

Population nutrient intake approaches dietary recommendations: 1991 to 1995 Framingham Nutrition Studies

BARBARA E. MILLEN, DrPH, RD; PAULA A. QUATROMONI, MS, RD; MARY M. FRANZ, MS, RD; BARBARA E. EPSTEIN, MPH; L. ADRIENNE CUPPLES, PhD; DONNA L. COPENHAFFER, PhD

ABSTRACT

Objective To estimate population nutrient intake levels and to assess adherence to current dietary recommendations for health promotion and disease prevention.

Design Cross-sectional analysis of nutrient intake estimated from 3-day food records. Median macronutrient and micronutrient intake levels for men, women, and the total population are reported along with the proportions of men and women who achieved intakes compatible with nutrient goals defined by published guidelines.

Setting Adult participants (2,520: 1,375 women and 1,145 men) in the Framingham Offspring-Spouse Study surveyed between 1991 and 1995.

Statistical analyses χ^2 Analyses were used to test for gender differences in the proportions of persons who had intakes that met nutrient guidelines.

Results Population intake levels of certain key nutrients, including total and saturated fat, appear to be approaching recommended levels. High proportions of the Framingham population (70% or more) met current recommendations for intakes of protein, polyunsaturated and monounsaturated fat, cholesterol, alcohol, vitamins C and B-12, and folacin. About half or fewer met guidelines for carbohydrate; total and saturated fat; fiber; beta carotene; vitamins A, E, and B-6; calcium; and sodium. Important gender differences in the proportion of those meeting nutrient guidelines were observed for 12 of the 18 nutrients examined, including carbohydrate; total, saturated, and monounsaturated fat; cholesterol; fiber; sodium; calcium; and several vitamins.

Conclusions Although progress has been made toward achieving population adherence to preventive nutrition recommendations, large proportions of adults fall short of guidelines for some key nutrients. Differences in adherence rates between men and women suggest areas for gender-specific, targeted nutrition messages and behavioral interventions. *J Am Diet Assoc.* 1997;97:742-749.

The role of diet in human health and disease has long been recognized. As early as 1902, Atwater (1) advised that improper diet could result in "general debility, perhaps in actual disease." Throughout the 20th century, the accumulation of research linking diet with health and disease has prompted the creation of nutrition policies at the federal level and spurred the ongoing development of dietary recommendations designed to improve the health and nutritional status of the US population.

Early dietary guidelines such as the Recommended Dietary Allowances (RDAs) targeted the elimination of nutritional deficiencies within the population (2). Later, as further associations between diet and health were elucidated, the focus of dietary recommendations shifted to nutrients implicated in the etiology of chronic diseases, including cancer and coronary heart disease. To promote health and reduce risk of chronic disease, dietary recommendations were developed by a myriad of public and private groups including the American Cancer Society (3,4), the National Cancer Institute (5), the National Academy of Sciences (6,7), the US Surgeon General (8), the American Heart Association (9), and the National Cholesterol Education Program (10). These recommendations, although promoted by diverse groups, were consistent with current national nutrition policy statements (11) in advising a reduction in dietary intakes of cholesterol and total and saturated fat; moderation in sugar, sodium, and alcohol intakes; an increase in dietary fiber; and the achievement and maintenance of ideal body weight. More recently, initiatives such as the Dietary Guidelines for Americans (12), Food Guide Pyramid (13) and the 5 A Day for Better Health program (14) have provided consumers with specific guidelines for food selection and have advocated increased consumption of foods believed to be protective against disease—in particular, fruits and vegetables.

Cross-sectional studies provide estimates of population food and nutrient intake; hence, they can offer insight into consumer adherence to established dietary guidelines and progress

B. E. Millen is associate dean for research and professor, Boston University School of Public Health, and director of the Framingham Nutrition Studies. P. A. Quatromoni is nutrition research manager and M. M. Franz and B. E. Epstein are research assistants, the Framingham Nutrition Studies, Department of Social and Behavioral Sciences, Boston University School of Public Health, Boston, Mass. L. A. Cupples is a professor of biostatistics in the Department of Epidemiology and Biostatistics, Boston University School of Public Health.

D. L. Copenhaffer is a biostatistician in the Department of Neurology, Boston University School of Medicine.

Address correspondence to: Barbara E. Millen, DrPH, RD, Boston University School of Public Health, 715 Albany St, M840, Boston, MA 02118.

toward national nutrition policy goals. This article reports current estimates between 1991 and 1995 of macronutrient and micronutrient intakes in the adult population of the Framingham Offspring-Spouse Study and assesses the nutrient intakes of Framingham men and women in relation to current dietary recommendations.

METHODS

The Framingham Study

The Framingham Heart Study was initiated in 1948 as a longitudinal, population-based study of cardiovascular disease; more recently, it has broadened its scope to include other chronic diseases. The original cohort consisted of 5,209 men and women, aged 28 to 62 years, who represented a two-thirds random sample of residents of Framingham, Mass. In 1971, 5,124 Framingham Heart Study offspring and, if married, their spouses, aged 12 to 60 years, were recruited to participate in the Framingham Offspring-Spouse Study (15). The study population is predominantly white, which reflects the ethnic distribution of the community at the time of establishment of the cohort in 1949. The data presented in this article were collected at the fifth examination (exam 5) of the Framingham Offspring-Spouse Study between 1991 and 1995. In all, 3,787 persons (1,998 women and 1,789 men) participated in exam 5.

Dietary Assessment

Methods for assessing nutrient intake in the Framingham Offspring-Spouse population have been reported previously (16). At exam 5, nutrient intake was estimated from a 3-day dietary record. The clinic nutritionist instructed participants to provide a prospective record of their food intake over 2 weekdays and 1 weekend day and to maintain their usual dietary regimen. Portion sizes were estimated using a validated (17), two-dimensional food-portion visual. Additional information regarding salt use was obtained from the Framingham Food Habit Questionnaire.

The 3-day food records were generally initiated within a few days after the Framingham clinic visit; 81% were completed within 3 months of the clinic examination. Some 2,520 persons (1,375 women and 1,145 men) contributed complete dietary information, which was used in these analyses. Similar proportions of men and women responded to the dietary protocol, and the overall response rate was 67%. Those who complied with the dietary protocol were somewhat older (mean age=57 years) than nonparticipants (mean age=53 years). The age range of men who complied with the dietary protocols was 31 to 82 years; for women, the age range was 26 to 81 years. The median age was 57 years for both genders, and the mean (\pm standard deviation) ages were 57.2 \pm 10.0 and 56.5 \pm 9.7 years for men and women, respectively.

Dietary records were processed by trained coders according to standardized protocols. Nutrient calculations were performed using the Minnesota Nutrition Data System software developed by the Nutrition Coordinating Center at the University of Minnesota, Minneapolis (Food Database 6A, Nutrient Database 23 versions 2.4 and 2.6, 1994). Salt intake information from the Food Habit Questionnaire was used in coding the dietary records to respond to the extensive database probes regarding salt added in food preparation. Three-day mean nutrient intakes were calculated for each person and used to determine the population's mean and median nutrient intakes that were used in the analyses described herein. Nutrient estimates were based exclusively on consumption of foods; vitamin and mineral supplements did not contribute to the nutrient intake levels presented here.

Comparison with Dietary Recommendations

Published recommendations were used for assessing the proportion of Framingham participants who achieved levels of nutrient intake that were compatible with population-based guidelines for nutrient intake. For macronutrients, cholesterol, dietary fiber, and sodium, adherence was achieved if the person's mean intake met, at a minimum, the following guidelines: \leq 30% of energy from total fat (9-12,18), $<$ 10% saturated fat (9-12,18), 10% to 15% monounsaturated fat (18), up to 10% polyunsaturated fat (18), 50% to 60% carbohydrate (9,10,18), 10% to 20% protein (18), $<$ 300 mg cholesterol (9,10,18), 20 to 30 g dietary fiber (5), and $<$ 3 g sodium (9). Adherence to the recommendation for moderate alcohol intake was considered achieved if women consumed \leq 1 drink per day and men consumed \leq 2 drinks per day (12). For the micronutrients (vitamins A, C, E, B-6, and B-12; folacin; and calcium), adherence was considered achieved if the person's mean intake was \geq 100% of the gender-specific 1989 RDA (19). An RDA does not exist for beta carotene, although it is a nutrient that has received much recent attention given its role as an antioxidant nutrient. Therefore, we derived recommended values for beta carotene (6.0 mg for men, 4.8 mg for women) using the RDA for vitamin A (1,000 μ g retinol equivalent [RE] for men, 800 μ g RE for women) and the conversion factor of 1 RE for 6 μ g beta carotene (19).

We defined adherence to micronutrient recommendations as a 3-day mean intake that met or exceeded 100% of the RDA. The RDA is the level of intake that, on the basis of scientific knowledge, the Food and Nutrition Board judges to be safe and adequate to meet the known nutrient needs of practically all healthy persons (19). Other researchers have arbitrarily chosen different cutoff points, such as two thirds or 75% of the RDA, for determining dietary adequacy.

Statistical Analysis

Three-day median macronutrient and micronutrient intakes were calculated separately for men, women, and the total population. For most (11 of 19) nutrients, the distribution of intake was nonsymmetrical (skewness $\geq |1.0|$). Given this observation, the most appropriate statistic to report to characterize population intake levels is the median. For nutrients that are distributed normally, median and mean values are identical. In most instances within our data set, median values did not differ dramatically from means, except for alcohol. Proportions of men, women, and the total population who adhered to each of the dietary guidelines were determined. Differences between men and women in the proportions of persons adhering to nutrient recommendations were tested by χ^2 statistics. Because the age distributions of men and women who completed the dietary protocols and were included in these analyses were extremely similar, age adjustment was not necessary.

RESULTS

Median macronutrient and micronutrient intakes for 2,520 Framingham men and women for 1991 to 1995 are presented in the Table. Estimates of the proportions of men and women whose macronutrient and micronutrient intakes were compatible with current dietary recommendations are presented in Figures 1 and 2.

Framingham men had median intakes of total and saturated fat that approached, but somewhat exceeded, published recommendations (33.2% and 11.0% of energy, respectively), whereas their median intakes of carbohydrate and dietary fiber (47.1% of energy and 17.3 g, respectively) fell short of recommended intakes (Table). Men met recommendations for intakes of several macronutrients: protein (16.7% of energy),

Table
Median nutrient intakes in Framingham men and women (1991 to 1995)

Dietary component	Dietary guideline	Men (n=1,145)	Women (n=1,375)	Total population (n=2,520)
Energy (kcal)	Achieve or maintain ideal body weight	2,152	1,580	1,797
Carbohydrate (% of energy)	50%-60%	47.1	49.7	48.4
Total fat (%)	≤30%	33.2	32.0	32.5
Saturated fat (%)	<10%	11.0	10.3	10.6
Polyunsaturated fat (%)	up to 10%	6.4	6.6	6.5
Monounsaturated fat (%)	10%-15%	12.5	11.8	12.2
Protein (%)	10%-20%	16.7	17.3	17.0
Alcohol (drinks/day)	≤2 drinks/day for men ≤1 drinks/day for women	0.271	0.006	0.019
Cholesterol (mg)	<300 mg	266	184	213
Cholesterol (mg/1,000 kcal)		123	115	119
Dietary fiber (g)	20-30 g	17.3	14.3	15.7
Sodium (g)	<3 g	3.4	2.5	2.9
Sodium (g/1,000 kcal)		1.6	1.6	1.6
Beta carotene (mg) ^a	6.0 mg for men 4.8 mg for women	2.5	2.8	2.6
RDA				
Vitamin A (μg RE)	1,000 μg for men 800 μg for women	991	887	940
Vitamin C (mg)	60 mg	96.3	92.8	94.5
Vitamin E (mg α-tocopherol)	10 mg for men 8 mg for women	9.3	7.7	8.4
Vitamin B-6 (mg)	2.0 mg for men 1.6 mg for women	2.0	1.6	1.8
Vitamin B-12 (μg)	2.0 μg	4.8	3.5	4.1
Folacin (μg)	200 (μg) for men 180 (μg) for women	280	235	256
Calcium (mg)	800 mg	754	599	666

^aEstimated value derived from Recommended Dietary Allowance (RDA, 19) for vitamin A (1,000 μg RE for men; 800 μg RE for women) and the conversion factor of 1 retinol equivalent (RE) being equal to 6 μg of beta carotene.

polyunsaturated fat (6.4% of energy), monounsaturated fat (12.5% of energy), cholesterol (266 mg), and alcohol (0.271 drinks per day). Median intakes of most micronutrients (folacin and vitamins C, B-6, B-12) met or exceeded recommended intake levels among the men, with a few exceptions. Median vitamin A (991 μg RE) and vitamin E intakes (9.3 mg α-tocopherol) fell slightly short of RDA levels. Most notable, median beta carotene intake (2.5 mg) failed to reach the suggested intake level we derived (6.0 mg), and median sodium intake (3.4 g) was higher than current recommendation.

Median nutrient intakes of Framingham women met or slightly deviated from published recommendations for carbohydrate (49.7% of energy), total fat (32.0% of energy), saturated fat (10.3% of energy), polyunsaturated fat (6.6% of energy), monounsaturated fat (11.8% of energy), protein (17.3% of energy), cholesterol (184 mg), alcohol (0.006 drinks per day), and sodium (2.8 g). Women also had median intakes

of folacin and vitamins A, C, B-6, B-12 that met or exceeded the RDAs. Median intakes of calcium (599 mg) and dietary fiber (14.3 g) were considerably lower than the current recommendations. Similarly, median beta carotene intake (2.8 mg) was below the suggested intake level, and vitamin E intake (7.7 mg α-tocopherol) was just below the RDA.

When the data from men and women were combined, population median intakes of total and saturated fat and sodium approached, but somewhat exceeded, nutrient guidelines. Median intakes of carbohydrate, dietary fiber, calcium, and beta carotene fell short of suggested intake levels. Median intakes of alcohol and cholesterol were in accordance with recommendations, as were intake of protein and polyunsaturated and monounsaturated fat. Median intakes of most micronutrients met or surpassed the RDA.

As individuals, high proportions of the overall Framingham population (70% or more) achieved recommended intake

levels for polyunsaturated and monounsaturated fat, protein, alcohol, cholesterol, vitamins C and B-12, and folacin (Figures 1 and 2). Approximately half or fewer consumed recommended amounts of carbohydrate; total and saturated fat; dietary fiber; beta carotene; vitamins A, E, and B-6; calcium; and sodium.

The percentage of Framingham men and women whose 3-day mean intake achieved established dietary guidelines differed for many nutrients (Figures 1 and 2). Most notably, men were more likely than women to meet recommendations for dietary fiber (36% of men vs 21% of women), vitamin B-12 (94% vs 83%), folacin (76% vs 71%), and calcium (45% vs 25%) ($P < .01$ for all comparisons). Women were more likely than men to adhere to dietary guidelines for carbohydrate (48% of women vs 36% of men), total fat (40% vs 33%), saturated fat (47% vs 38%), cholesterol (84% vs 61%), vitamin A (56% vs 50%), beta carotene (29% vs 20%), and sodium (70% vs 35%) ($P < .01$ for all comparisons). High and similar rates of adherence (>70%) were observed for intakes of polyunsaturated fat, protein, alcohol, and vitamin C among both men and women. Lower rates of adherence (approximately 50% or less) were observed for intakes of vitamins E and B-6 in both genders.

DISCUSSION

High proportions of the Framingham adult population (70% or more) met current guidelines for the intake of 8 of 18 key nutrients that are associated with health promotion and disease prevention. This study combines information on intakes of a broad range of macronutrients and micronutrients in men and women, which are often unavailable simultaneously. These data, collected between 1991 and 1995, provide current estimates of nutrient intake and progress toward the goals of national nutrition policies. Dietary patterns in the adult Framingham population were characterized during a period of widespread change in the availability of new food products and consumer information. Since phase 1 of the third National Health and Nutrition Examination Survey (NHANES III) (20,21), conducted between 1988 and 1991, more fat-modified food products have become available (22) and widespread public nutrition campaigns have been conducted, including the National Cholesterol Education Program (10), Project LEAN (22), and 5 A Day for Better Health (14). Therefore, the Framingham Offspring-Spouse Study is in a unique position to contribute timely information on eating behaviors of a non-Hispanic, white, adult population, particularly with respect to national nutrition policy recommendations.

Adherence to Dietary Guidelines

Our findings suggest that a larger proportion of persons may be achieving the recommended intakes for total and saturated fat than was previously reported for Framingham participants (23). Currently, more than one third of Framingham participants (37%) have total fat intakes less than or equal to 30% of energy, and nearly one half (43%) meet the recommendation for saturated fat intake. Dietary data obtained from Framingham participants between 1984 and 1988 demonstrated that the proportions of subjects adhering to recommendations for total and saturated fat were substantially lower during this earlier period (approximately 20% for total fat and 25% for saturated fat) (24). Thus, adherence to published recommendations for total and saturated fat appears to be rising within the adult population, particularly among women.

The estimated proportions of persons who met the recommendations for protein and polyunsaturated and monounsaturated fat were quite high in Framingham (>75% of the

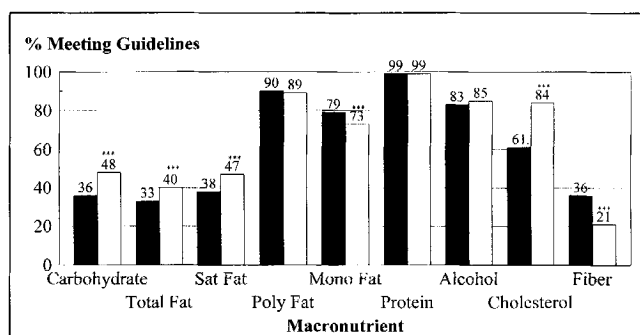


FIG 1. Percentage of Framingham men and women who met macronutrient requirements. *** $P < .001$ for tests of significance between genders. Black bar = men; white bar = women. Key: Sat Fat = saturated fat, Poly Fat = polyunsaturated fat, Mono Fat = monounsaturated fat.

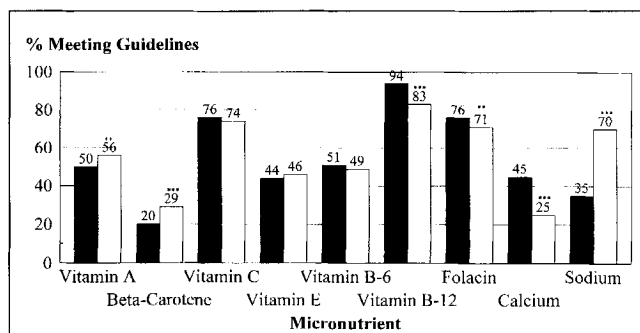


FIG 2. Percentage of Framingham men and women who met micronutrient guidelines. ** $P < .01$ and *** $P < .001$ for tests of significance between genders. Black bar = men; white bar = women.

population). These findings are not unexpected because the recommended intake levels are quite broad for protein and monounsaturated fat, and given our use of the lower end of the recommended intake range as the minimum criterion for adherence. Nonetheless, high intakes of animal protein may be undesirable as they have been linked to urinary calcium losses and, to a lesser degree, to some types of cancers (2). In this most recent Framingham nutrition study, approximately 70% of the protein consumed was derived from animal foods; as well, monounsaturated fat intake in the Framingham population is derived predominantly from animal food sources (25), not vegetable sources. Thus, the proportions meeting the recommendations for high monounsaturated fat intake reported here should not be misinterpreted as a general trend toward the consumption of a "Mediterranean diet," which has been associated with a very low prevalence of disease in certain regions of Europe and Greece and promoted as an alternative to current dietary recommendations (26,27).

Nearly three quarters of Framingham subjects achieved the recommended intake level for cholesterol, with more women than men consuming less than 300 mg/day. A steady decline in dietary cholesterol intake has been observed in the United States since the 1970s (23). This important dietary change may have been facilitated by the fact that dietary cholesterol has been the primary target of most educational and media campaigns to date. Further, cholesterol is largely derived from

a limited number of foods, including eggs, organ meats, and other animal products, that consumers easily recognize. In contrast, dietary fat is more widespread throughout a variety of food sources, so modifying fat intake is more challenging.

In the Framingham participants, adherence to dietary recommendations was only moderate for carbohydrate (43% of the population) and quite low for dietary fiber (28%). Increased consumption of complex carbohydrate and dietary fiber has been widely advocated as a means of replacing dietary fat (2,7). There is sufficient prior evidence to suggest that consumption of foods rich in complex carbohydrate and fiber (grains, fruits, vegetables, and legumes) remains well below suggested intake levels in both the Framingham (25) and the US population (28). Consistent with our observations in Framingham participants, recent estimates indicate that only 40% of the US population consumes the number of servings of grain products necessary to achieve the recommendation for carbohydrate intake (29,30).

Adherence to the recommendation for moderate alcohol intake was high in Framingham (84% of the population). The population mean alcohol intake in Framingham (8.62 g, or 0.64 drinks per day) appears to be compatible with national estimates (20). The distribution of alcohol intake in both men and women in Framingham, however, was highly skewed, so it may be more meaningful to consider that the median intake of alcohol is 0.27 g, or 0.019 drinks per day, in the Framingham population. Despite the low prevalence of overconsumption of alcohol in the population in general, an earlier analysis of dietary patterns in the Framingham Offspring-Spouse cohort (25) demonstrated that 17% of men and 15% of women are currently consuming amounts of alcohol that exceed recommended intake levels. Thus, alcohol intake needs to be targeted in behaviorally based nutrition educational programs for certain subgroups of the population.

In recent years, the role of micronutrients in chronic disease has been investigated extensively. Abundant evidence suggests that the antioxidant vitamins (vitamins A, C, and E and beta carotene) may offer protection against cancer and coronary heart disease by mediating a host of biological functions (28,31-33). Inadequate consumption of folacin and vitamins B-12 and B-6 has been associated with elevated blood levels of homocysteine, a suspected risk factor for coronary heart disease (32). Low calcium intake has been associated with increased risk of both osteoporosis and hypertension (7). Likewise, excessive sodium consumption has been identified as a contributing factor in the development of hypertension (7).

In this study, we observed that achievement of recommended intake levels of micronutrients known to be associated with chronic disease risk was quite variable. Median intakes of vitamins C and B-12 and folacin were high; approximately three quarters or more of Framingham participants met or exceeded the RDAs for these nutrients.

Approximately one third of Framingham participants consumed 800 mg calcium or more on average, with fewer women (25%) achieving the recommended intake than men. These data are supported by a national observation that only about 20% of US women and 25% or less of the general US population achieve the RDA for calcium (29). Consistent with a national report that 43% to 60% of adult men and women have reduced their use of table salt (29), we found that slightly more than half of Framingham adults adhered to the sodium guideline.

About half or fewer Framingham subjects met the RDAs for vitamins A, E, and B-6, and only 25% of the population achieved the suggested intake level for beta carotene. National data documenting the adequacy of beta carotene intakes are not yet available. A large proportion of Americans fail to consume

recommended intakes of vitamin E (34). Inadequate intakes of vitamins A and B-6 have also been reported in national surveys, particularly among women (35). Fruits and vegetables as well as whole grains and legumes are the primary contributors to intakes of beta carotene (28) and vitamin E (34). Despite recommendations to increase fruit and vegetable consumption, intakes of these foods remain consistently low in both the Framingham population (25) and in the US population, with as few as 10% of US adults consuming the recommended five daily servings (28). Clearly, initiatives to educate consumers about the health-promoting benefits of increased consumption of fruits and vegetables need to remain a priority.

The optimal eating pattern associated with reduction of risk of chronic disease appears to be one that is low in total and saturated fat and high in complex carbohydrate, fiber, and nutrient density. Thus, there is a need to balance nutrition educational messages that promote achievement of ideal body weight and decreased intake of fats and cholesterol with messages that target adequacy of micronutrient intake. Difficulty meeting recommendations for some micronutrients, particularly vitamin B-6, has been reported when eating patterns consistent with the US Dietary Guidelines are adopted (36). It is important to note that even though Framingham men and women appear to be choosing diets that are lower in fat and cholesterol, many are achieving reasonably high intake levels of certain micronutrients. Emphasis on selection of nutrient-dense foods can help consumers achieve recommended intakes of these nutrients as they further reduce their intakes of total and saturated fat and cholesterol.

Gender Differences in Rates of Adherence to Dietary Guidelines

We observed a number of statistically significant ($P < .01$) gender differences in adherence to dietary recommendations in Framingham participants. Greater proportions of women than men met the recommendations for carbohydrate, total and saturated fat, cholesterol, vitamin A, beta carotene, and sodium, whereas more men than women met the guidelines for monounsaturated fat, dietary fiber, vitamin B-12, folacin, and calcium. These findings are consistent with a previous analysis in Framingham (24).

Little information exists in the literature regarding gender differences in the adoption of healthful eating habits. Some studies indicate that women are more likely than men to report changing their diets (37,38). Others have contradicted the prevailing sense that women are changing their diets more rapidly than are men by showing that gender differences are small, at least among the older population (39,40). The 1993 American Dietetic Association Survey of American Dietary Habits documented that, in a nationally representative sample of the US adult population, women placed a higher level of importance on good nutrition than did men (41). Women also indicated higher levels of care in selecting foods to achieve a healthful diet. These researchers identified 35- to 54-year-old women and 25- to 34-year-old men as two subgroups of the population that may be most receptive to advice about improving dietary behaviors because of the dramatic increase in their self-ratings of the personal importance of nutrition since 1991.

Our observations suggest that in addition to population-based dietary guidelines and initiatives that address nutrients and dietary patterns of concern in the general population, men and women may have unique needs for nutrition information and interventions that are not adequately targeted by broad-brush dietary recommendations designed for the general public. Preventive nutrition messages targeted to adult men need to emphasize reducing intakes of total and saturated fat,

cholesterol, and sodium and increasing intakes of complex carbohydrates. In contrast, women appear to need messages that further emphasize adequate intakes of calcium, vitamin B-12, and folacin. Despite the observation that Framingham women are consuming more carbohydrate overall than men (49.7% of energy vs 47.1%, with rates of adherence being 48% and 36%, respectively), fewer women met fiber guidelines. This is consistent with our finding that sucrose is a more predominant energy source in Framingham women than men (8.2% vs 7.5%, $P < .0001$) and our previous report (25) that high intake of refined sugar appears to be a particular concern in the diets of certain groups of Framingham women. Taken together, these observations suggest that women also need specific nutrition messages that encourage the increased intake of foods higher in dietary fiber and lower in refined sugar. Recognition of differences in nutrient intake between men and women is important and may facilitate the improved formulation of behaviorally based, gender-specific nutrition messages and interventions.

Comparisons with National Estimates of Nutrient Intake

Estimates of median nutrient intake in Framingham between 1991 and 1995 are largely consistent with estimates for the adult, non-Hispanic, white population surveyed in 1988 to 1991 in phase I of NHANES III (20,21). Overall, diets of more than half of Framingham participants did not meet the recommended intake levels for 7 of 18 nutrients examined. Data from NHANES III indicate that although population intakes of total and saturated fat have declined during the past decade, they have yet to meet the national nutrition recommendations (20,22). National estimates also suggest that intakes fall short of guidelines for carbohydrate, dietary fiber, and certain micronutrients including calcium (29) and vitamins A, E, and B-6 (34,35).

The failure of consumers to achieve intake levels compatible with certain dietary guidelines is not completely understood. For example, public nutrition education campaigns may have overlooked certain key messages (39) or used methods of consumer education that may not have been completely effective in promoting dietary change within the population (30,42,43). In addition, consumers may be confused by conflicting nutrition information (37,38). It may be timely to clearly promote population-based recommendations to increase consumption of whole grains, legumes, fruits, and vegetables. By providing clear and specific guidelines for food selection, practical instruments such as the Food Guide Pyramid may help consumers achieve higher rates of adherence to dietary recommendations (41,44). Continued efforts are needed to educate the public about how to incorporate current dietary guidelines into their daily lives through approaches that provide practical information and familiar terminology.

Methodologic Considerations

The method used to assess nutrient intake in this study was a 3-day dietary record that encompassed 2 weekdays and 1 weekend day. The 3-day record has been demonstrated as a reliable (45) and valid (46) method of estimating population food and nutrient intake. A 3-day record also improves the estimate of a person's intake by providing information on less frequently eaten foods (47) and reducing the error associated with day-to-day variability in individual intake—the largest source of random variation in energy intake (47,48). This is particularly important when estimating intake levels of nutrients known to be highly variable such as vitamins A and C (49,50). Nonetheless, there is concern that certain persons,

particularly those who are obese, may underestimate their intake perhaps by as much as 10% to 20% (45,48); this appears particularly true as the number of recorded days of intake increases (45,47). Our decision to obtain 3 days of dietary information was made in an attempt to find a balance between the well-documented need for multiple-day data (47-49) and heavier respondent burden, lower rates of participation, and the potential for information bias associated with longer time frames for recording intake (45,47). Estimates of nutrient intake in the Framingham population have been quite consistent with estimates from national surveys over the years (20,21,51).

The estimates of median nutrient intake reported here for men (2,152 kcal) falls somewhat below the *average* recommended level of 2,300 kcal; for women, the estimated median intake (1,580 kcal) is also lower than the average recommended level (1,900 kcal). The average recommended energy intakes for men and women are based on persons maintaining a light-to-moderate level of activity so as to promote the maintenance of muscle mass and well-being (20, p 33). It is not clear whether the differences we observed between reported and average recommendations may be due to underreporting of nutrient intake by some subjects (45,48) or may reflect lower than recommended levels of activity in Framingham men and women.

Two important characteristics of the Framingham cohort need to be considered when interpreting the findings of this study. First, men and women who contributed complete dietary information necessary for these analyses tended to be somewhat older, on average, than those who did not complete the dietary protocols. This difference in age may result in a slight underestimation of nutrient intake, as older persons tend to consume less energy than younger persons and, as a result, may have diets that are less nutrient dense (52). A second consideration for interpreting these findings is that the Framingham cohort is predominantly white. Rates of adherence observed in this cohort, although informative for non-Hispanic, white adults, are not directly applicable to other racial groups.

Practice and Policy Implications

Our assessment of adherence to dietary recommendations within the Framingham population has important implications for future research, policy, and educational initiatives. Continued investigations are needed to further explore associations between diet and chronic disease and to identify healthful patterns of food and nutrient intake. Current dietary recommendations may need to be reviewed, modified, or focused as new evidence concerning the role of diet in chronic disease becomes available and information about dietary patterns of men and women is elucidated. Collaboration among agencies and groups involved in the formulation of dietary recommendations is necessary to ensure that new directives are consistent and developed in a timely manner. Perhaps most importantly, nutrition information delivered to the public must be easily understood, practical, and relevant. Adult men and women may benefit from more targeted preventive nutrition messages, in particular those that emphasize carbohydrate, total and saturated fat, cholesterol, and sodium for men; vitamin B-12, folacin, calcium, and fiber for women; and beta carotene and vitamins A, E, and B-6 for the general population. Finally, continued nutrition monitoring is needed to measure public adherence to dietary recommendations. Newly developed instruments such as the US Department of Agriculture Healthy Eating Index (53) may be useful for assessing a person's overall dietary quality. At the national level, ongoing

nutrition surveys such as NHANES will continue to provide valuable information concerning trends in food and nutrient intake, particularly among age and culturally diverse subgroups of the population.

CONCLUSIONS

Between 1991 and 1995 high proportions of Framingham men and women (70% or more) achieved nutrient intake levels that were compatible with national preventive nutrition recommendations for protein, polyunsaturated and monounsaturated fat, cholesterol, alcohol, vitamins C and B-12, and folacin. Approximately half or fewer adults met recommendations for other nutrients, including carbohydrate; total and saturated fat; fiber; beta carotene; vitamins A, E, and B-6; calcium; and sodium. Women were more likely than men to meet recommendations for carbohydrate, total and saturated fat, cholesterol, vitamin A, beta carotene, and sodium intake, whereas men were more likely than women to achieve intakes of monounsaturated fat, fiber, vitamin B-12, folacin, and calcium that were consistent with recommendations. Clear and concise behaviorally based intervention strategies and educational messages that target the differing dietary patterns of men and women are needed to assist the population in achieving current dietary recommendations. ■

This research was supported, in part, by National Heart, Lung, and Blood Institute grants and contracts R01-HL-46193 and the Framingham Heart Study was supported by NIH/NHLBI contract N01-HC-38038.

References

1. Atwater WO. Quoted in: Revising the *Dietary Guidelines for Americans*: history and rationale. *Nutr Rev*. 1994;52:394-395.
2. Willett WC. Diet and health: what should we eat? *Science*. 1994;264:532-537.
3. Nutrition and cancer: causation and prevention. An American Cancer Society Special Report. *Cancer*. 1984;34:121-126.
4. Bal DG, Foerster SB. Changing the American diet: impact on cancer prevention policy recommendations and program implications for the American Cancer Society. *Cancer*. 1991;67:2671-2680.
5. Butrum RR, Clifford CK, Lanza E. National Cancer Institute dietary guidelines: rationale. *Am J Clin Nutr*. 1988;48(suppl):888-895.
6. Committee on Diet, Nutrition, and Cancer, Assembly of Life Sciences, National Research Council. *Diet, Nutrition, and Cancer*. Washington, DC: National Academy Press; 1982.
7. National Research Council. *Diet and Health: Implications for Reducing Chronic Disease Risk*. Washington, DC: National Academy Press; 1989.
8. *The Surgeon General's Report on Nutrition and Health*. Washington, DC: US Dept of Health and Human Services; 1988. DHHS (PHS) publication 88-50210.
9. *Dietary Treatment for Hypercholesterolemia: A Manual for Patients*. Dallas, Tex: American Heart Association; 1988.
10. National Cholesterol Education Program. *Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults*. Bethesda, Md: US Dept of Health and Human Services, Public Health Service, National Institutes of Health, National Heart, Lung, and Blood Institute; 1988. NIH publication 88-2925.
11. US Dept of Health and Human Services, Public Health Service. *Healthy People 2000. National Health Promotion and Disease Prevention Objectives*. Boston, Mass: Jones and Bartlett Publishers; 1992.
12. *Nutrition and Your Health: Dietary Guidelines for Americans*. 4th ed. Washington, DC: US Depts of Agriculture and Health and Human Services; 1995.
13. *The Food Guide Pyramid*. Washington, DC: US Dept of Agriculture, Human Nutrition Information Service; 1992. Home and Garden Bulletin No. 252.
14. Havas S, Heimendinger J, Reynolds K, Baranowski T, Nicklas TA, Bishop D, Buller D, Sorenson G, Beresford SAA, Cowan A, Damron D. 5 A Day For Better Health: a new research initiative. *J Am Diet Assoc*. 1994;94:32-36.
15. Kannel WB, Feinleib M, McNamara PM, Garrison RJ, Castelli W. An investigation of coronary heart disease in families: the Framingham Offspring Study. *Am J Epidemiol*. 1979;110:281-290.
16. Posner BM, Martin-Munley SS, Smigelski C, Cupples LA, Cobb JL, Schaefer E, Miller DR, D'Agostino RB. Comparison of techniques for estimating nutrient intake—the Framingham Study. *Epidemiology*. 1992;3:171-177.
17. Posner BM, Smigelski C, Duggal A, Morgan JL, Cobb J, Cupples LA. Validation of two-dimensional models for estimation of portion size in nutrition research. *J Am Diet Assoc*. 1992;92:738-741.
18. National Heart, Lung, and Blood Institute, National Institutes of Health, US Department of Health and Human Services. National Cholesterol Education Program. Report of the Expert Panel on Population Strategies for Blood Cholesterol Reduction: Executive Summary. *Arch Intern Med*. 1991;151:1071-1084.
19. Food and Nutrition Board. *Recommended Dietary Allowances*. 10th ed. Washington, DC: National Academy Press; 1989.
20. McDowell MA, Briefel RR, Alaimo K, Bischof AM, Caughman CR, Carroll MD, Loria CM, Johnson CL. *Energy and Macronutrient Intakes of Persons Ages 2 Months and Over in the United States: Third National Health and Nutrition Examination Survey, Phase 1, 1988-91*. Hyattsville, Md: National Center for Health Statistics; 1994. Advance data from Vital and Health Statistics, No. 255.
21. Alaimo K, McDowell MA, Briefel RR, Bischof AM, Caughman CR, Loria CM, Johnson CL. *Dietary Intake of Vitamins, Minerals, and Fiber of Persons Ages 2 Months and Over in the United States: Third National Health and Nutrition Examination Survey, Phase 1, 1988-91*. Hyattsville, Md: National Center for Health Statistics; 1994. Advance data from Vital and Health Statistics, No. 258.
22. Van Horn L, Bujnowski M, Schwaba J, Mathieu-Harris M, Donato K, Cleeman J. Dietitians' contributions to cholesterol education: a decade of progress. *J Am Diet Assoc*. 1995;95:1263-1267.
23. Posner BM, Franz MM, Quatromoni PA, Gagnon DR, Sytkowski PA, D'Agostino RB, Cupples LA. Secular trends in diet and risk factors for cardiovascular disease: the Framingham Study. *J Am Diet Assoc*. 1995;95:171-179.
24. Posner BM, Cupples LA, Gagnon D, Wilson PWF, Chetwynd K, Felix D. Healthy People 2000. The rationale and potential efficacy of preventive nutrition in heart disease: the Framingham Offspring-Spouse Study. *Arch Intern Med*. 1993;153:1549-1556.
25. Millen BE, Quatromoni PA, Gagnon DR, Cupples LA, Franz MM, D'Agostino RB. Dietary patterns of men and women suggest targets for health promotion. The Framingham Nutrition Studies. *Am J Health Promotion*. 1996;11:42-52.
26. Kushi LH, Lenart EB, Willett WC. Health implications of Mediterranean diets in light of contemporary knowledge, 2: meat, wine, fats, and oils. *Am J Clin Nutr*. 1995;61(suppl):1416S-1427S.
27. Willett WC, Sacks F, Trichopoulos A, Drescher G, Ferro-Luzzi A, Helsing E, Trichopoulos D. Mediterranean diet pyramid: a cultural model for healthy eating. *Am J Clin Nutr*. 1995;61(suppl):1402S-1406S.
28. Block G. Dietary guidelines and the results of food consumption surveys. *Am J Clin Nutr*. 1991;53:356S-357S.
29. *Healthy People 2000 Midcourse Review and 1995 Revisions*. Washington, DC: US Dept of Health and Human Services, Public Health Service; 1995.
30. Anderson GH. Dietary patterns vs. dietary recommendations: identifying the gaps for complex carbohydrate. *Crit Rev Food Sci Nutr*. 1994;34:435-440.
31. Kushi LH, Lenart EB, Willett WC. Health implications of Mediterranean diets in light of contemporary knowledge, 1: plant foods and dairy products. *Am J Clin Nutr*. 1995;61(suppl):1407S-1415S.
32. Ascherio A, Willett WC. New directions in dietary studies of coronary heart disease. *J Nutr*. 1995;125:647S-655S.
33. Kritschewsky D. Dietary guidelines: the rationale for intervention. *Cancer*. 1993;72:1011-1014.
34. Murphy SP, Subar AF, Block G. Vitamin E intakes and sources in the United States. *Am J Clin Nutr*. 1990;52:361-367.
35. Murphy SP, Rose D, Hudes M, Viteri FE. Demographic and economic factors associated with dietary quality in the 1987-88 Nationwide Food Consumption Survey. *J Am Diet Assoc*. 1992;92:1352-1357.

36. Dollahite J, Franklin D, McNew R. Problems encountered in meeting the Recommended Dietary Allowances for menus designed according to the Dietary Guidelines for Americans. *J Am Diet Assoc.* 1995;95:341-344.
37. Ferrini R, Edelstein S, Barrett-Connor E. The association between health beliefs and health behavior change in older adults. *Prev Med.* 1994;23(1):1-5.
38. Ferrini R, Edelstein SL, Barrett-Connor E. Factors associated with health behavior change among residents 50 to 96 years of age in Rancho Bernardo, California. *Am J Prev Med.* 1994;10(1):26-30.
39. Popkin BM, Haines PS, Patterson RE. Dietary changes in older Americans. *Am J Clin Nutr.* 1992;55:823-830.
40. Horwath CC. Dietary changes reported by a random sample of elderly people. *J Nutr Elderly.* 1992;12(2):13-27.
41. Morreale S, Schwartz NE. Helping Americans eat right: developing practical and actionable public nutrition education messages based on the ADA Survey of American Dietary Habits. *J Am Diet Assoc.* 1995;95:305-308.
42. Achterberg CL. Qualitative research: what do we know about teaching good nutritional habits? *J Nutr.* 1994;124 (suppl):1808S-1812S.
43. Bal DG, Foerster SB. Dietary strategies for cancer prevention. *Cancer.* 1993;72:1005-1010.
44. Achterberg C, McDonnell E, Bagby R. How to put the Food Guide Pyramid into practice. *J Am Diet Assoc.* 1994;94:1030-1035.
45. Howat PM, Mohan R, Champagne C, Monlezun C, Wozniak P, Bray GA. Validity and reliability of reported dietary intake data. *J Am Diet Assoc.* 1994;94:169-173.
46. Beaton GH, Milner J, Corey P, McGuire V, Cousins M, Stewart E, de Ramos M, Hewitt D, Grambsch PV, Kassim N, Little JA. Sources of variance in 24-hour dietary recall data: implications for nutrition study design and interpretation. *Am J Clin Nutr.* 1979;32:2546-2559.
47. Rizek RL, Pao EM. Dietary intake methodology, I: USDA surveys and supporting research. *J Nutr.* 1990;120:1525-1529.
48. Schoeller DA. Limitations in the assessment of dietary energy intake by self-report. *Metabolism.* 1995;44(suppl 2):18-22.
49. St Jeor ST, Guthrie HA, Jones MB. Variability in nutrient intake in a 28-day period. *J Am Diet Assoc.* 1983;83:155-162.
50. Pao EM, Mickle SJ, Burk MC. One-day and 3-day nutrient intakes by individuals—Nationwide Food Consumption Survey findings, spring 1977. *J Am Diet Assoc.* 1985;85:313-324.
51. Posner BM, Cupples LA, Franz MM, Gagnon DR. Diet and heart disease risk factors in adult American men and women: the Framingham Offspring-Spouse Nutrition Studies. *Int J Epidemiol.* 1993;22:1014-1025.
52. Wellman NS. Dietary guidance and nutrient requirements of the elderly. *Prim Care.* 1994;21:1-18.
53. Kennedy ET, Ohls J, Carlson S, Fleming K. The Healthy Eating Index: design and applications. *J Am Diet Assoc.* 1995;95:1103-1108.

PRACTICE POINTS: Translating research into practice

Nutrition education: Changing eating behavior requires concrete advice

Many people are concerned about the adequacy of their diets but their personal stories reveal beliefs about good nutrition that interfere with their ability to make behavior changes. They believe that anything that tastes good must not be good for you and that nutritious food costs more than other foods. They don't believe they have the time to plan and prepare nutritious meals. It is no surprise to dietitians that a substantial number of people are not meeting important dietary recommendations. Practical, concrete recommendations for dietary change are needed to translate the dietary recommendations of national nutrition education campaigns into quick and easy ways for consumers to meet their nutrition needs from the grocery store to the table. I have listed a few ideas for helping clients overcome real or perceived barriers to good nutrition developed by the dietitians at SPRCNP.

- "Meal in a Bag" is an employee lunchtime class used to demonstrate how to prepare nutritious meals in 30 minutes or less. In this class, employees divide into groups of two to four persons and each group is given a different menu along with preparation directions and shopping list. Each group prepares a meal from provided ingredients and the class then samples from the different meals, buffet style. Employees each take home a collection of the menus used in class; we suggest that they keep them in the glove compartments of their cars for use when they go grocery shopping.

- One of our most effective visual tools for dispelling the notion that nutritious foods cost more is a display called "Look what \$10 can buy." A large mat board divided in half shows \$10 worth of empty-energy foods consisting of only

four items; the other side shows a large array of nutritious food for \$10 that could feed a person for many days. We use this board in classes and health fairs.

Several other practical suggestions for eating more nutritiously include the following:

- Satisfy a chocolate craving while eating a serving of fruit and a dairy product at the same time by dipping strawberries into fat-free chocolate yogurt.
- Live by the motto "eat a grain and fruit before 10 AM."
- Plan a "nutritional safety net" for your desk or car for really hectic days. Stash items such as pretzels, cereal, crackers, dried fruit, small cans of fruit or vegetable juice so that you will always have nutritious snacks on hand.

When working with clients, dietitians need to be aware of several current trends in our society. Many fast-food and family-type restaurants are featuring big servings by using sales tactics that promote the larger-size food serving for only a few cents more. With approximately one third of our population overweight, dietitians need to promote the message that being adventurous in eating and taking the time to enjoy a variety of tastes are a better value than consuming larger quantities. The home meal replacement market is also growing rapidly, with ready-to-eat foods taking up more and more space in grocery stores. Dietitians need to provide their clients with ideas for foods to add to the ready-to-eat foods to make a complete, nutritious meal.—**Julianne C. Seiber, MS, RD**, is a nutritionist at St Paul-Ramsey County Nutrition Program (SPRCNP) in St Paul, Minn, and chair of the Public Health Nutrition dietetic practice group.