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Dietary Intake, Dietary Patterns, and Changes With Age: An Epidemiological Perspective

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Cohort and cross-sectional data were reviewed to describe the changes in dietary intake with age. Total energy intake decreases varied substantially with age, by 1000 to 1200 kcal in men and by 600 to 800 kcal in women. This resulted in concomitant declines in most nutrient intakes. For some nutrients, substantial numbers of older Americans consumed only one fifth to one third of the recommended dietary allowance. For most nutrients, research is lacking with which to judge the health impact of reduced nutrient consumption with age, although there is some evidence of an age-related decline in absorptive and metabolic function. With the aging of the population, more research is needed on nutrient requirements and health outcomes, and public health efforts are needed to increase physical activity and food intake among older people.

ALTHOUGH there is a growing understanding of the importance of diet in health promotion and disease prevention, our present knowledge of nutrient requirements of elderly individuals and changes in dietary intake with age is limited. This study presents data on how nutrient intakes and dietary habits change from adulthood through old age.

Knowledge About Requirements of Older Persons

Although our science base is growing, knowledge of the nutrient requirements of elderly people remains inadequately documented. At present, the most widely accepted standards used for interpretation of dietary data are the National Academy of Sciences Recommended Dietary Allowances (RDAs) (1). The RDAs are defined as the levels of intake of essential nutrients that, on the basis of scientific knowledge, are judged by the Food and Nutrition Board to be adequate to meet the known nutrient needs of practically all healthy persons (1). There are several important considerations in assessing the adequacy of the RDA standards for older people. The RDAs provide for a single category of older people, applying a single set of standards to all persons aged 51 years and older. However, with the advancement of the aging process, changes in physical abilities, and the presence of chronic conditions, nutritional needs may be quite different as people progress from their 50s through the second half of their life span.

Although the RDAs have been the accepted reference available to health professionals and researchers for assessing diets of individuals and groups, they were not ideally suited for some of these purposes (2). In the near future, dietary reference intakes (DRIs) will be replacing the last issue of the RDA report. The decision to establish revised reference intakes was based on the following needs: (i) to critically review the underlying estimates and the criteria for adequacy; (ii) to assess new scientific evidence from a range of studies, including epidemiological studies of chronic disease; (iii) to include the concept of reduction in the risk of chronic disease; and (iv) to move away from deficiency diseases to more functional outcomes related to health and diseases. DRI is used as a collective term to accommodate various nutrient-based reference values, as shown in Table 1 (3).

For the DRIs, two categories for older adults were chosen: individuals aged 51 through 70 years and those aged older than 70 years. Although recent studies provide data on several nutrients that may inform future recommendations for older adults (4–9), it remains to be seen if the scientific data are plentiful enough to provide a strong basis for establishing DRIs for the elderly groups beyond the estimated average requirement. A more focused research agenda may evolve as a result of the process of establishing the DRIs. For the present report, mention of recommended intakes will refer to the RDAs, or to the DRIs, as appropriate.

Issues in Estimating Change in Intake With Age

Data collection methods and databases.— Assessing dietary change over time is limited by a number of methodological issues. Data collection methods differ (e.g., a single 24-hour recall vs multiple-day diet diaries). Even if the same dietary assessment method is used, there may be important differences from one time to another. Nutrient composition databases change with time. For instance, fiber values previously appeared as crude fiber (a subset of total fiber) and fiber data were available for only a limited number of food items. At present, U.S. Department of Agriculture (USDA) food tables contain values for total dietary fiber, not crude fiber, and for all food items. There have also been technological advances made in methods of measuring components of fiber. Valid comparisons of fiber intake over time are at best difficult to make. Similar problems exist in assessing changes in fat intake. For example, changes in the Third National Health and Nutrition Examination Survey (NHANES III) methods that may have influenced nutrient estimates included automated data collection, improved protocol for probing for information about food sources of dietary fat, and a different nutrient database (10).

Table 1. Dietary Reference Intake Values†

Reference Value	Definition
EAR	The intake that meets the estimated nutrient need of 50% of the individuals in that group.
RDA	The intake that meets the nutrient need of almost all (97%–98%) individuals in that group.
AI	Average observed or experimentally derived intake by a defined population or subgroup that appears to sustain a defined nutritional state, such as normal circulating nutrient values, growth, or other functional indicators of health.
UI	The maximum intake by an individual that is unlikely to pose risks of adverse health effects in almost all (97%–98%) individuals.

Note: EAR = estimated average requirement; RDA = recommended dietary allowance; AI = adequate intake; UI = tolerable upper intake level.
†Values represent daily intakes, averaged over time.

Longitudinal versus cross-sectional data.—What we know about dietary intake and patterns in elderly persons compared with younger adults comes from longitudinal and cross-sectional studies.

Most dietary data are cross-sectional. That is, data on intake in different age groups are obtained from different individuals, rather than by observing the same individuals as they age.

In a cross-sectional study, it is virtually impossible to separate changes attributable to cohort differences in food preferences from actual physiologic changes due to aging. As people age, they not only undergo physiological changes, but they also bring with them food behaviors that have evolved from the social, cultural, economic, and environmental history of their lifetime experiences. With the aging population, other issues also interfere with interpretation of cross-sectional studies. Nonresponse rate increases in the older age groups, potentially biasing the estimates. Fading memory may make it more difficult to report food intake accurately. Another issue is selective mortality, and the possibility that persons with certain dietary patterns may have better survival; in that case, we cannot be sure that those who have reached older ages—the survivors—demonstrate a pattern that represents changes with aging or one that is related to survival. In addition, food habits in older people are determined not only by lifetime preferences and physiological changes, but also by living arrangements, aloneness, finances, transportation access, and disability, among other issues. Thus, differences seen in cross-sectional studies must be interpreted with these issues in mind.

Longitudinal studies, which follow the same individuals through the life cycle, may seem to offer the best approach to examine changes over time. However, these studies, too, have shortcomings. As noted previously, dietary collection methods also evolve over time, making observed differences difficult to interpret. Nutrient intake is influenced not only by physiological factors associated with aging, but also by changes in the food supply (such as the availability of low-fat food items) and in public perceptions about what constitutes a desirable diet (such as recent emphasis on fiber intake). In addition, as noted previously, age-related changes in cognitive ability and differences between survivors and nonsurvivors can also make interpretation of longitudinal studies difficult.

In any longitudinal study, sample selection and representativeness of the cohort are issues that limit our confidence in the generalizability of these studies' results to the population at large. Most members of such cohorts are better-educated and more health-conscious. Finally, there are few longitudinal studies with large samples and with comprehensive dietary data collected over several decades, and even fewer with published results in the scientific literature.

Despite the problems with both types of data, both provide useful information and afford useful comparisons. Where findings are similar, our confidence in the interpretation of the cross-sectional studies is enhanced. Dissimilarities may also be useful, in aiding our understanding of factors such as cohort and survival effects. Despite the difficulty in attributing dietary changes to physiological, cohort, or cultural effects, the large national cross-sectional representative surveys provide the major source of accurate information on dietary intake of people at different stages of the life cycle.

Description of the Data Sets

Longitudinal studies.—There are several longitudinal studies that examine intakes of specific nutrients in a sample and health outcomes at a later date, including the Honolulu Heart Program, Nurses Health Study, Health Professionals Follow-Up Study, Adventists Health Study, Iowa Women's Study, and the Cardiovascular Heart Study (11–16). Emphasis in these studies is on health outcomes, and no published information was found on changes in nutrient intake in these populations over time. Cross-sectional results from the Framingham Study (17) have been reported on trends in diet over time, but no results have been published on changes with age. The sample included the original cohort, spouses, and offspring. For these reasons, data from the previously mentioned studies are not reported here.

Only a few longitudinal studies were identified that include dietary data on the whole diet, collected at more than one point in time, and on which results on dietary change over time have been published (18–22). The studies are summarized in Table 2.

Garry and colleagues (18) followed a sample of 304 healthy men and women, between the ages of 60 and 85 (mean age, 71.5 years), in the New Mexico Study of Nutrition and Aging. The sample was primarily white, physically active, middle income, well-educated, without chronic disease, and not taking any medication. Dietary changes were examined over 6 years. The dietary assessment method included 3-day food records. At the end of the 6 years, 213 of the original sample remained in the study; results were reported on 159 of those participants, 77 men and 82 women, who completed the diet records. Results of the analyses re-

Table 2. Longitudinal Studies That Have Reported on Dietary Change Over Time in a Cohort of Older Americans

Reference	Purpose and Sample	Dietary Assessment Instrument
Garry and colleagues, 1989 (18)	Examine changes over 6 y Convenience sample 1979, $n = 304$ Age range, 71.5–85 y (138 men, 166 women) Mean age, 72 y 1986, $n = 213$ (77 men, 82 women)	3-d (consecutive) food record every y
Garry and colleagues, 1992 (19)	Examine changes in dietary intake over 9 y	
Hallfrisch and colleagues, 1988 (20)	Examine relationship between crude fiber intake and risk factors for CAD Initial sample, $n = 845$ men Age range, 20–103 y Longitudinal analysis on 380 participants (at least 3–8 records over an average period of 8 y) Cross-sectional analysis on 783 participants	7-d food records
Hallfrisch and colleagues, 1990 (21)	Examine changes in dietary intake over time $n = 105$ men 1960s 27–65 y 1970s 1980s 50–88 y	7-d food records
Elahi and colleagues, 1983 (31)	Examine changes in dietary intake over time and differentiate age, cohort, and time effects $n = 180$ men Age range, 35–74 y	7-d food records
Flynn and colleagues, 1992 (22)	Assess diet change over time 1969–1989 University of Missouri faculty/staff $n = 144$ men Age range, late 30s to 60s	4-d diet records (every 4–6 y) for 4 y

Note: CAD = coronary artery disease.

vealed little change over time. The major limitations of the study were the short duration of the follow-up period, the small sample size, and the select, very healthy convenience sample. Because of the small sample size, the cohort was grouped into a single age cohort.

In the 9-year longitudinal follow-up, analyses showed significant decreases in total fat and cholesterol consumption in the women (19). In the men, in addition to decreases in fat intake, there were decreases in energy and protein, whether expressed as absolute consumption or per kg of body weight.

The Baltimore Longitudinal Study of Aging (BLSA) (20) gathered data between 1960 and 1987. The sample consisted of 180 men, who were predominately white, highly educated, upper-middle class, and living in the community. Their ages ranged from 35 to 74 years at entry into the study. Seven-day diet records were collected from 1961 to 1975. Subsequently, Hallfrisch and colleagues (21) conducted a longitudinal analysis on the sample of 105 men who completed at least 3 to 8 days of food records, over 3 decades. The strength of this study lies in the long duration of follow-up and in the fact that the same diet method and nutrient database was used for all analyses. Limitations arise from the nature of the sample, which represented primarily white, highly educated men.

In a longitudinal study of 20 years, Flynn and colleagues (22) assessed diet change over time. The convenience sample included 144 University of Missouri male faculty members and staff. At entry, their ages ranged from the late 30s through 60s. The dietary assessment method consisted of 4-day diet records, every 4 to 6 years. Again, the follow-up period was long, but the sample size was small and unrepresentative.

National follow-up studies.—Persons aged 55 years and older at the time of the NHANES I (1971–1975) were interviewed again in 1984 in the NHANES I Epidemiologic Follow-Up Study (NIEFS) (23). A total of 2653 individuals with appropriate data were reexamined (1103 men, 1550 women; 2264 whites, 373 African Americans and 16 of other races). Of these, 922 were 55 to 64 years old and 1731 were aged 65 years and older at the NHANES I examination. At the time of the NIEFS, the subjects were 10 years older. The assessment instrument used in the NHANES I baseline was a 19-item food group questionnaire. The dietary assessment instrument used in the NIEFS analyses was an extensive 93-item food frequency questionnaire. Consequently, it is difficult to draw conclusions about dietary changes with any confidence.

National cross-sectional surveys.—The National Center for Health Statistics and the USDA conduct periodic surveys of the health and nutritional status of representative samples of Americans. National-level cross-sectional surveys with comprehensive dietary data on the older American population include the Nationwide Food Consumption Surveys (NFCS), the National Health Interview Surveys (NHIS), the Continuing Survey of Food Intakes by Individuals (CSFII), and the NHANES (24–27). The surveys are summarized in Table 3.

The strength of these national surveys lies in their sample sizes and representativeness. All included thousands of persons over the age of 50 years, and in some surveys, there were substantial numbers of the very old. All of these studies were conducted using rigorous sampling procedures; in most of these surveys, the response rate was very high; sample weights corrected for factors such as nonresponse in certain subgroups; and carefully trained interviewers applied comparable assessment methods to all persons in the study. These characteristics result in confidence in the representativeness of the data.

- The NHIS (1987 and 1992). The NHIS is conducted annually. In 1987 and 1992, the National Cancer Institute sponsored a special supplement that included dietary data. Data were obtained from 16,065 white, 2748 African American, and 1330 Hispanic respondents, 18 to 99 years old. The sample included 7412 persons (2873 men and 4539 women) 50 years and older, comprising approximately 63% of the total sample. There was more information available on dietary intake in elderly persons than was previously available in any national data set, and there was no upper age limit for inclusion. The 1987 and 1992 NHIS differ from other national surveys in that the dietary assessment consisted of a 60-item food frequency questionnaire rather than diet recalls or records. This was unique in that it provided estimates of usual intake of individuals, rather than 1-day's or few-days' intake, and estimates of the distribution of nutrient intake in the population. Nutrient intake data were reported by age, sex, and race based on data from the 1987 NHIS by Block and Subar (28). Trend data were reported by Norris and colleagues (29).
- The NHANES. These surveys include NHANES I (1971–1975), NIEFS (1976–1980), NHANES II (1976–1980), Hispanic HANES (HHANES; 1982–1984), and NHANES III (1988–1994). They are conducted by the National Center for Health Statistics. The first and second NHANES included persons only up to 74 years old. In NHANES III, there was no upper age limit for inclusion in the sample. The NHANES surveys used a 24-hour recall, conducted by a nutritionist or dietitian, and abstract three-dimensional volume models to improve assessment of portion size. NHANES III also included a 61-item food frequency questionnaire.

NHANES II (1976–1980). The study population over the age of 50 totaled approximately 9200; 40% of those were aged 66 to 74 years.

NHANES III (1989–1994). In NHANES III, there were over 6830 participants in the age categories of 50 years and older.

Table 3. National Cross-sectional Surveys With Comprehensive Dietary Data on Older Americans

Surveys	Design and Sample	Dietary Assessment Method
NFCS (1977–1978)	Probability sample representative of 48 states $N = 30{,}000$ $n = 4983$, 55 y or older No upper limit, 159 ≥ 85 y	3-consecutive-d 24-h recalls and 2-d food record
NFCS (1987–1988)	Probability sample representative of 48 states $N = 5884$ adults (19 y and older) $n = 2204$, 50 y or older	24-h recall and 2-d food record
CSFII (1994–1996)	Probability sample representative of 50 states $N = 15{,}000$ $n = 9070$, 60 y or older	Two nonconsecutive 24-h recalls
NHIS (1987)	Multistage cluster design, representative of 50 states $N = 45{,}000$ (Cancer EPI Supplement) $n = 7412$, 50 y or older	60-item food frequency questionnaire
NHIS (1992)	Multistage cluster design, representative of 50 states $N = 12{,}000$ (Cancer EPI Supplement) $n = 4143$, 50 y or older	60-item food frequency questionnaire
NHANES I (1971–1974)	Multistage probability design, sample representative of 50 states $N = 31{,}973$ $n = 5373$, 50 y or older	24-h dietary recall and limited food frequency questionnaire
NIEFS	1982, 14,407 aged 25–74 y 1992, 3980 aged 55–74 y at baseline (NHANES I)	Food frequency questionnaire
NHANES II (1976–1980)	Multistage probability design, sample representative of 50 states $N = 25{,}283$ $n = 5900$, 50–74 y	24-h dietary recall
HHANES I (1982–1984)	Probability sampling, Hispanic subgroups of southwestern states, Florida, and New York Sample of persons 50 y or older: 1413 Mexican Americans, 679 Cubans, and 498 Puerto Ricans	24-h recall and food frequency questionnaire
NHANES III (1988–1994)	Multistage probability design, sample representative of 50 states $N = 33{,}994$ $n = 6830$, 50 y or older	24-h recall and food frequency questionnaire

Notes: NFCS = Nationwide Food Consumption Surveys; CSFII = Continuing Survey of Food Intakes by Individuals; NHIS = National Health Interview Surveys; NHANES = National Health and Nutrition Examination Surveys; NIEFS = NHANES I Epidemiologic Follow-Up Study; HHANES = Hispanic Health and Nutrition Examination Survey.

HHANES (1982–1984). The HHANES was a survey of three major Hispanic subgroups in the United States: Mexican Americans, Cubans, and Puerto Ricans. The sample consisted of civilian, noninstitutionalized Hispanics up to the age of 74. Respondents in the 50- to 74-year-old age bracket included 1413 Mexican Americans, 679 Cubans, and 575 Puerto Ricans. The Cuban population resided in Florida, the Puerto Rican population lived in the New York City metropolitan area, and the Mexican population resided in the five southwestern states. Samples of Cuban and Puerto Rican older adults were relatively small. There are no publications of findings on diet and the elderly population from this data set.

- The NFCS (1977–1978 and 1987–1988). These USDA surveys were conducted every 10 years, until replaced by the CSFII. Data from the 1977 to 1978 and the 1987 to 1988 NFCS are described later. The dietary data consisted of a 24-hour recall combined with 2 days of a diet record (3 consecutive days in all). The 1977 to 1978 total sample included approximately 36,000 participants, with 1012 men and 1655 women aged 65 years and older. The total number interviewed in the 1987 to 1988 NFCS was approximately 10,000, with approximately 1048 persons who were aged 65 years and older.
- CSFII (1994–1996). The CSFII has been conducted by the USDA since 1985. The 1985 and 1986 surveys included adults aged up to 50 years. Older persons were not included until 1989. Both the 1989 to 1991 and 1994 to 1996 surveys provide information on at least 2 days of food intakes among individuals of all ages. The 1994 to 1996 survey was completed by more than 15,000 individuals and included a larger sample of elderly individuals compared with the 1989 to 1991 survey. The 1994 to 1996 CSFII included more than 4700 men and approximately 4370 women aged 60 years and older. Only data from the later survey are reported here.

Results

Energy and Macronutrients

Figure 1, from NHANES II (30) illustrates the energy intake pattern seen in both the cross-sectional and longitudinal studies: energy intake declines substantially across the age spectrum. The oldest age category in NHANES II, 70 to 74 years, had the lowest energy intakes. At all ages, men consumed more than women, but this difference decreased with age, as energy intake decreases faster in men than in women.

Among the longitudinal studies, energy intake and macronutrient intake decreased with age for the two studies, which spanned 2 decades or longer. In the BLSA, Elahi and colleagues (31) examined nutrient intake of the same cohort of individuals over three periods of time: 1961 to 1965, 1966 to 1970, and 1971 to 1975. The most significant change over the 3 decades was an overall decrease in caloric intake and, as expected, concurrent decreases in the macronutrients (fat, protein, and carbohydrates). The percentage of calories from total fat and cholesterol decreased over time (Table 4). The percentage of calories from protein was

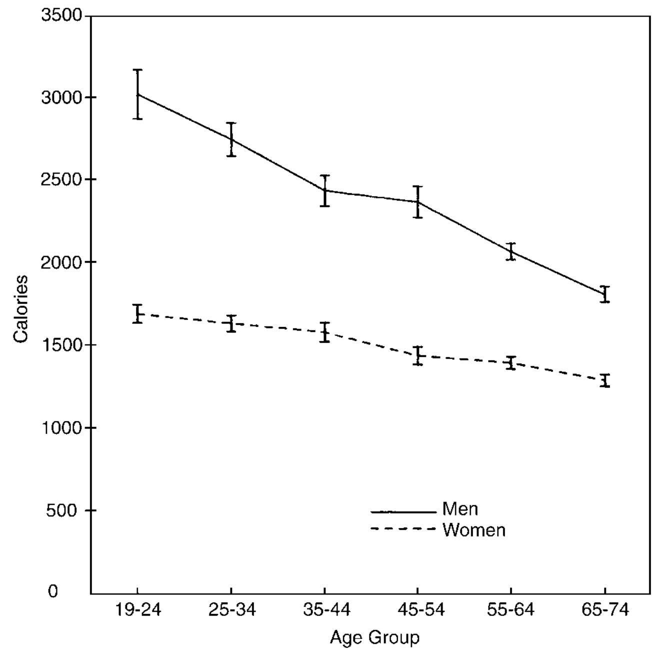

Figure 1. Mean daily caloric intake (95% confidence intervals), by age and sex. Data from NHANES II reproduced with permission from Block and colleagues (30).

relatively constant at 15% to 16%, and calories from carbohydrates increased from 38.4% to 44.5%. The other longitudinal study lasting 2 decades or more also found that intake of calories decreased with a concurrent and consistent decrease in all other nutrients examined (22).

As noted previously, it is difficult in longitudinal studies to separate changes associated with aging from changes that simply reflect temporal trends. The changes in the total fat

Table 4. Energy Intake From Longitudinal Studies

Age, y	Group (*n*)	1960†	1970s	1980s†
Total kcal/d of 105 Men Completing Longitudinal Study During 3 Decades				
Mean	(105)§	2553	2318	2162
79–89		—	—	2255
68–78		—	2301	2148
57–67	Old (8)§	2664	2336	2140‡
46–56	Middle-age (53)§	2437	2260	2280
35–45	Young (37)§	2602	2501	—
24–34	Very young (7)§	3046	—	—
Body Weight (kcal/kg) of 105 Men Completing Longitudinal Study During 3 Decades				
Mean	(105)§	33.7	29.9	27.6
79–89		—	—	29.2
68–78		—	30.4	27.9
57–67	Old (8)§	34.9	30.4	26.8‡
46–56	Middle-age (53)§	32.0	28.8	28.6‡
35–45	Young (37)§	34.5	31.8	—
24–34	Very young (7)§	40.5	—	—

Note: Republished with permission from Hallfrisch and colleagues, 1990 (21).
†Cross sectional correlation with age within decade, $p < .01$.
‡Time difference, $p < .05$.
§Longitudinal change, $p < .0001$ for means, $p < .05$ for age groups.

and cholesterol in the diets of the men of the BLSA certainly reflect changes that had been occurring nationwide. However, we have found that the longitudinal studies are consistent with the cross-sectional studies, leaving no doubt that there is a substantial decrease in food intake with increasing age.

Mean intakes of energy and macronutrients (fat, protein, and carbohydrates) from the first phase of NHANES III (1988–1991) are reported in detail in Table 5 (32), for the entire age spectrum. Consistent across races, and for women and men, total food energy intake and macronutrients decreased with age. The percentage of calories from fat tended to be lower in those older than 60 than in younger age groups, usually reaching its lowest value in the oldest age groups. Although the percentage of calories from fat declined with age, the proportion of calories from protein tended to be higher than that of younger adults. Dietary cholesterol declined with age in both men and women and in all ethnic groups.

African Americans and Mexican Americans tended to have lower mean energy intake than whites, with African Americans having the lowest. This observation of lower caloric intakes among African Americans was also seen in NHANES II (30) and in the 1987 NHIS (28). In NHANES II, African Americans consistently consumed fewer calories, less total fat, and fewer total saturated fat acids, oleic, and linoleic acids on average than did whites. On the other hand, African Americans consumed more dietary cholesterol for most age-sex groups except for the 65- to 74-year-old women and the 55- to 64-year-old men (30). In NHANES III, Mexican American men had the highest cholesterol intakes, followed by African American men.

Estimates of nutrient intake are consistently lower in the CSFII (1994–1996) than NHANES III, but patterns of intake with age are similar to NHANES III. Total energy intake and macronutrients decreased with age.

The NHIS (28), used an abbreviated food frequency questionnaire, and thus the absolute values are underestimates. The relative intakes, however, are consistent with the findings of the longitudinal and national survey data. Energy estimates decreased as age group increased with concurrent decreases in mean intake of macronutrients. This, in turn, has a considerable impact on intake of micronutrients.

Nutrient Density

As total energy intake decreases with age, the absolute amount of most nutrients also decreases. However, it is sometimes useful to consider the nutrient density of diets, that is, the nutrient intake as a proportion of total calories. It is often the case that energy intake declines more substantially than does intake of micronutrients. Fiber is a good illustration of this fact. In the Figure 2A data from NHANES II (33), it can be seen that absolute grams of fiber decrease with age in men. However, Figure 2B shows fiber intake expressed as grams of fiber per 1000 kcal. It can be seen that, in terms of nutrient density, the proportion of dietary intake that is composed of fiber increases with age in men.

This increase in nutrient density with age has two components: the decline in the denominator, kcal, and for some nutrients, the actual increase in absolute amount of intake

Table 5. Mean Intake of Energy and Macronutrients, by Age, Sex, and Race/Ethnicity: United States 1988–1991 Phase I NHANES III

Energy and Nutrient and Age, y	White		Black		Mexican American	
	Men	Women	Men	Women	Men	Women
Energy, kcal						
20–29	3125	1953	3070	2034	2673	1862
30–39	2941	1894	2697	1849	2644	1861
40–49	2574	1786	2513	1658	2533	1764
50–59	2410	1617	1926	1657	2125	1635
60–69	2118	1602	1882	1402	1963	1297
70–79	1924	1431	1532	1457	1660	1290
80+	1802	1335	—	1272	—	—
Carbohydrate, g						
20–29	364	241	341	241	323	233
30–39	345	228	304	220	305	236
40–49	302	213	272	198	292	222
50–59	272	197	227	203	258	207
60–69	254	202	217	178	242	169
70–79	235	186	187	175	212	172
80+	228	180	—	179	—	—
Carbohydrate, % kcal						
20–29	47.3	49.9	45.7	48.1	49.6	50.9
30–39	47.5	49.5	46.0	48.9	47.3	51.6
40–49	47.0	48.4	44.3	48.5	47.3	51.4
50–59	46.0	49.6	47.0	49.9	48.9	50.8
60–69	48.7	51.1	47.0	51.2	49.9	52.2
70–79	49.3	52.6	48.8	49.9	52.0	54.5
80+	51.1	54.4	—	57.0	—	—
Protein, g						
20–29	109	68	117	74	106	82
30–39	108	70	99	67	104	80
40–49	95	66	99	64	98	68
50–59	95	64	74	62	85	69
60–69	85	64	78	56	78	56
70–79	75	57	63	62	73	50
80+	69	52	—	50	—	—
Protein, % kcal						
20–29	14.0	14.3	15.2	14.5	16.0	15.9
30–39	15.0	15.4	15.0	14.8	15.8	15.4
40–49	15.1	15.4	16.4	15.7	15.6	15.8
50–59	16.0	16.1	16.1	15.4	16.3	17.3
60–69	16.3	16.4	17.2	16.2	16.5	17.5
70–79	15.9	16.4	17.1	17.3	17.8	16.4
80+	15.7	15.9	—	15.5	—	—
Fat, g						
20–29	121	74	124	86	99	72
30–39	116	76	106	74	100	70
40–49	100	72	100	67	93	66
50–59	99	63	73	64	78	58
60–69	81	60	73	53	73	46
70–79	74	53	59	58	59	45
80+	69	47	—	42	—	—
Fat, % kcal						
20–29	34.4	33.7	35.5	37.2	32.2	33.7
30–39	34.9	34.5	34.1	34.8	33.2	33.0
40–49	34.6	35.6	34.6	35.4	32.5	33.0
50–59	36.2	33.9	33.2	34.5	32.6	31.8
60–69	33.4	33.0	33.4	33.5	32.7	31.5
70–79	33.9	32.3	34.1	34.2	31.1	30.6
80+	33.7	31.4	—	29.4	—	—

(*Continued on next page*)

Table 5. Mean Intake of Energy and Macronutrients, by Age, Sex, and Race/Ethnicity: United States 1988–1991 Phase I NHANES III (*Continued*)

Energy and Nutrient and Age, y	White		Black		Mexican American	
	Men	Women	Men	Women	Men	Women
Saturated fat, g						
20–29	43	26	41	29	34	25
30–39	41	27	34	24	35	25
40–49	33	25	33	22	31	22
50–59	33	21	23	23	26	20
60–69	28	20	24	17	25	16
70–79	26	18	20	19	20	15
80+	24	16	—	14	—	—
Saturated fat, % kcal						
20–29	12.4	11.9	11.8	12.6	10.9	11.7
30–39	12.2	12.2	11.1	11.3	11.5	11.6
40–49	11.6	12.2	11.5	11.5	10.7	11.1
50–59	12.1	11.3	10.6	12.1	10.8	10.7
60–69	11.5	11.1	11.1	10.7	11.0	10.9
70–79	11.7	10.7	11.5	11.2	10.4	10.2
80+	11.8	10.8	—	—	—	—
Monosaturated fat, g						
20–29	45	27	48	32	36	26
30–39	44	28	41	28	37	25
40–49	38	27	38	25	35	24
50–59	37	23	29	24	30	21
60–69	30	22	28	21	27	19
70–79	28	19	23	22	22	16
80+	26	17	—	16	—	—
Monosaturated fat, % kcal						
20–29	12.9	12.3	13.5	13.8	11.8	12.3
30–39	13.2	12.6	13.2	12.9	12.1	11.9
40–49	12.8	13.0	13.2	13.4	12.1	12.1
50–59	13.6	12.3	13.0	12.7	12.4	11.4
60–69	12.6	12.1	13.0	12.8	11.9	11.4
70–79	12.7	11.7	13.1	12.8	11.4	10.8
80+	12.9	11.5	—	—	—	—
Polyunsaturated fat, g						
20–29	23	16	26	19	21	15
30–39	23	16	22	17	21	14
40–49	22	16	21	15	20	14
50–59	21	14	15	13	16	13
60–69	16	13	15	12	16	9
70–79	15	12	12	13	13	10
80+	14	10	—	8	—	—
Polyunsaturated fat, % kcal						
20–29	6.6	7.1	7.4	8.0	6.8	7.0
30–39	6.9	7.1	7.1	7.9	6.9	6.8
40–49	7.5	7.7	7.2	7.8	6.9	7.1
50–59	7.7	7.6	6.8	6.9	6.8	7.0
60–69	6.8	7.2	6.6	7.2	7.0	6.4
70–79	6.8	7.2	6.6	7.5	6.5	6.9
80+	6.6	6.7	—	5.8	—	—
Cholesterol, mg						
20–29	378	230	474	298	461	295
30–39	372	242	417	264	434	283
40–49	329	232	409	248	421	284
50–59	320	217	299	252	383	264
60–69	306	204	340	214	354	227
70–79	264	187	278	246	310	243
80+	253	172	—	205	—	—

(*Continued*)

Table 5. Mean Intake of Energy and Macronutrients, by Age, Sex, and Race/Ethnicity: United States 1988–1991 Phase I NHANES III (*Continued*)

Energy and Nutrient and Age, y	White		Black		Mexican American	
	Men	Women	Men	Women	Men	Women
Fiber, g						
20–29	18.22	12.31	18.09	10.91	26.28	16.68
30–39	20.29	13.66	16.40	11.73	23.73	17.05
40–49	18.36	12.81	14.96	11.10	22.81	16.41
50–59	18.73	13.66	14.46	12.96	21.77	17.62
60–69	17.77	15.17	13.89	12.64	20.86	13.66
70–79	17.65	14.72	12.93	13.19	17.99	13.01
80+	17.08	12.81	—	11.84	—	—

Note: NHANES = National Health and Nutrition Examination Survey.

with age. Thus, men's absolute intake of fiber declined with age, but their energy intake declined more; in NHANES III as well, fiber was seen to decrease slightly with age in white men. On the other hand, women's intake of fiber actually increased with age, in addition to their declining energy intake, resulting in an even steeper increase in fiber per 1000 kcal. This increase in fiber intake among older women was also seen in NHANES III. This paradoxical increase in some food components with age is seen for a number of nutrients, particularly those derived from fruits and vegetables or other fiber sources, although usually primarily in women (33). In addition to this observation from cross-sectional data, Elahi and colleagues (31) saw an increase in total fiber intake with age, among the well-educated men in the BLSA.

Micronutrients

Table 6 presents the mean intake of several minerals, and Table 7 presents vitamins, by age group, from NHANES III (32). With few exceptions, mineral intake declines with age after age 50, usually reaching its lowest point in the oldest age group. Decreases in calcium, iron, and zinc intake with age were seen in the following surveys: NHANES III, NHANES II, and CSFII (1994–1996), all based on 24-hour recalls; and in the NHIS, based on the food frequency questionnaire. In NHANES III data, white men aged 70 to 79 years obtained 832 mg of calcium and 12.2 mg of zinc, while white women obtained only 651 mg of calcium and 8.8 mg of zinc. Levels in other ethnic groups were lower. The current recommendations call for 1200 mg for calcium and 12 and 15 mg for zinc for women and men, respectively.

The intake of most B vitamins tended to decline with age in men and to remain fairly constant in women (Table 7). A similar pattern was seen for vitamin E: In NHANES III, it appeared that men's intake of vitamin E declined with age (except in the oldest age group), while for women it was fairly constant. Mean and median intakes of vitamin E declined with increasing age for both sexes in NHANES II, which had data only up to age 74 (34), and in the NHIS (28). Folate intake was fairly constant over the age span, with means of 310 μg/day in men and 274 μg in women. The current recommendation calls for 400 μg/day.

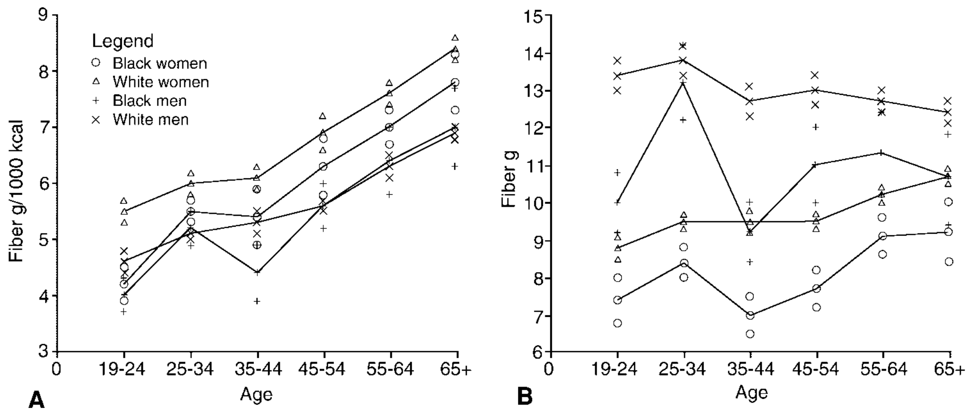

Figure 2. Dietary fiber intakes, by age, sex, and race in g/1000 kcal, **A**, and in g, **B**. Values are mean ± *SEM*. Adapted with permission from Lanza and colleagues (33).

In contrast to the general fall in micronutrient intake with age, vitamin C and vitamin A or carotene intake did not decrease with age and, in fact, tended to increase with age. This pattern was consistent in NHANES II, NHANES III, and CSFII, all by 24-hour recall, and in NHIS by food frequency questionnaire. Vitamin A and carotene intake increased with age in both genders until the oldest age group, 80 years and older. Among whites and African Americans, vitamin C intake tended to decrease with age in men, but increased with age in women.

Distributions of Nutrient Intake

Distributions are of interest since they present a more accurate and complete picture of the population's nutrient intake. Distributions for most nutrients are not normally distributed, but are skewed to the right—that is, there is a long "tail" to the right, with some people consuming very high levels. This skewness drags up the mean, producing a higher mean than would be the case in a normal distribution. Consequently, means give an inflated estimate of the central tendency of the population. Medians are more appropriate, representing that value for which half the population consumed more and half the population consumed less of a nutrient.

The single 24-hour recall data collected in the NHANES surveys can provide precise estimates of mean intakes of nutrients, but are less appropriate for describing the distribution of intake. With 24-hour recall data, the distribution is wider (a wider, flatter bell-shaped curve), resulting in an exaggerated impression of the proportion of the population with very high or very low intakes. The 2-day nonconsecutive 24-hour recalls used in CSFII can provide more appropriate data on distributions, because intraindividual variability is somewhat smoothed over 2 days and there are fewer of the extreme values often seen in 24-hour recall data. (Several nonconsecutive 24-hour recalls would be ideal for describing distributions. With 2 days, the distribution of intakes obtained will still be wider for some nutrients than the distribution of true intakes.)

Figure 3 illustrates the distribution of intakes of protein, vitamin A, and energy from the 2-day CSFII data. For protein, both the median and the entire distribution shift downward with age, for both men and women. Among young men, the median protein intake is slightly less than 100 g, although 10% of young men consume only about 50 g. In contrast to the pattern for protein intake, the distribution of vitamin A intake is shifted upward with age. Although the 75th percentile for young women is about 900 retinol equivalent (RE), the 75th percentile for older women is almost 1300 RE.

Table 8 presents nutrient distributions for women, and Table 9 presents these distributions for men, from the 2-day CSFII (1994–1996) data. It can be seen that by age 70 to 79 years, the median (50th percentile) energy intake of women is only 1358 kcal. That is, 50% of women in that age group consume that amount or less. Among women aged 80 years and older, the median is only 1296 kcal. The lower percentiles are also illuminating. By age 70 to 79 years, 10% of men consumed less than 1000 kcal per day, and 10% of women consumed less than 768 kcal per day. Again, these values represent the average of 2 nonconsecutive days of intake.

Distribution data indicated 50% of women consume less than 13 g of fiber and 50% of men consume less than 17 g of fiber. The National Cancer Institute recommends consumption of 20 to 30 g per day.

Only about 5% of older women consume the DRI recommendation for calcium (1200 mg), and only 10% of older men consume the recommended 1200 mg of calcium. In addition, 75% of women do not regularly consume the 12 mg RDA for zinc. Seventy-five percent of men aged 50 to 69 years and 90% of men older than 70 years do not consume the recommendation of 15 mg of zinc. Twenty-five percent of older women and 10% of older men consume only 5 mg or less.

As many as 75% of older women and men consume less than the RDA for vitamin E—8 and 10 α-tocopherol equivalents, respectively. Approximately 95% of older men and 90% of older women do not consume the DRI of folate, which is 400 μg. For the B vitamins, thiamin and riboflavin, more than 25% of both men and women have marginal levels compared with their respective DRIs.

Table 6. Mean Intake of Minerals by Age, Sex, and Race/Ethnicity: United States 1988–1991 Phase I NHANES III

	White		Black		Mexican American	
Nutrient and Age, y	Men	Women	Men	Women	Men	Women
Calcium, mg						
20–29	1142	806	875	656	1028	754
30–39	1122	788	733	574	995	847
40–49	851	717	703	530	890	701
50–59	902	660	533	564	749	701
60–69	895	743	609	477	837	606
70–79	832	651	608	549	673	—
80+	742	633	—	484	—	—
Copper, mg						
20–29	1.63	1.11	1.69	1.13	1.62	1.14
30–39	1.80	1.19	1.47	1.04	1.70	1.18
40–49	1.62	1.13	1.35	0.98	1.60	1.10
50–59	1.57	1.12	1.19	1.04	1.39	1.09
60–69	1.47	1.14	1.05	0.95	1.36	0.91
70–79	1.32	1.04	1.08	0.92	1.20	1.03
80+	1.21	0.92	—	—	—	—
Iron, mg						
20–29	17.66	12.43	18.02	12.12	17.45	12.68
30–39	19.83	13.01	16.50	11.00	17.19	13.03
40–49	18.64	12.15	15.89	10.74	15.92	11.80
50–59	17.94	11.95	12.94	10.83	15.50	11.72
60–69	16.84	13.23	13.24	10.64	14.65	10.56
70–79	16.10	12.90	13.49	11.55	14.31	11.26
80+	16.65	11.80	—	—	—	—
Magnesium, mg						
20–29	358	243	320	213	366	250
30–39	391	268	297	213	364	266
40–49	361	359	286	201	348	247
50–59	358	259	242	211	312	257
60–69	333	265	246	208	299	216
70–79	308	247	222	219	274	201
80+	282	221	—	205	—	—
Phosphorus, mg						
20–29	1751	1141	1613	1082	1748	1207
30–39	1728	1151	1390	997	1678	1222
40–49	1464	1081	1333	928	1549	1118
50–59	1471	1025	1028	936	1338	1117
60–69	1395	1074	1111	832	1298	919
70–79	1259	962	948	908	1126	859
80+	1167	895	—	795	1047	—
Potassium, mg						
20–29	3353	2289	3105	2019	3263	2333
30–39	3627	2583	2710	1965	3153	2424
40–49	3386	2465	2654	1903	3075	2262
50–59	3397	2515	2247	2023	2841	2421
60–69	3145	2630	2280	1964	2747	2046
70–79	2978	2412	2209	2052	2591	1957
80+	2635	2247	—	1976	—	—
Sodium, mg						
20–29	4780	2996	4801	3277	3924	2863
30–39	4520	2980	4145	2907	3792	2820
40–49	3933	2835	4039	2672	3673	2755
50–59	3713	2553	3041	2563	3465	2704
60–69	3429	2634	2879	2221	3138	2076
70–79	3192	2379	2604	2200	3098	2013
80+	2912	2274	—	2008	—	—

(*Continued*)

Table 6. Mean Intake of Minerals by Age, Sex, and Race/Ethnicity: United States 1988–1991 Phase I NHANES III (*Continued*)

	White		Black		Mexican American	
Nutrient and Age, y	Men	Women	Men	Women	Men	Women
Zinc, mg						
20–29	15.22	9.41	15.76	10.24	14.99	10.58
30–39	16.63	9.74	13.73	8.81	14.82	10.56
40–49	13.95	9.51	12.91	8.27	14.65	9.25
50–59	15.27	9.67	10.10	8.61	11.87	9.09
60–69	13.38	9.88	10.45	7.87	10.64	8.38
70–79	12.24	8.79	10.73	8.07	9.99	7.90
80+	10.89	7.83	—	7.97	—	—

Note: NHANES = National Health and Nutrition Examination Survey.

Over half of men and women meet the current RDA for Vitamin C of 60 mg. However, a substantial minority of the population consumes far less, based on an average of 2 non-consecutive days. Ten percent of older women consume only two thirds of the current RDA, and 10% of older men consume only about one fourth of the RDA.

Eating Patterns

One of the earliest publications characterizing the eating patterns of the elderly population in the United States, by Fanelli and Stevenhagen (35), was based on data from the 1977 to 1978 NFCS. There were 159 participants older than 85 years. Core foods, those routinely consumed by a population group, were identified, and there were no marked differences between men and women or among three different age groups (55–64, 65–74, and 75 years and older). Whole milk, white bread, coffee, and sugar were the most frequently mentioned foods. Orange juice and bananas were the most frequently mentioned fruits. The most commonly used vegetables were tomatoes, potatoes, and lettuce. Eggs and milk were the more frequent protein-rich foods reported.

Murphy and colleagues (36) examined diets of those aged over 65 years in this same data set and reported a higher percentage of the older age group, 85 years and older, had poorer quality diets. Diet quality was defined as a diet that provided two thirds or more of the RDA for nine selected nutrients.

Food group consumption and dietary patterns in elderly individuals were examined using data from NHANES I and the NIEFS (37). Subjects were 55 years and older at baseline, and 65 and older at follow-up. NHANES I used a 19-item food frequency questionnaire representing broad food groups, while NIEFS used a 93-food-item questionnaire. The daily number of servings of food groups was calculated from these instruments. The later survey produced higher estimates of intake of milk and cheese, butter and/or margarine, salty snacks, fish and/or shellfish, servings of fruits and vegetables, cereals, and legumes and/or nuts, and lower estimates of servings of sweets and alcoholic beverages. Because the number and specificity of food items on a questionnaire influence responses, these results are difficult to interpret.

Popkin and colleagues (38) reported on dietary changes in older Americans based on cross-sectional data from the 1977 to 1978 and the 1987 to 1988 NFCS. They found that the top ten sources of energy, fat, and fiber in 1977 re-

Table 7. Mean Intake of Vitamins by Age, Sex, and Race/Ethnicity: United States 1988–1991 Phase I NHANES III

	White		Black		Mexican American	
Nutrient and Age, y	Men	Women	Men	Women	Men	Women
Vitamin A, IU						
20–29	6598	4537	6986	4161	6592	5454
30–39	8055	6166	5412	4591	6876	6901
40–49	7949	5534	6498	4915	6595	5722
50–59	7443	5930	5800	7630	6234	5278
60–69	8108	7613	5751	6882	7025	4705
70–79	8206	7819	7156	7779	8293	7898
80+	7363	7170	—	—	—	—
Carotene, RE						
20–29	500	314	501	238	793	590
30–39	582	471	342	338	819	769
40–49	582	431	487	363	871	698
50–59	553	439	454	614	661	511
60–69	592	601	421	560	634	391
70–79	570	605	495	621	686	572
80+	500	554	—	—	—	—
Thiamin, mg						
20–29	2.11	1.40	2.13	1.48	1.93	1.39
30–39	2.10	1.37	1.89	1.27	1.89	1.45
40–49	1.90	1.32	1.79	1.20	1.76	1.33
50–59	1.89	1.27	1.52	1.28	1.74	1.30
60–69	1.83	1.46	1.52	1.18	1.55	1.10
70–79	1.72	1.31	1.43	1.24	1.51	1.11
80+	1.67	1.30	—	1.31	—	—
Riboflavin, mg						
20–29	2.56	1.72	2.33	1.61	2.25	1.64
30–39	2.60	1.70	2.05	1.40	2.22	1.74
40–49	2.23	1.64	1.98	1.32	2.09	1.54
50–59	2.28	1.56	1.55	1.41	1.94	1.51
60–69	2.26	1.77	1.74	1.28	1.90	1.40
70–79	2.11	1.61	1.73	1.43	1.67	—
80+	1.99	1.60	—	1.52	—	—
Niacin, mg						
20–29	31.12	19.47	32.36	19.63	25.98	17.18
30–39	30.40	19.48	28.08	18.10	26.32	18.42
40–49	28.65	19.41	25.52	18.62	24.50	17.03
50–59	28.62	18.95	21.10	16.53	22.41	17.79
60–69	25.59	19.78	20.55	15.01	19.05	14.70
70–79	22.88	17.97	18.69	16.49	18.20	13.63
80+	21.54	17.14	—	15.92	—	—
Vitamin B, mg						
20–29	2.30	1.47	2.38	1.45	2.30	1.58
30–39	2.32	1.52	2.06	1.34	2.16	1.61
40–49	2.20	1.44	1.92	1.23	2.06	1.37
50–59	2.22	1.52	1.54	1.26	1.92	1.52
60–69	2.09	1.67	1.52	1.29	1.68	1.30
70–79	1.96	1.62	1.65	1.38	1.67	—
80+	1.93	1.57	—	1.43	—	—
Folate, μg						
20–29	322	227	309	204	368	258
30–39	377	242	287	192	333	262
40–49	327	224	274	182	315	218
50–59	330	244	246	216	311	239
60–69	335	285	259	240	327	207
70–79	310	274	257	234	244	212
80+	310	256	—	—	—	—

(*Continued*)

Table 7. Mean Intake of Vitamins by Age, Sex, and Race/Ethnicity: United States 1988–1991 Phase I NHANES III (*Continued*)

	White		Black		Mexican American	
Nutrient and Age, y	Men	Women	Men	Women	Men	Women
Vitamin B_{12}, μg						
20–29	6.77	3.72	7.16	5.30	6.30	4.17
30–39	7.74	4.67	6.78	3.96	5.90	4.70
40–49	6.88	3.71	6.21	3.92	5.56	3.59
50–59	6.07	4.36	4.45	3.92	4.43	3.38
60–69	6.25	4.08	5.18	3.82	6.12	3.44
70–79	5.36	3.50	4.89	4.10	—	—
80+	6.12	3.29	—	—	—	—
Vitamin C, mg						
20–29	109	81	155	103	143	116
30–39	125	97	124	88	115	112
40–49	116	88	119	81	129	96
50–59	118	94	97	80	100	90
60–69	106	112	87	105	111	84
70–79	102	97	96	100	127	86
80+	98	106	—	94	—	—
Vitamin E, mg αTE						
20–29	10.19	7.66	10.97	7.68	10.51	8.16
30–39	12.24	8.29	9.32	7.37	10.28	10.19
40–49	10.43	7.82	9.20	6.72	9.46	6.81
50–59	11.99	7.79	7.77	6.46	8.71	6.31
60–69	10.08	8.74	6.88	6.03	7.61	5.97
70–79	8.91	7.81	9.28	6.47	6.85	6.20
80+	9.45	7.66	—	5.40	—	—

Note: NHANES = National Health and Nutrition Examination Survey; IU = international unit; RE = retinol equivalent; αTE = α-tocopherol equivalents.

mained the top ten in 1987. The investigators reported shifts from consumption of high-fat to low-fat milk and milk products, and from high-fat beef and pork to low-fat chicken and fish.

Similar data were derived from NHANES III by Alaimo and colleagues (32). Table 10 lists the top 50 sources of energy intake for persons aged 20 to 30 years and those aged 70 years and older.

Information on self-reported changes in food patterns was obtained by Sobell and colleagues (39). Participants in the BLSA were interviewed in 1985 about changes over the previous 12 to 15 years in their consumption of eight food categories (beef, chicken, fish, butter/cream, whole milk, fruits, vegetables, and high-fiber breads/cereals). Approximately two thirds of the participants reported having made changes in five to eight of these items, usually in the "desirable" direction.

The most recent data on food patterns from a national survey come from the CSFII (1994–1996) (40). Information collected included sources of food, eating-occasion variables, patterns, and other health-related variables. A higher proportion of elderly persons eat breakfast than do younger adults. Over 90% of both men and women aged 60 years and older eat breakfast, with breakfast contributing over 20% of daily calories, 17.2% to 19.0% of daily total fat for men, and 16.7% to 17.8% of daily total fat for women. Among adults, calories from foods obtained and eaten away from home are highest among those aged 20 to 29 years (approximately 37% of energy for men and 34% for women)

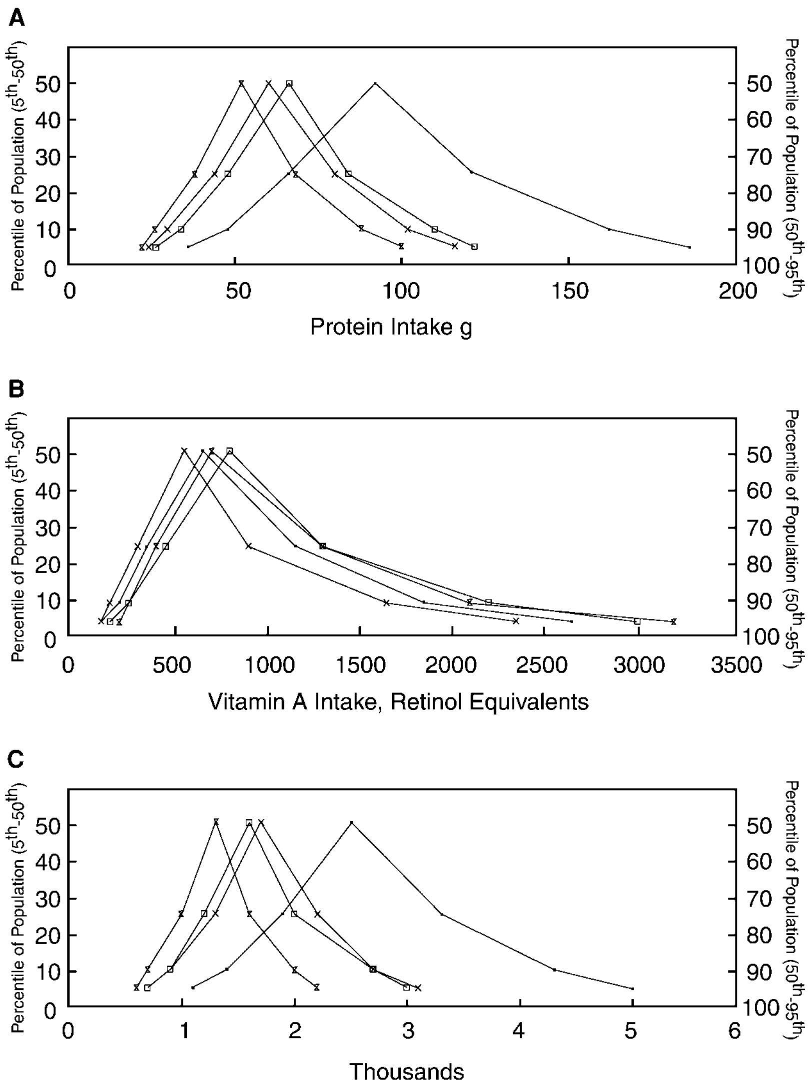

Figure 3. Distributions of nutrient intake in persons aged 20–29 and ≥80 years: **A**, protein; **B**, vitamin A; and **C**, energy distribution. — Men 20–29 years; –x– women 20–29 years; men 80+ years; and hourglass shape = women 80+ years.

and lowest among those aged 70 years and older (approximately 16% for men and 11% for women).

Patterson and colleagues (41) reported on the U.S. population's consumption of fruits and vegetables. The proportion of those meeting the recommended servings was higher among older than among younger persons, and this was true for both whites and African Americans. Nevertheless, fewer than one third of older persons ate the recommended servings of vegetables, and fewer than half ate the recommended servings of fruit. Among older persons, more men had adequate numbers of servings of vegetables (including potatoes) than did women. Women, on the other hand, were more likely than men to have adequate servings of fruit. Even fewer African Americans than whites met the USDA guidelines for recommended servings of fruits and vegetables. Among African Americans, less than one fourth of those in the older age group ate the recommended servings of vegetables, and fewer than one third ate the recommended servings of fruit.

In general, the cross-sectional studies on food patterns described previously have found that older people are less likely to consume red meat, whole milk, and other fatty foods than younger people, and are more likely to consume fruits and vegetables than are younger people. That this represents actual age differences and not just a cohort effect is supported by the longitudinal data cited above (21,22,31) and Sobell and colleagues (39). This obviously reflects temporal trends to some extent (as in reference 38) that cannot be clearly separated from the changes due to the aging process. However, it appears that these changes in desirable directions may be larger among older than younger persons, and are larger and more consistent among older women than among older men.

Supplement Use

A significantly larger proportion of older persons than younger persons take vitamin supplements (42). In data from NHANES I (1971–1975), persons aged 65 to 74 years

Table 8. Mean and Percentile Distributions of Nutrient Intake in Women: Data From 2 Nonconsecutive Days of Dietary Intake (CSFII, 1994–1996)

Energy and Nutrient and Age, y	Mean	5th	10th	25th	50th	75th	90th	95th
	Percentile							
Energy, kcal								
20–29	1793	747	919	1276	1709	2197	2741	3122
50–59	1553	710	874	1134	1492	1878	2310	2671
60–69	1436	654	814	1062	1396	1738	2110	2418
70–79	1393	646	768	1036	1358	1696	2056	2278
80+	1332	603	750	1004	1296	1608	1966	2175
Protein, g								
20–29	65.2	24.5	31.4	44.7	61.0	81.1	102.5	117.0
50–59	61.6	24.6	30.9	43.4	59.4	75.7	93.9	105.9
60–69	59.4	23.4	30.4	42.9	56.9	72.6	90.2	103.5
70–79	56.7	22.9	29.4	40.9	53.0	69.9	86.0	98.7
80+	55.4	22.2	27.2	38.0	51.7	68.6	88.0	100.9
Fat, g								
20–29	64.4	18.6	25.7	39.6	59.6	82.5	109.6	129.4
50–59	57.9	16.9	23.3	32.3	54.1	74.1	97.8	112.9
60–69	52.4	16.2	22.1	33.6	48.3	67.4	86.8	104.9
70–79	49.8	15.4	20.8	32.2	46.5	61.6	81.3	97.3
80+	47.7	15.1	20.7	30.4	45.9	61.1	76.9	88.6
Cholesterol, mg								
20–29	218	32	54	100	172	278	455	553
50–59	207	32	56	97	165	268	431	537
60–69	213	43	58	99	167	287	442	538
70–79	194	43	61	101	154	249	373	485
80+	192	33	52	92	158	260	386	460
Fiber, g								
20–29	14.0	3.4	4.8	7.3	11.2	16.5	22.4	28.0
50–59	14.0	4.1	5.4	8.5	12.9	18.1	23.8	27.9
60–69	13.6	4.0	5.5	8.1	12.4	17.6	23.1	27.1
70–79	14.0	4.0	5.7	8.6	12.4	17.6	24.2	29.3
80+	13.9	3.9	5.2	8.4	12.9	18.3	23.5	27.7
Vitamin A, RE								
20–29	821	96	157	289	535	926	1634	2323
50–59	913	121	191	336	614	1112	1919	2594
60–69	985	117	195	358	641	1168	1968	2724
70–79	1031	153	226	400	692	1210	2047	2723
80+	1149	176	253	425	709	1258	2114	3211
Thiamin, mg								
20–29	1.36	.43	.57	.87	1.24	1.70	2.27	2.63
50–59	1.59	.51	.62	.85	1.16	1.55	2.03	2.40
60–69	1.26	.46	.59	.82	1.16	1.53	2.02	2.33
70–79	1.24	.48	.63	.84	1.16	1.53	1.96	2.26
80+	1.20	.44	.59	.83	1.12	1.49	1.89	2.23
Riboflavin, mg								
20–29	1.59	.50	.68	.99	1.44	1.99	2.60	3.07
50–59	1.48	.58	.70	.99	1.38	1.84	2.37	2.75
60–69	1.48	.52	.68	.98	1.39	1.86	2.36	2.72
70–79	1.52	.54	.72	1.00	1.38	1.89	2.40	2.84
80+	1.52	.60	.74	1.026	1.37	1.87	2.39	2.77
Vitamin B_6, mg								
20–29	1.48	.42	.57	.90	1.34	2.54	2.54	3.04
50–59	1.46	.47	.59	.92	1.35	1.84	2.43	2.86
60–69	1.46	.46	.61	.94	1.35	1.86	2.39	2.85
70–79	1.50	.47	.60	.91	1.36	1.91	2.54	2.95
80+	1.50	.42	.60	.90	1.37	2.0	2.58	3.04
Vitamin B_{12}, mg								
20–29	3.7	.5	.8	1.6	2.8	4.5	6.8	8.9
50–59	3.9	.5	.8	1.5	2.7	4.3	6.4	8.5
60–69	4.1	.5	.8	1.5	2.8	4.4	6.6	9.2
70–79	4.1	.5	.8	1.5	2.7	4.3	6.6	9.1
80+	4.8	.6	.8	1.5	2.5	4.3	7.0	9.4

(*Continued*)

Table 8. Mean and Percentile Distributions of Nutrient Intake in Women: Data From 2 Nonconsecutive Days of Dietary Intake (CSFII, 1994–1996) (*Continued*)

Energy and Nutrient and Age, y	Mean	5th	10th	25th	50th	75th	90th	95th
	Percentile							
Folate, μg								
20–29	220	52	70	110	183	281	404	511
50–59	214	61	90	120	183	270	387	474
60–69	213	60	80	124	186	267	369	450
70–79	225	64	87	131	193	286	411	489
80+	224	56	77	122	197	285	397	499
Vitamin C, mg								
20–29	89	6	12	26	63	121	192	261
50–59	89	9	15	32	67	122	185	236
60–69	89	8	16	33	70	121	189	237
70–79	93	11	20	39	79	128	184	221
80+	89	13	19	35	77	127	163	197
Vitamin E, αTE								
20–29	6.77	1.57	2.30	3.74	5.77	8.46	12.10	15.94
50–59	6.77	1.61	2.30	3.77	5.85	8.58	11.70	14.33
60–69	6.60	1.77	2.47	3.66	5.62	8.10	11.45	14.41
70–79	6.51	1.72	2.26	3.53	5.40	7.74	10.77	14.49
80+	5.97	1.71	2.31	3.46	5.00	7.23	10.35	12.84
Iron, mg								
20–29	13.16	4.40	5.76	8.25	11.57	15.81	21.97	26.35
50–59	12.04	4.80	5.95	7.83	10.76	14.70	19.25	23.83
60–69	11.97	4.43	5.50	7.67	10.75	14.95	19.66	23.72
70–79	12.04	4.25	5.53	7.65	10.62	14.83	19.94	25.03
80+	12.20	4.09	5.24	7.69	10.60	15.36	20.86	25.55
Zinc, mg								
20–29	9.42	3.09	4.11	5.85	8.37	11.59	15.63	19.21
50–59	8.68	3.13	3.94	5.59	7.70	10.66	13.95	16.32
60–69	8.37	2.80	3.69	5.17	7.46	10.40	13.77	16.57
70–79	8.13	2.79	3.59	5.17	7.11	10.00	13.34	16.57
80+	8.22	2.82	3.52	4.99	7.26	10.06	13.83	16.33
Calcium, mg								
20–29	683	159	240	385	618	876	1215	1406
50–59	602	180	231	346	535	781	1048	1250
60–69	578	148	206	332	512	761	1032	1213
70–79	593	164	220	339	533	770	1032	1259
80+	583	177	262	365	524	757	1008	1171
Potassium, mg								
20–29	2181	763	1011	1491	2029	2699	3460	4060
50–59	2375	1000	1222	1686	2285	2937	360	4124
60–69	2292	887	1180	1636	2216	2838	3452	3946
70–79	2283	898	1160	1637	2195	2812	3538	3971
80+	2183	898	1202	1586	2064	2618	3361	3845
Sodium, mg								
20–29	2939	1045	1352	1952	2792	3640	4666	5399
50–59	2623	996	1270	1793	2450	3241	4179	4839
60–69	2503	911	1183	1695	2342	3127	4029	4609
70–79	2385	926	1178	1665	2286	2983	3692	4223
80+	2342	799	1065	1672	2278	2897	3698	4262

Note: CSFII = Continuing Survey of Food Intake of Individuals; RE = retinol equivalent; αTE = α-tocopherol equivalents.

consumed more supplements than persons in each of the younger age categories. Exceptions were for vitamin E, which was consumed more commonly in the middle years, and iron supplements, which were consumed most among young women. The proportion consuming single-entity supplements regularly was approximately twice as high in the oldest as compared with the youngest age groups.

Table 9. Mean and Percentile Distributions of Nutrient Intake in Men: Data From 2 Nonconsecutive Days of Dietary Intake (CSFII, 1994–1996)

Energy and Nutrient and Age, y	Mean	5th	10th	25th	50th	75th	90th	95th
Energy, kcal								
20–29	2708	1102	1389	1884	2486	3285	4311	4960
50–59	2221	983	1195	1595	2148	2701	3349	3715
60–69	2039	927	1109	1493	1948	2499	3054	3431
70–79	1839	855	1044	1363	1746	2192	2695	3002
80+	1699	719	891	1206	1606	2027	2690	3006
Protein, g								
20–29	101.9	36.6	48.6	67.7	93.3	123.2	161.6	187.8
50–59	89.8	36.7	45.9	63.9	85.5	110.1	138.4	157.4
60–69	82.8	34.6	43.7	59.6	78.4	101.8	127.0	144.1
70–79	72.3	32.7	41.3	53.1	69.2	87.3	109.4	122.8
80+	68.2	25.1	34.4	47.0	65.3	85.3	109.3	122.2
Fat, g								
20–29	100.2	31.6	41.9	63.1	90.1	126.9	170.8	201.2
50–59	86.7	26.2	35.1	53.7	80.0	112.8	144.0	166.3
60–69	76.8	24.4	32.4	48.6	71.3	98.2	128.8	147.1
70–79	63.5	23.0	30.5	44.7	63.4	86.3	109.9	124.8
80+	63.4	18.2	26.1	39.2	57.3	79.5	102.9	127.0
Cholesterol, mg								
20–29	342	67	101	169	275	448	664	813
50–59	335	68	97	162	270	457	653	806
60–69	312	63	90	152	249	422	611	757
70–79	279	57	83	134	219	356	537	649
80+	261	54	75	117	211	367	518	632
Fiber, g								
20–29	17.7	4.6	6.5	10.0	15.0	22.8	31.7	39.1
50–59	18.1	4.7	6.6	10.7	16.4	23.5	31.4	37.2
60–69	18.0	5.1	6.9	10.8	16.1	23.0	30.9	37.6
70–79	17.7	5.3	7.0	10.8	15.9	22.2	30.3	37.0
80+	15.6	3.9	5.3	9.1	14.3	20.0	27.1	34.2
Vitamin A, RE								
20–29	926	114	175	340	633	1129	1840	2634
50–59	1119	135	210	415	749	1335	2300	3089
60–69	1261	178	260	472	839	1483	2514	3448
70–79	1339	185	286	503	911	1534	2751	3708
80+	1059	163	242	430	781	1311	2190	3012
Thiamin, mg								
20–29	1.95	.67	.84	1.25	1.76	2.38	3.21	3.85
50–59	1.77	.65	.84	1.19	1.63	2.21	2.81	3.32
60–69	1.73	.64	.81	1.14	1.60	2.14	2.80	3.24
70–79	1.63	.67	.83	1.12	1.50	2.03	2.59	3.05
80+	1.49	.57	.72	1.01	1.36	1.81	2.38	2.83
Riboflavin, mg								
20–29	2.25	.70	.95	1.41	2.02	2.81	3.78	4.55
50–59	2.06	.76	.98	1.37	1.87	2.52	3.33	3.91
60–69	2.06	.74	.96	1.36	1.86	2.54	3.31	3.88
70–79	2.03	.85	1.02	1.38	1.84	2.46	3.21	3.87
80+	1.76	.60	.81	1.21	1.63	2.19	2.82	3.24
Vitamin B_6, mg								
20–29	2.20	.65	.86	1.30	1.96	2.79	3.70	3.70
50–59	2.04	.67	.86	1.29	1.86	2.55	3.36	4.06
60–69	2.04	.68	.89	1.31	1.85	2.52	3.31	3.99
70–79	1.94	.61	.78	1.22	1.78	2.45	3.20	3.85
80+	1.73	.52	.65	1.06	1.59	2.23	2.97	3.52
Vitamin B_{12}, mg								
20–29	5.8	.8	1.5	2.6	4.6	7.2	10.3	13.5
50–59	6.5	.9	1.5	2.6	4.3	6.7	10.5	14.7
60–69	6.2	.9	1.4	2.5	4.1	6.5	10.0	14.2
70–79	6.4	.9	1.4	2.4	3.8	5.9	9.5	13.3
80+	4.4	.7	1.1	2.1	3.6	5.4	8.1	10.4

(*Continued*)

Table 9. Mean and Percentile Distributions of Nutrient Intake in Men: Data From 2 Nonconsecutive Days of Dietary Intake (CSFII, 1994–1996) (*Continued*)

Energy and Nutrient and Age, y	Mean	5th	10th	25th	50th	75th	90th	95th
Folate, µg								
20–29	299	75	99	150	241	385	565	693
50–59	283	78	105	156	241	357	503	636
60–69	287	80	106	161	240	359	501	644
70–79	287	81	105	159	244	369	509	640
80+	244	60	79	137	215	321	430	532
Vitamin C, mg								
20–29	109	8	14	31	71	144	247	332
50–59	102	8	15	35	73	136	220	288
60–69	104	9	17	38	78	141	222	291
70–79	98	9	16	38	81	136	205	247
80+	93	7	16	35	70	123	197	262
Vitamin E, αTE								
20–29	9.60	2.11	3.14	5.33	8.20	12.06	16.76	21.25
50–59	9.33	2.29	3.20	5.23	7.90	11.48	16.22	20.59
60–69	9.03	2.18	3.14	4.89	7.37	11.01	14.99	19.13
70–79	8.71	2.24	3.09	4.63	7.13	10.06	14.70	19.59
80+	7.10	1.40	2.19	3.78	5.92	8.54	13.76	16.59
Iron, mg								
20–29	18.75	6.36	8.32	11.82	16.23	22.41	30.62	37.80
50–59	16.87	6.31	7.90	11.03	14.93	20.31	27.89	33.53
60–69	16.94	6.45	7.83	10.67	14.71	20.34	28.43	35.54
70–79	16.47	6.07	7.44	10.27	14.11	20.20	28.43	34.90
80+	14.52	5.14	6.49	8.86	12.55	17.75	24.18	31.26
Zinc, mg								
20–29	14.37	4.39	6.11	8.77	12.67	17.73	23.94	29.90
50–59	13.16	4.42	5.72	8.16	11.54	15.81	21.23	25.98
60–69	12.22	4.31	5.31	7.56	10.84	14.82	20.27	24.10
70–79	11.04	3.86	4.95	6.87	9.83	13.40	18.05	21.16
80+	10.07	3.25	4.34	6.22	8.77	12.36	16.45	19.46
Calcium, mg								
20–29	953	226	325	521	816	1213	1704	2137
50–59	785	216	297	452	686	1001	1406	1691
60–69	769	217	293	451	686	1011	1330	1561
70–79	768	240	308	458	719	991	1300	1509
80+	693	203	262	397	611	891	1210	1485
Potassium, mg								
20–29	3109	1093	1396	2068	2848	3891	5028	5820
50–59	3143	1241	1565	2219	2289	3838	4923	5710
60–69	3044	1229	1544	2190	2940	3760	4633	5208
70–79	2839	1183	1489	2058	2736	3444	4366	4925
80+	2568	903	1173	1806	2465	3150	4089	4683
Sodium, mg								
20–29	4411	1441	2008	2882	4025	5480	7225	8665
50–59	3794	1382	1792	2578	3568	4724	5942	7101
60–69	3533	1338	1712	2409	3336	4402	5640	6456
70–79	3106	1185	1473	2139	2958	3886	4934	5521
80+	2915	1075	1360	1978	2719	3575	4662	5344

Note: CSFII = Continuing Survey of Food Intake of Individuals; RE = retinol equivalent; αTE = α-tocopherol equivalents.

More recent data on supplement use were obtained from the 1987 NHIS. As in earlier surveys, older people were significantly more likely to consume vitamin supplements (43). Women were more likely to consume supplements regularly than were men of the same age and race. Daily usage among white women was highest within the age range of 55 to 65 years (39.9%) and 65 to 74 years (38.4%) and

Table 10. Nutrient Sources of Energy, in Two Different Age Groups (Data From NHANES III)

20–29 y (n = 3400)			≥70 y (n = 2623)		
Rank	Food	% of Total Energy	Rank	Food	% of Total Energy
1	Regular soft drinks	8.76	1	White bread, including Italian or French	4.58
2	Pizza	5.09	2	Cake, sweet rolls, doughnuts, pastries	3.65
3	Beer	3.94	3	Whole wheat, rye, other dark breads	3.06
4	Hamburgers, cheeseburgers, meat loaf	3.73	4	2% low-fat milk	2.80
5	White bread, including Italian or French	3.25	5	White potatoes, not fried	2.69
6	Cake, sweet rolls, doughnuts, pastries	3.25	6	Cookies	2.63
7	French fries, fried potatoes	2.97	7	Other cold cereal	2.37
8	Potato chips, corn chips, popcorn	2.73	8	Ice cream, ice milk	2.03
9	Rice	2.59	9	Other pies or cobbler	2.01
10	Other cheese or cheese spread	2.48	10	Whole milk, chocolate whole milk	1.90
11	Rolls, buns, English muffins, bagels	2.46	11	Margarine	1.88
12	Fried chicken	2.29	12	Hamburgers, cheeseburgers, meat loaf	1.80
13	Whole milk, chocolate whole milk	2.28	13	Cooked cereals	1.77
14	Beef, including roasts, steaks, sandwiches	1.95	14	Beef, including roasts, steaks, sandwiches	1.73
15	Mixed dishes with beef, pork, veal, lamb	1.82	15	Orange or grapefruit juice	1.72
16	Lunch meats	1.72	16	Chicken or turkey, roasted/broiled	1.67
17	Cookies	1.68	17	Rolls, buns, English muffins, bagels	1.66
18	Spaghetti, pasta with tomato sauce	1.66	18	Eggs, including breakfast sandwiches	1.59
19	Eggs, including breakfast sandwiches	1.56	19	Skim milk or 1% milk	1.52
20	2% low-fat milk	1.53	20	Rice	1.51
21	Chicken or turkey, roasted/broiled	1.52	21	Regular soft drinks	1.51
22	Hi C, Kool Aid, or drinks/juice with vitamin C	1.51	22	Vegetable soup, vegetable beef, tomato	1.49
23	Ice cream, ice milk	1.47	23	Bananas	1.49
24	Tortillas	1.35	24	Other cheese or cheese spread	1.48
25	Salad dressing, not low fat	1.34	25	Mixed dishes with beef, pork, veal, lamb	1.44
26	Liquor or mixed drinks, including mixers	1.33	26	Lunch meats	1.40
27	Other cold cereal	1.31	27	Fiber or bran cereals	1.32
28	Pork, including chops, roast, dinner ham	1.26	28	Biscuits or muffins	1.27
29	White potatoes, not fried	1.15	29	Salad dressing, not low fat	1.24
30	Orange or grapefruit juice	1.12	30	Pork, including chops, roast, dinner ham	1.24
31	Chocolate candy, candy bars	1.10	31	Sugar or honey	1.22
32	Macaroni and cheese, mixed dishes with cheese	1.10	32	Spaghetti, pasta with tomato sauce	1.20
33	Noodles, macaroni, pasta salad	1.03	33	Other soups, like chicken noodle	1.13
34	Tacos, burritos, enchiladas, etc.	1.01	34	Fried chicken	1.10
35	Whole wheat, rye, other dark breads	0.96	35	Stew or pot pie with carrots, vegetables	1.10
36	Breakfast sausage, including sandwiches	0.93	36	Pinto, navy, other dried beans	1.07
37	Pinto, navy, other dried beans	0.91	37	Crackers	1.03
38	Sugar or honey	0.90	38	Liquor or mixed drinks, including mixers	0.94
39	Fried fish	0.84	39	Peanuts, other nuts or seeds	0.92
40	Peanuts, other nuts or seeds	0.82	40	Jellies, jams, preserves, syrup	0.92
41	Biscuits or muffins	0.75	41	Potato chips, corn chips, popcorn	0.90
42	Hot dogs	0.67	42	French fries, fried potatoes	0.89
43	Stew or pot pie with carrots, vegetables	0.60	43	Noodles, macaroni, pasta salad	0.86
44	Other pies or cobbler	0.58	44	Hi C, Kool Aid, or drinks/juice with vitamin C	0.84
45	Crackers	0.57	45	Fish broiled or baked	0.81
46	Mixed dishes with chicken	0.56	46	Fried fish	0.79
47	Margarine	0.54	47	Pancakes, waffles, French toast	0.78
48	Jellies, jams, preserves, syrup	0.53	48	Mixed dishes with chicken	0.75
49	Pancakes, waffles, French toast	0.52	49	Any other vegetable	0.75
50	Skim milk or 1% milk	0.47	50	Breakfast sausage, including sandwiches	0.71

Note: NHANES = National Health and Nutrition Examination Survey.

declined slightly for those aged 75 years and older (34.9%). Among age-sex categories, whites tended to consume the most supplements compared with all other races. Hispanics consumed supplements at a frequency intermediate between those of whites and African Americans.

Slesinski and colleagues (44) reported on the trends in use of vitamin and mineral supplements in the U.S. population based on the 1987 and 1992 NHIS. There were few meaningful changes in the older age groups of 55 years and older, with the exception of calcium use, which declined between 1987 and 1992.

Total intake of nutrients, intake from supplements added to nutrient intake from food, is not available from most surveys because supplement data were not obtained in detail.

Discussion

The most important observation from the information reviewed previously is also one that comes as no surprise: The data from both cohort and cross-sectional surveys are consistent in indicating a very substantial decline with age in energy intake and quantity of food consumed. Mean energy intake declines by 1000 to 1200 kcal in men and by 600 to 800 kcal in women between those aged in their 20s and those in their 80s (Table 5). By age 80, 10% of men consume 890 kcal or fewer per day, and 10% of women consume 750 kcal or fewer (Tables 8 and 9), based on data from 2 nonconsecutive days of intake.

This decline presumably follows in part from a decrease in physical activity and in part from the decline in muscle mass with age. This results in a lower requirement for energy. (Substantial decrements in energy intake may, in turn, result in lower physical activity, a declining cycle.) Potential problems arise because, as total food intake declines, for most nutrients there is a concomitant decline in nutrient intake. Tables 8 and 9 suggest potentially important declines with age in median protein, zinc (both down by approximately one third in men), calcium, vitamin E, and other nutrients, especially in men. Further examination of the lower end of the distribution (e.g., the 10th percentile) suggests that a substantial number of minority elders consume grossly less than the RDA. In the 2-day data in Table 9, 10% of men obtained only one fifth to one third of the recommendations for protein, zinc, calcium, vitamin E, thiamin, riboflavin, vitamin B6, and vitamin B12.

Unfortunately, there is little evidence on which to base a judgment about the adequacy of these nutrient intakes that are concomitant with lower energy intakes in elderly individuals. For protein, the RDA committee notes that "there is surprisingly little information on which to base recommendations for protein intake in the elderly." Similar statements are made for other nutrients.

Furthermore, it is noted repeatedly by the RDA committee that there is no current evidence for most nutrients that absolute requirements decrease with age. Indeed, there is some evidence that absorption and utilization efficiency declines with age for some nutrients, potentially resulting in increased rather than decreased requirements for intake.

Occasionally, nutrient intake is expressed as a proportion of energy intake (i.e., nutrient intake per 1000 kcal). When expressed this way, it is clear that for at least some nutrients, the nutrient density of the diet does not decrease with age. That is, the energy intake declines with age at a faster rate than the specific nutrient intake. However, there is no evidence that this is an appropriate reflection of nutrient needs, for most nutrients. For example, women in their 20s consume approximately 0.36 mg of calcium per 1000 kcal, while for women in their 80s, this figure is 0.40 mg of calcium per 1000 kcal. Expressed this way, calcium intake in older women appears no less than that in younger women. However, it seems more important from a health standpoint to note that 524 mg of calcium (the median among women in their 80s) is both severely insufficient and is lower than that of younger women.

Another observation of interest in these data is the apparent health consciousness of older women. Although energy intake declines with age, the absolute value of certain nutrients actually increases with age. Vitamin A, vitamin C, and potassium intakes are all substantially higher in women in their 80s compared with those in their 20s (Table 8). These nutrients are found especially in fruits and vegetables, and this observation is consistent with the food pattern data cited previously. Older people, particularly older women, are more likely to consume fruits and vegetables. This general health consciousness is also seen in the much higher proportion of older women who consume vitamin supplements regularly.

Again, however, it is always important to observe the distribution of intake. Not all older women eat healthfully. For vitamin C, for example, 10% of women in their 80s obtained only 19 mg of vitamin C or less (about one third of the RDA) in a 2-day average.

Recommendations

Nutrition research is urgently needed to determine metabolic changes and nutrient needs of older people.

Outcomes research is needed to determine prospectively whether persons who maintain a higher nutrient intake with age have better health outcomes.

Intervention research is needed to determine whether providing increased macro- and micronutrients to elderly individuals can prevent or mitigate some of their health problems.

Public health efforts are needed to promote the maintenance of physical activity levels and food intake in elderly persons.

Acknowledgments

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