
mean ± SEM	99 ± 1	86 ± 2	71 ± 2	74 ± 1	63 ± 2	74 ± 2	43 ± 2	67 ± 3	56 ± 2	85 ± 3
median	84	71	57	63	46	61	33	55	46	7
folate (% RDA)										
mean ± SEM	162 ± 3	122 ± 3	99 ± 3	124 ± 3	99 ± 4	127 ± 7	70 ± 4	120 ± 7	98 ± 5	139 ± 8
median	134	97	79	100	71	103	48	103	79	110
iron (% RDA)										
mean ± SEM	142 ± 2	133 ± 3	113 ± 2	115 ± 3	105 ± 3	115 ± 3	84 ± 4	84 ± 6	91 ± 5	105 ± 6
median	122	113	90	99	88	99	69	76	75	8
calcium (% RDA)										
mean ± SEM	107 ± 2	105 ± 2	39 ± 1	40 ± 1	106 ± 4	104 ± 3	31 ± 2	94 ± 5	32 ± 1	94 ± 11
median	90	87	33	36	84	86	25	79	29	66
zinc (% RDA)										
mean ± SEM	105 ± 2	100 ± 3	74 ± 3	69 ± 2	79 ± 5	85 ± 4	49 ± 2	65 ± 4	54 ± 4	84 ± 4
median	78	76	54	53	57	63	40	47	40	69
potassium (% RDA)										
mean ± SEM	151 ± 2	133 ± 2	102 ± 2	114 ± 2	95 ± 3	116 ± 3	61 ± 4	111 ± 3	80 ± 3	141 ± 6
median	135	117	85	100	77	99	45	104	71	129

[a]DMGFV = dairy, meat, grain, fruit, and vegetable groups; 1 = food group(s) present; 0 = food group(s) absent. For example, DMGFV = 11111 denotes that all five food groups (dairy, meat, grain, fruit, and vegetable) were consumed; DMGFV = 11100 indicates that three food groups (dairy, meat, and grain) were consumed and two food groups (fruit and vegetable) were not consumed.

[b]The ratio of white:black and male:female respondents in the sample population was 1:7.73 (rounded) and 0.9:1.0, respectively.

[c]SEM = standard error of the mean.

[d]RDA = sex-age-specific 1989 Recommended Dietary Allowance (9). As there is no established RDA for potassium, the standard used in this analysis was 2,000 mg/day.

Table 3. Percent of the population consuming less than 100% of the RDA[a] of selected nutrients by leading patterns of food group intake, second National Health and Nutrition Examination Survey, 1976-1980 (14)

rank	DMGFV[b] pattern	protein	vitamin C	vitamin A	vitamin E	vitamin B-6	folate	zinc	iron	calcium	potassium
1	11111	27	18	47	64	63	28	66	35	58	22
2	11101	26	66	67	69	73	53	68	42	60	36
3	01101	50	71	76	77	84	68	82	56	98	62
4	01111	52	24	62	74	81	50	86	51	99	51
5	11100	41	91	88	85	87	70	82	60	62	69
6	11110	37	32	80	82	82	48	78	51	61	51
7	01100	66	96	96	94	97	86	93	73	99	90
8	10111	78	26	46	78	87	47	87	72	65	45
9	01110	63	38	88	88	91	69	91	69	99	76
10	11011	39	15	50	72	71	37	75	58	73	27

[a]RDA = sex/age-specific 1989 Recommended Dietary Allowance (9); RDA of protein = 0.8 g protein/kg body weight. As there is no established RDA for potassium, the standard used in this analysis was 2,000 mg/day.
[b]DMGFV = dairy, meat, grain, fruit, and vegetable groups; 1 = food group(s) present; 0 = food group(s) absent. For example, DMGFV = 11111 denotes that all five food groups (dairy, meat, grain, fruit, and vegetable) were consumed; DMGFV = 11100 indicates that three food groups (dairy, meat, and grain) were consumed and two food groups (fruit and vegetable) were not consumed.

reported by only 35% of all whites and 25% of all blacks. Omission of fruit (DMGFV = 11101) was the most commonly reported incomplete pattern, comprising nearly one fourth of all survey respondents. Diets that lacked both the dairy and fruit groups (DMGFV = 01101) were reported by 9% of total survey population. The pattern in which only the meat and the grain groups (DMGFV = 01100) were consumed was reported by more than 7% of blacks and approximately 2% of whites.

The patterns ranked 1 and 2 (DMGFV = 11111, all groups, and DMGFV = 11101, no fruit) were reported by fewer blacks than whites, whereas more blacks than whites reported patterns omitting two and three food groups.

Associated nutrient intake

Table 2 presents the nutrient intake profile (mean ± standard error of the mean [SEM] and median) associated with the most prevalent patterns of food group intake. Overall F tests for differences among patterns in mean intakes of all nutrients and dietary components examined were highly significant ($P<.00001$). Patterns ranked 1 and 2 provided the highest mean energy intake compared with all others ($P<.0011$). The pattern ranked 8 (DMGFV = 10111, consuming all groups except meat) was associated with the smallest percent energy from protein and the highest percent energy from carbohydrate ($P<.0011$). Patterns ranked 2 and 5 (DMGFV = 11101 and DMGFV = 11100, consuming no fruit and vegetable) provided the highest percent energy from fat. The highest mean dietary fiber intake was associated with the pattern ranked 1 (DMGFV = 11111). Only those patterns where both fruit and vegetable groups were consumed (DMGFV = 11111, 01111, 10111, and 11011) yielded a mean dietary fiber intake of 12 g/day or more.

Only the most frequently reported pattern (DMGFV = 11111) provided mean amounts of all noted vitamins and minerals at levels greater than or equal to the RDA. All others provided less than the RDA level for two or more nutrients. Patterns ranked 3 and 5 (DMGFV = 01101, consuming no dairy and fruit, and DMGFV = 11100) provided more than four vitamins and minerals in less than recommended amounts. In the least favorable pattern (DMGFV = 01100, meat and grain only), mean amounts of all vitamins and minerals analyzed were consumed at levels below the RDA ($P<.0011$). Vitamin B-6, vitamin E, zinc, and calcium were the nutrients most likely to be consumed at levels below the RDA in all patterns except the leading one.

Table 3 presents the proportion of the population consuming less than 100% of the age/sex-specific RDA for selected nutrients among the 10 most frequently reported patterns of food intake. The most prevalent pattern (DMGFV = 11111) was associated with the largest proportion of the population consuming levels of nutrients at or above RDA levels.

Biochemical/anthropometric indexes

Table 4 presents the mean ± SEM and median of selected biochemical and anthropometric indexes of nutritional status associated with the 10 most prevalent patterns of food group intake. None of the parameters (except level of serum vitamin C) differed significantly among the various patterns. The patterns ranked 5 and 7 (DMGFV = 11100 and DMGFV = 01100, consuming no dairy, fruit, and vegetable) were associated with the lowest mean levels of serum vitamin C. More than 42% of respondents with patterns DMGFV = 01101 and DMGFV = 11100 and 51% with pattern DMGFV = 01100 were in the lowest quartile of serum vitamin C levels. In food patterns including both fruits and vegetables, the proportion in the lowest quartile of serum vitamin C levels was approximately 11%. (Data for quartile distribution of biochemical indexes by patterns of food group intake are not shown.)

Discussion

Our article presents a method for evaluating patterns of food consumption based on food groups. These results confirm previous observations that a large proportion of the US population consumes diets that lack one or more food groups (1-4).

Table 4. Selected biochemical indexes of nutritional status associated with the 10 most prevalent patterns of food group intake, second National Health and Nutrition Examination Survey, 1976-1980 (14)

rank	DMGFV[a] pattern	age (n = 11,529)	QI[b] (n = 11,529)	serum albumin[c] (n = 10,808)	hematocrit[d] (n = 11,413)	hemoglobin[e] (n = 11,413)	serum vitamin C[f] (n = 10,750)	serum zinc[g] (n = 9,948)
		years		g/L		g/L	← μmol/L	→
1	11111							
	mean ± SEM	45 ± 0.4	25.2 ± 0.1	47 ± 0.1	0.42 ± 0.001	143 ± 0.4	69 ± 1	13.3 ± 0.1
	median	56	24.7	47	0.42	143	68	13.3
2	11101							
	mean ± SEM	38 ± 0.4	25.0 ± 0.1	48 ± 0.1	0.42 ± 0.001	145 ± 0.5	49 ± 1	13.6 ± 0.1
	median	37	24.5	47	0.43	145	45	13.3
3	01101							
	mean ± SEM	40 ± 0.5	25.4 ± 0.2	47 ± 0.2	0.42 ± 0.001	143 ± 0.6	45 ± 2	13.4 ± 0.1
	median	43	24.8	47	0.42	142	40	13.3
4	01111							
	mean ± SEM	46 ± 0.6	25.8 ± 0.2	47 ± 0.2	0.42 ± 0.002	142 ± 0.6	65 ± 2	13.3 ± 0.1
	median	57	25.3	46	0.42	141	68	13.0
5	11100							
	mean ± SEM	40 ± 0.7	25.4 ± 0.2	47 ± 0.2	0.43 ± 0.002	146 ± 0.8	43 ± 1	13.5 ± 0.1
	median	44	25.1	47	0.43	146	40	13.3
6	11110							
	mean ± SEM	44 ± 0.8	24.9 ± 0.2	47 ± 0.2	0.42 ± 0.002	143 ± 0.7	65 ± 2	13.3 ± 0.1
	median	54	24.6	47	0.42	142	68	12.8
7	01100							
	mean ± SEM	40 ± 0.7	26.2 ± 0.4	47 ± 0.2	0.42 ± 0.003	141 ± 0.1	40 ± 2	13.2 ± 0.2
	median	43	25.4	46	0.42	141	28	13.0
8	10111							
	mean ± SEM	49 ± 1.6	24.8 ± 0.5	47 ± 0.3	0.40 ± 0.003	137 ± 0.1	77 ± 2	13.1 ± 0.2
	median	62	24.7	46	0.41	139	80	12.8
9	01110							
	mean ± SEM	44 ± 1.5	26.1 ± 0.6	46 ± 0.3	0.41 ± 0.003	139 ± 0.1	59 ± 4	13.1 ± 0.2
	median	57	25.6	45	0.41	140	57	12.8
10	11011							
	mean ± SEM	42 ± 1.4	25.0 ± 0.5	47 ± 0.4	0.42 ± 0.003	143 ± 0.1	74 ± 2	13.3 ± 0.3
	median	47	25.3	47	0.42	143	74	13.3

[a]DMGFV = dairy, meat, grain, fruit, and vegetable groups; 1 = food group(s) present; 0 = food group(s) absent. For example, DMGFV = 11111 denotes that all five food groups (dairy, meat, grain, fruit, and vegetable were consumed; DMGFV = 11100 indicates that three food groups (dairy, meat, and grain) were consumed, and 2 food groups (fruit and vegetable) were not consumed.
[b]QI = Quetelet index (weight [kg]/height [m]²).
[c]To convert g/L albumin to g/dL, multiply g/L by 0.1.
[d]To convert hematocrit from SI units to traditional units, multiply by 100.
[e]To convert g/L hemoglobin to g/dL, multiply g/L by 0.1.
[f]To convert μmol/L serum ascorbate to mg/dL, multiply μmol/L by 0.01761.
[g]To convert μmol/L zinc to μg/dL, multiply μmol/L by 6.536.

Previous studies (27-29) have reported an association between nutrient adequacy and dietary scores based on representation of the major food groups in the diet. Our study extends this work by providing information on nutrient adequacy and specific identifiable combinations of food groups and affirms the value of recommendations to consume foods from certain food groups every day. The most frequently reported pattern, DMGFV = 11111, was the only one with mean vitamin and mineral intake at RDA levels (Table 2). Additionally, this pattern contained the highest proportion of respondents with nutrient intakes equal to or greater than their age/sex-specific RDA (Table 3).

Despite differences among patterns in micronutrient and dietary fiber intake, the mean percent of energy contributed by each of the macronutrients showed no clear relationship to food group patterns (Table 2). For example, the pattern ranked 7 (DMGFV = 01100) provided about the same proportion of energy from carbohydrate and fat as the pattern ranked 1 (DMGFV = 11111). The only pattern in which the mean energy contribution of macronutrients approximated that of current dietary guidance was the one that omitted meat (DMGFV = 10111).

Not surprisingly, the biochemical parameters (with the exception of serum vitamin C) associated with the 10 leading patterns showed no interpretable variation (Table 4), possibly because the available biochemical measures are relatively nonspecific and the diet patterns are derived from a single recall. Other reasons for a lack of concordance between dietary and biochemical data have been examined by Beaton (30). The lowest mean levels of serum vitamin C (Table 4) were associated with food patterns in which the fruit group was missing (DMGFV = 11101, 01101, 11100, 01100). These patterns were also associated with lowest levels of dietary vitamin C intake (Table 2). Considering that serum vitamin C level is often used as an indicator of vitamin C nutritional status (31), it would appear that the dietary patterns developed in our report would be useful for classifying individuals with usually low intakes of fruits and vegetables and, therefore, of dietary vitamin C.

Our study is based on data collected during 1976 to 1980. Because increasing attention has been paid to diet and health in recent years, it is conceivable that dietary patterns have improved. Results of the USDA Continuing Survey of Food Intakes of Individuals 1985-1986, however, reveal that a large proportion of its sample population did not include foods from the fruit, dairy, and vegetable groups on the survey day (3), and little change has been observed in vegetable intake among women from 1975 to 1985 (9). In a February 1990 Gallup Poll (32), 50% of the respondents reported a recent increase in consumption of oat bran or vitamin supplements, but only 8% reported an increase in intakes of vegetables, fruit, or fruit juice. These observations suggest that the food group patterns reported here not only provide baseline data but are also likely to be currently relevant for identifying population subgroups with poor dietary patterns.

Our method for describing dietary patterns has some limitations: it lacks information about specific food items (eg, low-fat vs whole milk in the dairy group), methods of preparation, amount of each food group eaten (above the minimum), and the contribution of foods excluded from our analysis. However, recognizing that this information on patterns is based on a single dietary intake recall with all its inherent limitations (33), our technique of using the broad food groups has certain advantages. It is minimally affected by day-to-day variation in food intake or errors in estimation of portion sizes, both of which are notable sources of error in measurement of dietary intake. For example, although individuals may not consume carotene-rich fruits and vegetables every day, they might be expected to consume some foods from the fruit and the vegetable groups on a daily basis. Therefore, although information on specific food items provided by this data set is likely to be less reliable, the food group estimates may approximate usual pattern of intake to a greater degree. However, to our knowledge, our hypothesis regarding the reliability of food groups over time has not been examined in the literature. Because certain food groups are known sources of specific nutrients, these patterns can also be used to identify nutrients most likely to be lacking in the diet. Food group patterns, therefore, can be used to screen diets in nutrition counseling and education and monitor long-term health effects of dietary behavior when dietary information available at baseline is minimal.

Implications

The data presented here support traditional beliefs that diets that include foods from all major food groups are more likely to be nutritionally adequate. For example, along with recommendations to reduce dietary fat and increase intake of dietary fiber as a means to improve health, messages regarding basic principles of good nutrition also need reinforcement. Additionally, nutrition practitioners may find the methods we used to evaluate food group intake patterns useful for dietary assessment. Further evaluation of this method, using data in which replicated measures of dietary intake of an individual are available, is warranted.

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