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Unique Dietary Patterns and Chronic Disease Risk Profiles of Adult Men: The Framingham Nutrition Studies

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ABSTRACT

Objective To identify the dietary patterns of adult men and examine their relationships with nutrient intake and chronic disease risk over long-term follow-up.

Design/subjects Baseline 145-item food frequency questionnaires from 1,666 Framingham Offspring-Spouse cohort men were used to identify comprehensive dietary patterns. Independent 3-day dietary records at baseline and 8 years later provided estimates of subjects' nutrient intake by dietary pattern. Chronic disease risk factor status was compared at baseline and 16-year follow-up across all male dietary patterns.

Statistical analyses Cluster analysis was applied to food frequency data to identify non-overlapping male dietary patterns. Analysis of covariance and logistic regression were used to compare nutrient intake, summary nutritional risk scores, and chronic disease risk status at baseline and follow-up by male dietary pattern.

Results Five distinct and comprehensive dietary patterns of Framingham Offspring-Spouse men were identified and ordered according to overall nutritional risk: Transition to Heart Healthy, Higher Starch, Average Male, Lower Variety, and Empty Calories. Nutritional risk was high and varied by dietary pattern; key nutrient contrasts were stable over 8-year follow-up. Chronic disease risk also varied by dietary pattern and specific subgroup differences persisted over 16 years, notably rates of overweight/obesity and smoking.

Conclusions Quantitative cluster analysis applied to food frequency questionnaire data identified five distinct, comprehensive, and stable dietary patterns of adult Framingham Offspring-Spouse cohort men. The close associations between the dietary patterns, nutritional risk, and chronic disease profiles of men emphasize the importance of targeted preventive nutrition interventions to promote health in the male population.
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Nutritious dietary patterns promote the health of the public by contributing to optimal nutritional status and reducing many of the biologic risk factors associated with adult morbidity and mortality, including heart disease, hypertension, certain cancers, obesity, diabetes, and osteoporosis (1,2). Current expert population-based nutrition recommendations emphasize dietary patterns that offer a wide variety of micronutrient-dense foods, limit empty kilocalories, and encourage the consumption of protective dietary factors that lower chronic disease risk (1-8). Despite national health campaigns to encourage healthful eating practices among Americans, there is an epidemic of obesity and diabetes (6) and the diets of many people remain low in micronutrient density and high in total and saturated fat, sugars, and sodium (1-3). A review of the achievements in the National Cholesterol Education Program (9) suggests that future improvements in population health will not be accomplished until nutrition interventions demonstrate effectiveness in promoting long-term healthful dietary behavior. To further these goals, experts have underscored the importance of characterizing unique dietary patterns in the population to more fully evaluate their associations with health and disease outcomes and to examine their roles in promoting optimal food and nutrient intake (10-12).

We previously validated the cluster analysis approach used in application with semi-quantitative dietary assessment methods (food frequency questionnaires [FFQs]) to identify distinct and comprehensive dietary patterns of Framingham men and women (12-14). We have conducted particularly detailed evaluations of the associations between the dietary patterns of women and a variety of health outcomes, including carotid stenosis (a preclinical marker of cardiovascular diseases [CVDs]) (15,16), the development of overweight and obesity (17), and the metabolic syndrome (18,19). In this report, we explore in-depth the dietary patterns of Framingham Offspring-Spouse cohort men, characterizing their associated nutritional risk and stability over 8 years of follow-up. We also examine the persistent chronic disease risk characteristics of Framingham Offspring-Spouse cohort men by dietary pattern through the most recent Framingham study follow-up examinations.

METHODS

Participants

For more than 50 years, the Framingham Heart Study has investigated the natural progression of CVDs and, more recently, other health problems among residents of Framingham, MA (20,21). In 1971, a second-generation cohort was recruited and 5,124 Framingham study offspring and their spouses were invited to participate in the Framingham Offspring-Spouse study (2,483 men and 2,641 women) (22).

Members of the Framingham Offspring-Spouse cohort participate in standardized clinical assessments about every 4 years, including a complete physical exam, laboratory tests, noninvasive diagnostic testing, and updating of medical histories and other pertinent information. At certain examinations, detailed dietary data are collected. The dietary patterns and nutrient intake reported here were collected among Framingham Offspring-Spouse men at exams 3 (1984-1988) and 5 (1992-1996). CVD risk factor profiles were assessed at exams 3 and 7 (1998-2001). The Boston University Medical Center's Human Subjects Institutional Review Board approved all protocols and all participants provided informed consent.

Identifying Dietary Patterns

The dietary patterns of men were characterized using cluster analysis applied to food consumption data derived from the 145-item FFQ (12-14). Some 1,666 men, 91% of those who participated in exam 3, provided complete FFQ dietary data information for these analyses (approximately 1,831 men, aged 18 to 77 years, participated at Framingham Offspring-Spouse exam 3; ie, 74% of the original Framingham Offspring-Spouse cohort male subjects).

Details of the cluster analysis methodology and its application in the Framingham Nutrition Studies have been described previously (12-14). In brief, we classified the 145 FFQ items into 38 groupings of foods that were similar to but more detailed than those found in the American Dietetic Association's Exchange List for Meal Planning (23,24). The groupings were based on similarities in nutrient content (such as vitamin A–rich vegetables and medium-fat meats). In a refinement of this method that focuses on food-related distinctions in the dietary patterns, three alcohol items (beer, wine, and liquor) were excluded in these analyses. Next, the 38 food groups were clustered, based on similarities in their reported frequency of consumption, using the standard statistical method VARCLUS (SAS version 6, 1989; SAS Institute, Inc; Cary, NC). This resulted in 13 food clusters (see footnotes to Table 1) that contained food groups with similar reported frequency of consumption in men (number of daily servings). It is important to note that this procedure clusters foods according to their usual frequency of consumption, not by intake at similar times of day, at the same meal, or in similar serving sizes. For example, relative to other men in this cohort, those who reported a relatively higher consumption of whole grains also consumed the following food groups more frequently: low-fat dairy products, low-fat poultry, low-fat health foods, oils, and soft vegetable fats. In the final step, Ward's clustering method (25) was used to separate men into nonoverlapping groups based on similarities in the frequency of their consumption of the 13 food groupings. Five comprehensive and nonoverlapping dietary patterns of Framingham men emerged from these analyses.

Estimating Nutrient Intake

In addition to defining habitual dietary patterns, we established independent estimates of nutrient intake from 3-day dietary records collected at baseline and 8 years of follow-up using our validated, published methodology (26,27). Nutrient calculations were performed using the Minnesota Nutrition Data System software (version 2.6, 1988, Food Database 6A and Nutrient Database 23, Nutrition Coordinating Center, University of Minnesota, Minneapolis) (28).

We also computed each subject's overall nutritional risk by ranking his intake of each nutrient or dietary component in comparison with other men and then determining the person's mean ranking on the 19 nutrients that were examined in this report. We previously published this approach as part of the validation of the dietary clustering method (14). For risk-related dietary factors (total and saturated fat, cholesterol, and sodium) and for energy, protein, and monounsaturated fats, men's intakes were ranked from

Table 1. Mean daily food group consumption (number of daily servings) of Framingham Offspring-Spouse study men (N=1,666)[a]

Food group[b]	Dietary Pattern Group: Transition to heart healthy (n=341)	Higher starch (n=183)	Average male (n=216)	Lower variety (n=503)	Empty calorie (n=423)
	←		*mean (95% CI[c])*		→
Vegetables	**3.54 (3.37, 3.71)**[w]	2.68 (2.49, 2.87)[yz]	2.39 (2.24, 2.55)[yz]	*2.12 (2.03, 2.20)*[x]	2.40 (2.29, 2.51)[y]
Refined grains and desserts	*3.82 (3.60, 4.03)*[w]	5.90 (5.42, 6.38)[xy]	4.20 (3.85, 4.55)[w]	3.87 (3.66, 4.08)[w]	**6.15 (5.85, 6.46)**[x]
Fruits	**2.81 (2.60, 3.02)**[w]	1.76 (1.56, 1.96)[xy]	1.76 (1.60, 1.92)[x]	*1.64 (1.54, 1.73)*[x]	1.70 (1.57, 1.83)[x]
High-fat animal proteins	1.61 (1.51, 1.71)[w]	1.68 (1.55, 1.81)[w]	1.58 (1.46, 1.71)[w]	*1.36 (1.30, 1.42)*[x]	**2.25 (2.11, 2.38)**[y]
Shellfish and vegetarian foods	**0.16 (0.14, 0.17)**[w]	0.08 (0.07, 0.09)[xy]	0.09 (0.08, 0.10)[y]	*0.07 (0.06, 0.07)*[x]	0.08 (0.08, 0.09)[xy]
Whole grains, oils, and lower-fat foods	**4.17 (3.90, 4.44)**[w]	2.89 (2.61, 3.18)[y]	2.53 (2.30, 2.77)[y]	*2.01 (1.89, 2.13)*[x]	2.22 (2.06, 2.38)[xy]
Leaner proteins and diet beverages with caffeine	2.96 (2.80, 3.12)[w]	**3.53 (3.32, 3.75)**[z]	*2.62 (2.38, 2.85)*[wxy]	2.65 (2.52, 2.79)[x]	2.85 (2.71, 2.99)[wx]
Sweets and salty snacks	1.23 (1.11, 1.36)[w]	1.33 (1.16, 1.49)[w]	1.13 (0.97, 1.28)[w]	*0.96 (0.89, 1.03)*[x]	**2.02 (1.87, 2.17)**[y]
Organ meats, fish, and soups	**0.65 (0.61, 0.69)**[w]	0.40 (0.36, 0.44)[y]	0.40 (0.36, 0.43)[y]	*0.32 (0.30, 0.34)*[x]	0.34 (0.32, 0.37)[xy]
Whole milk, eggs, and animal fats	1.19 (1.05, 1.33)[w]	1.57 (1.38, 1.75)[y]	1.21 (1.05, 1.37)[wy]	*0.78 (0.72, 0.85)*[x]	**2.72 (2.53, 2.91)**[z]
Low-fat milk	0.70 (0.61, 0.80)[w]	0.48 (0.37, 0.59)[wx]	0.67 (0.56, 0.78)[w]	**0.85 (0.74, 0.95)**[w]	*0.38 (0.32, 0.44)*[x]
Diet and decaffeinated beverages	0.46 (0.38, 0.53)[w]	0.38 (0.27, 0.49)[wx]	**3.28 (3.13, 3.43)**[y]	*0.25 (0.21, 0.28)*[x]	0.27 (0.22, 0.33)[x]
Firm vegetable fats	0.45 (0.39, 0.52)[wx]	**2.92 (2.76, 3.07)**[z]	0.75 (0.62, 0.87)[y]	*0.40 (0.36, 0.44)*[w]	0.53 (0.45, 0.60)[w]

[a]The sample includes men who completed the food frequency questionnaire for cluster analysis from which food groups were derived.

[b]The components of each food group, except for those groups that are clearly identified by the label, are: vegetables: vitamin A-rich vegetables, vitamin C-rich vegetables, high-fiber vegetables, other vegetables. Refined grains and desserts: refined grains, high-fat desserts, lower-fat desserts, lower-fat sweets. Fruits: vitamin C-rich fruits, higher-fiber fruits, other fruits. High-fat animal proteins: high-fat dairy products, high-fat meats, mixed protein dishes. Shellfish and vegetarian foods: shellfish, legumes, high-fat health foods. Whole grains, oils, and lower-fat foods: whole grains, low-fat dairy products, low-fat poultry, oils, and soft vegetable fats, low-fat health foods. Leaner proteins and diet beverages: low-fat meats, high-fat poultry, energy-free caffeinated beverages. Sweets and salty snacks: high-fat sweets, sweetened caffeinated beverages, sweetened decaffeinated beverages, salty snacks. Whole milk, eggs, and animal fats: high-fat dairy beverages, eggs, animal fats. Low-fat milk: low-fat dairy beverages, nonfat (dairy) beverages.

[c]CI=confidence interval.

[wxyz]Means with differing superscripts are significantly different from each other ($P<.05$); means in bold are the highest; means in italics are the lowest.

lowest to highest (indicating rising levels of risk associated with higher ranks). For polyunsaturated fat, protective dietary components (dietary fiber, starch, and carbohydrate), or essential nutrients, men's intakes were ranked highest to lowest (indicating rising risk associated with lower intakes). Age-adjusted mean summary nutritional risk ranks were computed for the men in each dietary pattern group. Summary nutritional risk scores do not reflect absolute nutritional risk (as would comparison with an expert standard like the National Cholesterol Education Program (4,5), but rather they provide an assessment of relative nutritional risk (such as lower intakes of protective dietary components and higher levels of risk-related nutrients).

CVD Risk Factor Measurements

CVD risk factors are routinely measured at all Framingham exams (29) according to extensively published and validated methods (29-33) and were interpreted according to Framingham protocols, and using existing expert standards (4,6,7,34,35).

Analysis

Once the men's five dietary patterns were identified, the primary research aim was to examine associations between these dietary patterns and levels of nutrient intake, overall nutritional risk, and CVD risk profiles over follow-up. The age-adjusted mean levels of macro- and micronutrients and other dietary components as well as CVD risk factor characteristics were computed for each cluster of men at each time point. Analysis of covariance was used for calculating the least square means of continuous variables using the SAS procedure PROC GLM (36). For categorical variables, age-adjusted proportions were computed using logistic regression (PROC LOGISTIC) (36). From the logistic regression, we used the −2 log-likelihood to test the overall difference among the five dietary patterns groups. If the difference was significant overall ($P<.05$) or approached significance ($.05<P<.10$), we compared each group with the referent group (the group with either lowest or highest prevalence rate), adjusting for overall Type 1 error (37). We evaluated the stability of the dietary patterns by comparing the composite nutritional risk rank score of each male subject at baseline and 8 years of follow-up using the Spearman Rank correlation statistic (36,38).

RESULTS

We identified five nonoverlapping subgroups of men in the Framingham population, each of which had distinctive dietary patterns. Table 1 summarizes the age-adjusted mean daily intakes of the 13 clustered food groups by dietary pattern subgroup. We descriptively labeled each subgroup of men to reflect the unique features of their dietary pattern: Transition to Heart Healthy, Higher Starch, Average Male, Lower Variety, and Empty Calories. We note that men with the Transition to Heart Healthy dietary pattern had somewhat more favorable food and nutrient intakes overall (Tables 1, 2, and 3), although all dietary patterns of Framingham men were associated with relatively high nutritional risk.

The Transition to Heart Healthy group (n=341; 20.5% of the sample) consumed higher levels of vegetables, fruits, shellfish, vegetarian foods, whole grains, oils, lower-fat foods, organ meats, fish, and soups; their dietary pattern also contained lower levels of refined grains and desserts (Table 1). The Higher Starch dietary pattern (n=183; 11% of the sample) was characterized by higher intakes of leaner protein foods; caffeinated, low-energy beverages; firm vegetable fats; and comparatively higher levels of refined grains and desserts. The Average Male dietary pattern (n=216; 13% of the sample) was higher in unsweetened beverages (with and without caffeine), lower in leaner protein foods (including dairy products), and otherwise relatively moderate in terms of other food groups. Men with the Lower Variety dietary pattern (n=503; 30.2% of the sample) consumed the lowest level of most food groups, including high-fat animal proteins, whole milk, animal and vegetable fats, and sweets but also fruits, vegetables, whole grains, and oils. Men in the Empty Calorie group (n=423; 25.4% of the sample) consumed the highest levels of refined grains, desserts, high-fat animal proteins (including meats and mixed-protein dishes), whole milk, eggs, animal fats, sweets, and salty snacks and the lowest levels of low- and nonfat dairy products.

The age-adjusted mean macro- and micronutrient intakes and summary nutritional risk scores of the male dietary pattern subgroups at baseline and follow-up are contrasted in Tables 2 and 3; the nutritional risk scores at baseline and follow-up are compared in the Figure. The expert dietary guidelines (1-5,7,8), Recommended Dietary Allowances (39), and Dietary Reference Intake standards (40) (as appropriate) for each of the 19 nutritional components we studied are noted in Tables 2 and 3. Overall, the dietary patterns of men were associated with higher mean levels of total and saturated fat and lower intakes of carbohydrates and fiber than recommended by experts (1-8). Mean intakes of most micronutrients appeared adequate in all dietary pattern groups, although intakes of calcium, folate, and beta carotene were generally low relative to current nutritional guidelines (39-41). Nutrient intakes improved somewhat in all subgroups during 8 years of follow-up although energy intakes rose. Nonetheless, contrasting differences between dietary patterns were stable over time ($P<.05$); notably, intakes of saturated fat, sucrose, dietary fiber, starch, vitamin C, and selenium. Considering the summary nutritional risk scores, men with Average Male, Lower Variety, and Empty Calorie dietary patterns exceeded those in the Transition to Heart Healthy subgroup at baseline and follow-up ($P<.05$). The Spearman Rank correlation (Rho [P]=0.44; 95% confidence interval, 0.38 to 0.50) indicated a satisfactory level of agreement between the baseline and 8-year follow-up nutritional risk score of men and provided evidence that the nutrient contrasts among the dietary pattern subgroups remain reasonably stable over time.

The age-adjusted mean chronic disease risk factor profile of Framingham men at baseline and 16 years of follow-up are presented in Tables 4 and 5. Consistent with high nutritional risk in all Framingham men, chronic disease risk factor levels were high in all male dietary pattern subgroups at baseline and follow-up. Mean blood pressure and lipid levels generally exceeded expert guidelines and, consistent with higher energy intake levels at follow-up, overweight/obesity affected 67% to 81% of men at baseline and

Table 2. Age-adjusted mean nutrient intake of Framingham Offspring-Spouse study men, 1984-1988 (n=740)[a]

	Dietary Pattern Group				
Nutrient[b]	**Transition to heart healthy (n=154)**	**Higher starch (n=80)**	**Average male (n=102)**	**Lower variety (n=229)**	**Empty calorie (n=175)**
Selected macronutrients	←		*mean (95% CI[c])*		→
Energy (kcal)	2,155 (2,061, 2,248)[vwxy]	2,288 (2,158, 2,418)[vwy]	2,069 (1,954, 2,185)[w]	*2,020 (1,943, 2,096)*[wx]	**2,309 (2,221, 2,397)**[v]
Protein (%)	16.9 (16.3, 17.4)	*16.0 (15.2, 16.7)*	**17.1 (16.4, 17.8)**	16.8 (16.4, 17.3)	16.3 (15.8, 16.8)
Monounsaturated fat (%)	*13.1 (12.7, 13.6)*	**13.9 (13.2, 14.5)**	13.8 (13.2, 14.3)	13.2 (12.8, 13.6)	13.7 (13.3, 14.2)
Polyunsaturated fat (%)	**7.7 (7.3, 8.1)**[w]	7.2 (6.6, 7.8)[vw]	7.6 (7.1, 8.1)[vw]	*6.9 (6.6, 7.3)*[v]	7.0 (6.6, 7.4)[vw]
Risk nutrients					
Total fat (%)	*35.2 (34.1, 36.3)*[vw]	36.5 (34.9, 38.0)[vw]	36.8 (35.5, 38.2)[vw]	35.2 (34.3, 36.1)[w]	**37.1 (36.0, 38.1)**[v]
Saturated fat (%)	*11.6 (11.1, 12.1)*[wx]	12.5 (11.8, 13.2)[vwx]	12.5 (11.9, 13.1)[vwx]	12.2 (11.8, 12.6)[wx]	**13.4 (13.0, 13.9)**[v]
Alcohol (%)	**6.0 (5.0, 7.0)**	5.2 (3.7, 6.7)	5.0 (3.7, 6.4)	5.8 (4.9, 6.7)	*4.2 (3.2, 5.2)*
Sucrose (g)	*35.5 (31.2, 39.8)*[x]	49.5 (43.6, 55.5)[wx]	39.4 (34.2, 44.7)[vw]	42.1 (38.5, 45.6)[vw]	**50.8 (46.8, 54.9)**[x]
Cholesterol (mg/1,000 kcal)	*286.2 (263.6, 308.8)*[x]	305.2 (273.8, 336.5)[vwy]	309.3 (281.5, 337.1)[vwx]	292.1 (273.7, 310.6)[wx]	**337.7 (316.5, 358.9)**[v]
Sodium (mg/1,000 kcal)	3,334 (3,148, 3,520)[vwx]	**3,610 (3,352, 3,869)**[vx]	3,297 (3,068, 3,527)[vwx]	*3,148 (2,996, 3,300)*[w]	3,600 (3,425, 3,775)[v]
Protective nutrients					
Dietary fiber (g/1,000 kcal)	**18.8 (17.7, 19.9)**[v]	17.8 (16.3, 19.2)[vz]	16.5 (15.1, 17.8)[wxyz]	*14.9 (14.1, 15.8)*[wxy]	16.7 (15.7, 17.7)[xyz]
Starch (g)	104.9 (99.4, 110.4)[v]	**112.9 (105.3, 120.6)**[v]	97.7 (90.9, 104.5)[xy]	*93.8 (89.3, 98.4)*[x]	105.9 (100.7, 111.1)[v]
Calcium (mg/1,000 kcal)	740.7 (686.0, 795.3)[v]	759.5 (683.5, 835.5)[vw]	*731.4 (664.0, 798.9)*[vx]	742.2 (697.4, 787.0)[v]	**849.4 (798.0, 900.8)**[w]
Selenium (μg/1,000 kcal)	**140.6 (134.0, 147.2)**[v]	136.0 (126.9, 145.1)[vw]	129.5 (121.4, 137.6)[vw]	*125.8 (120.4, 131.1)*[w]	133.5 (127.4, 139.7)[vw]
Vitamin C (g/1,000 kcal)	**127.5 (115.7, 139.3)**[v]	103.1 (86.7, 119.5)[vw]	*102.7 (88.1, 117.2)*[vw]	106.5 (96.8, 116.1)[vw]	104.4 (93.3, 115.4)[w]
Vitamin B-6 (g/1,000 kcal)	**2.1 (1.9, 2.2)**	2.0 (1.8, 2.1)	1.9 (1.7, 2.1)	*1.8 (1.7, 2.0)*	2.0 (1.9, 2.1)
Vitamin B-12 (μg/1,000 kcal)	9.1 (6.8, 11.4)	*7.7 (4.6, 10.9)*	8.4 (5.6, 11.2)	8.6 (6.7, 10.5)	**9.8 (7.6, 11.9)**
Folate (μg/1,000 kcal)	**309.7 (286.4, 333.0)**	282.8 (250.4, 315.2)	*274.5 (245.7, 303.2)*	278.9 (259.8, 297.9)	289.1 (267.2, 311.0)
Vitamin E (g/1,000 kcal)	**11.2 (10.3, 12.2)**[v]	10.1 (8.8, 11.4)[vw]	10.1 (9.0, 11.3)[vw]	*9.3 (8.5, 10.1)*[w]	10.8 (9.9, 11.6)[vw]
Beta-carotene (μg/1,000 kcal)	3,771 (3,216, 4,327)	**3,801 (3,029, 4,574)**	3,389 (2,704, 4,075)	3,360 (2,904, 3,815)	*3,200 (2,677, 3,722)*
Carbohydrate (%)	43.5 (42.1, 44.9)	43.6 (41.6, 45.5)	*42.4 (40.6, 44.1)*	43.4 (42.2, 44.6)	**43.7 (42.4, 45.0)**
Nutritional risk rank[d]	*350 (338, 362)*[vx]	370 (353, 387)[wx]	375 (360, 390)[w]	377 (367, 387)[w]	**377 (366, 389)**[w]

[a]The sample is restricted to men who attended exams 3 and 5 and had complete nutrient intake data at both exams.

[b]Recommended intake levels for adult men are specified as follows, according to expert panels (3,4,39-41): protein, approximately 15% of kcal; carbohydrate 50% to 60% of kcal; total fat 25% to 35% of kcal; saturated fat <7% of kcal; polyunsaturated fat up to 10% of kcal; monounsaturated fat up to 20% of kcal; cholesterol <200 mg/d; dietary fiber 20 to 30 g/d; sodium <2,400 mg/d; calcium 1,200 mg/d; selenium 55 μg/d; vitamin C 90 mg/d; vitamin B-6 1.7 mg/d; vitamin B-12 2.4 μg/d; folate 400 μg/d.

[c]CI=confidence interval.

[d]Overall nutrient risk score based on the consumption of 19 nutrients by members of one dietary subgroup. Obtained by ranking the nutrient intake levels for each person in the cohort; a lower rank for a desirable intake level (eg, lower fat or higher vitamin/mineral intake) and a higher rank for a less desirable intake level (eg, higher fat or lower micronutrient intake). The overall mean rank of the dietary pattern group was then computed from the sum of the mean ranks of the 19 nutrients for each man in that subgroup. Nutrients that were considered include energy, protein, total fat, monounsaturated fat, polyunsaturated fat, saturated fat, alcohol, cholesterol, sodium, carbohydrate, fiber, calcium, selenium, vitamin C, vitamin B-6, vitamin B-12, folate, vitamin E, and beta carotene.

[vwxyz]Means with differing superscripts are significantly different from each other ($P<.05$); means in bold are the highest; means in italics are the lowest.

Table 3. Age-adjusted mean nutrient intake of Framingham Offspring-Spouse study men, 1992-1996 (n=740)[a]

Nutrient[b]	Dietary Pattern Group: Transition to heart healthy (n=154)	Higher starch (n=80)	Average male (n=102)	Lower variety (n=229)	Empty calorie (n=175)
	←———	———	*mean (95% CI[c])*	———	———→
Selected macronutrients					
Energy (kcal)	2,251 (2,153, 2,350)	**2,374 (2,237, 2,512)**	*2,137 (2,015, 2,259)*	2,143 (2,062, 2,224)	2,255 (2,162, 2,348)
Protein (%)	17.4 (16.8, 18.0)^{y}	*16.0 (15.2, 16.8)*^{xz}	16.9 (16.2, 17.6)^{xyz}	**17.4 (17.0, 17.9)**^{yz}	16.2 (15.7, 16.8)^{x}
Monounsaturated fat (%)	12.2 (11.7, 12.7)	*12.2 (11.6, 12.9)*	12.4 (11.8, 13.0)	12.2 (11.8, 12.6)	**12.7 (12.3, 13.2)**
Polyunsaturated fat (%)	6.8 (6.4, 7.1)	*6.4 (5.9, 6.9)*	**6.9 (6.5, 7.3)**	6.6 (6.3, 6.9)	6.7 (6.4, 7.0)
Risk nutrients					
Total fat (%)	32.1 (31.0, 33.2)	*32.0 (30.4, 33.6)*	32.9 (31.5, 34.3)	32.3 (31.4, 33.3)	**33.9 (32.9, 35.0)**
Saturated fat (%)	*10.5 (10.0, 11.0)*^{y}	10.7 (10.0, 11.5)^{y}	11.0 (10.3, 11.6)^{xy}	10.8 (10.4, 11.2)^{y}	**11.8 (11.3, 12.3)**^{x}
Alcohol (%)	4.1 (3.2, 4.9)	**4.2 (3.0, 5.4)**	3.7 (2.6, 4.7)	4.1 (3.4, 4.8)	*2.7 (1.9, 3.5)*
Sucrose (g)	45.0 (40.5, 49.5)^{x}	52.4 (46.1, 58.7)^{xy}	*44.3 (38.7, 49.8)*^{x}	44.6 (40.9, 48.3)^{x}	**54.0 (49.7, 58.2)**^{y}
Cholesterol (mg/1,000 kcal)	278.9 (257.9, 299.9)	**295.5 (266.2, 324.7)**	*268.7 (242.8, 294.6)*	276.3 (259.1, 293.5)	288.5 (268.7, 308.2)
Sodium (mg/1,000 kcal)	3,459 (3,267, 3,652)	**3,854 (3,587, 4,122)**	3,551 (3,314, 3,788)	*3,440 (3,283, 3,598)*	3,581 (3,400, 3,761)
Protective nutrients					
Dietary fiber (g/1,000 kcal)	**22.5 (21.2, 23.9)**^{x}	20.7 (18.9, 22.6)^{xyz}	19.1 (17.4, 20.7)^{xz}	17.9 (16.8, 19.0)^{xy}	*17.7 (16.5, 19.0)*^{x}
Starch (g)	123.6 (117.0, 130.2)^{xy}	**131.9 (122.8, 141.0)**^{x}	118.1 (110.0, 126.2)^{xy}	*114.0 (108.6, 119.3)*^{y}	119.6 (113.4, 125.8)^{xy}
Calcium (mg/1,000 kcal)	822.0 (764.2, 879.8)	**885.7 (805.3, 966.0)**	*803.5 (732.3, 874.8)*	817.0 (769.6, 864.3)	841.2 (786.9, 895.6)
Selenium (μg/1,000 kcal)	**147.4 (140.3, 154.4)**^{x}	140.3 (130.5, 150.1)^{xy}	*131.2 (122.5, 139.9)*^{y}	136.2 (130.4, 142.0)^{xy}	135.3 (128.6, 141.9)^{xy}
Vitamin C (g/1,000 kcal)	**138.7 (126.3, 151.1)**^{x}	131.1 (113.9, 148.4)^{y}	114.1 (98.7, 129.4)^{xy}	*113.0 (102.8, 123.2)*^{y}	113.6 (102.0, 125.3)^{y}
Vitamin B-6 (g/1,000 kcal)	**2.4 (2.2, 2.5)**	*2.2 (1.9, 2.4)*	2.3 (2.1, 2.5)	2.2 (2.0, 2.3)	2.2 (2.1, 2.3)
Vitamin B-12 (μg/1,000 kcal)	7.6 (6.1, 9.1)	6.9 (4.8, 9.0)	**7.7 (5.9, 9.6)**	*6.5 (5.3, 7.8)*	7.4 (6.0, 8.9)
Folate (μg/1,000 kcal)	**357.5 (330.4, 384.6)**^{x}	324.7 (287.0, 362.3)^{xy}	352.6 (319.2, 386.0)^{xy}	*306.6 (284.5, 328.8)*^{y}	326.5 (301.1, 351.0)^{xy}
Vitamin E (g/1,000 kcal)	11.3 (10.3, 12.4)	10.6 (9.1, 12.0)	**11.8 (10.5, 13.0)**	*10.2 (9.3, 11.0)*	11.1 (10.1, 12.1)
Beta-carotene (μg/1,000 kcal)	**5,226 (4,607, 5,845)**^{x}	4330 (3,470, 5,191)^{xy}	3,971 (3,208, 4,734)^{xy}	*3,301 (2,794, 3,808)*^{y}	3,492 (2,910, 4,074)^{y}
Carbohydrate (%)	48.2 (46.8, 49.6)	**49.3 (47.3, 51.2)**	48.0 (46.2, 49.7)	*47.6 (46.4, 48.7)*	48.6 (47.2, 49.9)
Nutritional risk rank[d]	*352 (339, 364)*^{x}	360 (344, 377)^{xz}	373 (358, 388)^{yz}	378 (368, 389)^{yz}	**380 (369, 391)**^{y}

[a]The sample is restricted to men who attended exams 3 and 5 and had complete nutrient intake data at both exams.

[b]Recommended intake levels for adult men are specified as follows, according to expert panels (3,4,39-41): protein approximately 15% of kcal; carbohydrate 50% to 60% of kcal; total fat 25% to 35% of kcal; saturated fat <7% of kcal; polyunsaturated fat up to 10% of kcal; monounsaturated fat up to 20% of kcal; cholesterol <200 mg/d; dietary fiber 20 to 30 g/d; sodium <2,400 mg/d; calcium 1,200 mg/d; selenium 55 μg/d; vitamin C 90 mg/d; vitamin B-6 1.7 mg/d; vitamin B-12 2.4 μg/d; folate 400 μg/d.

[c]CI=confidence interval.

[d]Overall nutrient risk score based on the consumption of 19 nutrients by members of one dietary subgroup. Obtained by ranking the nutrient intake levels for each person in the cohort; a lower rank for a desirable intake level (eg, lower fat or higher vitamin/mineral intake) and a higher rank for a less desirable intake level (eg, higher fat or lower micronutrient intake). The overall mean rank of the dietary pattern group was then computed from the sum of the mean ranks of the 19 nutrients for each man in that subgroup. Nutrients that were considered include energy, protein, total fat, monounsaturated fat, polyunsaturated fat, saturated fat, alcohol, cholesterol, sodium, carbohydrate, fiber, calcium, selenium, vitamin C, vitamin B-6, vitamin B-12, folate, vitamin E, and beta carotene.

^{xyz}Means with differing superscripts are significantly different from each other ($P<.05$); means in bold are the highest; means in italics are the lowest.

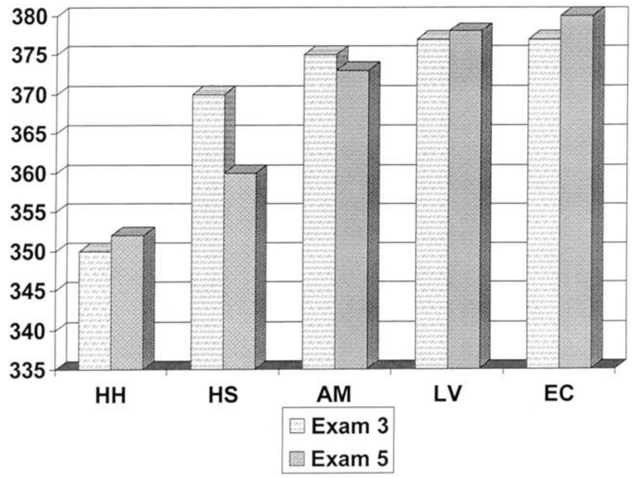

Figure. Comparison of Framingham Offspring-Spouse study men's overall nutrient risk scores, by dietary pattern subgroup, at exam 3 and at exam 5 (Rho [P]=0.44; 95% confidence interval 0.38 to 0.50). HH=Transition to Heart Healthy. HS=Higher Starch. AM=Average Male. LV=Lower Variety. EC=Empty Calorie.

76% to 91% at follow-up. Men in the Transition to Heart Healthy subgroup had lower total and low-density lipoprotein cholesterol levels, rates of overweight, and smoking than most other groups, but their mean glucose levels and diabetes rates were somewhat higher. During 16 years of follow-up, only smoking rates improved in all male dietary pattern subgroups; treatment rates for blood pressure and lipids were considerably higher and diabetes rates more than doubled. The contrasting differences in smoking rates, body mass index, and rates of overweight and obesity persisted over time among the male dietary pattern subgroups.

DISCUSSION

We identified five distinct and nonoverlapping dietary patterns in Framingham men, each of which was associated with differing and persistent nutritional and chronic disease risk profiles over long-term follow-up. These habitual dietary patterns of men were comprehensive (as reflected in a diverse array of foods, not a single marker food), and appeared to be stable over time. None of the male dietary patterns could be considered ideal from a nutritional or health risk perspective. Although the Transition to Heart Healthy dietary pattern was associated with somewhat more favorable food and nutrient intakes and chronic disease risk profiles, even this pattern (like all others) deviated substantially from expert nutritional guidelines at baseline and follow-up. Consistent with the high levels of nutritional risk in Framingham Offspring-Spouse cohort men, many of their chronic disease risk characteristics worsened over time. Rates of hypertension and lipid treatment, overweight and obesity, and diabetes rose dramatically over follow-up. Contrasts between the dietary pattern subgroups in smoking rates, body mass index, overweight, and obesity persisted over 16 years and new differences in lipid treatment emerged. None of the dietary patterns previously identified in Framingham women (42) is ideal, either; they differ significantly from each other in terms of food and nutrient intake, risk factor profile, overall nutritional risk score, and predicted risk of developing disease. Compared with men, however, nutritional and biological risk of women is relatively lower. Our prior research in Framingham women indicates that dietary patterns predict the development of overweight in lean women and are associated with the development of carotid stenosis and the metabolic syndrome. Given the higher nutritional risk that appears in the subgroups of men reported here, our future research is likely to find comparably higher rates of development of carotid stenosis, overweight, and the metabolic syndrome.

The close associations between male dietary patterns, nutritional risk, and chronic disease profiles suggest the importance of targeted preventive nutrition interventions to promote health in adult men. The comprehensive nature of the identified male dietary patterns offers distinct, potential foci for preventive nutrition education and counseling.

The importance of targeting the specific components of habitual male dietary patterns in nutritional interventions and health promotion campaigns is consistent with expert reports (1,2,9-11,41), which stress, in part, that dietary patterns and food-based approaches to dietary behavior change are likely to enhance the long-term effectiveness of preventive nutrition interventions. A dietary pattern strategy is also consistent with expert recommendations that acknowledge the importance of recognizing distinct consumer needs, preferences, and characteristics (indeed, the characteristics of discrete population subgroups) when designing health messages and behavioral interventions (41,43).

The dietary patterns reported here suggest specific targets for focused nutrition interventions. For example, the favorable consumption of vegetables and fruits, legumes, whole grains, and low-fat foods in men with the Transition to Heart Healthy pattern might warrant emphasis in health education and counseling. Nonetheless, the relatively high saturated fat intake associated with this pattern (albeit more favorable than other groups of men) also needs attention. Recommendations could focus on methods for reducing fat in these men's preferred food choices (lowering the frequency of consuming animal proteins and high-fat dairy products) while sustaining their relatively high intakes of micronutrient-dense foods.

The close associations between male dietary patterns, nutritional risk, and chronic disease profiles suggest the importance of targeted preventive nutrition interventions to promote health in adult men.

Recommendations for the Higher Starch dietary pattern could focus on retaining higher carbohydrate intakes but replacing refined grains with whole grain alternatives. Furthermore, dessert recipes could be modified to reduce fats and sugars, leaner poultry choices might be

Table 4. Mean age and age-adjusted cardiovascular risk factor levels of Framingham Offspring-Spouse study men, 1984-1988 (n=1,319)[a]

Risk factor[b]	All men (n=1,319)	Transition to heart healthy (n=274)	Higher starch (n=143)	Average male (n=178)	Lower variety (n=398)	Empty calorie (n=326)
		← *mean (95% CI[c])*				→
Age (y)	47.6	47.2	48.6	50.0	47.8	45.7
Systolic blood pressure (mm Hg)	124.8	**125.7 (124.0, 127.3)**	*124.1 (121.9, 126.4)*	124.9 (122.9, 126.9)	124.1 (122.8, 125.4)	125.3 (123.8, 126.8)
Diastolic blood pressure (mm Hg)	80.9	81.2 (80.1, 82.2)	81.0 (79.6, 82.4)	**81.8 (80.5, 83.1)**	*80.6 (79.7, 81.4)*	80.7 (79.7, 81.6)
Hypertension treatment (%)	13.2	14.0	12.8	**14.8**	**14.8**	*9.9*
Total cholesterol (mmol/L)[d]	5.50	*5.36 (5.2, 5.5)*[x]	5.41 (5.3, 5.6)[x]	**5.62 (5.5, 5.8)**[y]	5.48 (5.4, 5.6)[x]	5.44 (5.3, 5.5)[x]
High-density lipoprotein cholesterol (mmol/L)	1.20	1.16 (1.1, 1.2)	1.16 (1.1, 1.2)	*1.14 (1.1, 1.2)*	**1.17 (1.1, 1.2)**	1.16 (1.1, 1.2)
Low-density lipoprotein cholesterol (mmol/L)	3.60	*3.5 (3.4, 3.6)*[x]	3.6 (3.4, 3.7)[x]	**3.8 (3.6, 3.9)**[y]	3.6 (3.5, 3.7)[x]	3.6 (3.5, 3.7)[x]
Triglyceride (mmol/L)[e]	1.56	1.50 (1.4, 1.6)	*1.48 (1.3, 1.7)*	**1.59 (1.4, 1.8)**	1.57 (1.5, 1.7)	1.58 (1.4, 1.7)
Lipid treatment (%)	1.3	**1.6**	*0*	1.3	1.0	1.1
Body mass index (BMI)	27.1	27.1 (26.6, 27.5)[xz]	27.0 (26.4, 27.6)[xz]	**27.9 (27.4, 28.4)**[y]	27.2 (26.9, 27.6)[x]	*26.7 (26.3, 27.1)*[z]
Overweight (%)	53.2	*51.0*	56.5	**57.7**	52.6	51.8
Obese (%)	18.8	19.2	16.9	**23.0**	20.3	*15.0*
Overweight or obese (%)	72.0	70.4[x]	73.6[xy]	**81.2**[y]	73.1[x]	*67.2*[x]
Glucose (mmol/L)[f]	5.30	**5.38 (5.3, 5.5)**	*5.15 (5.0, 5.3)*	5.31 (5.2, 5.5)	5.33 (5.2, 5.4)	5.21 (5.1, 5.3)
Diabetes (%)	5.1	**6.6**[xz]	*1.0*[y]	4.4[xz]	4.5[x]	2.4[yz]
Smoking (%)	25.3	*16.1*[x]	28.2[xz]	25.4[xz]	22.5[y]	**33.0**[z]
Physical activity index	28.5	28.8 (28.0, 29.6)[xz]	29.0 (26.8, 29.0)[yz]	*28.1 (27.1, 29.2)*[yz]	28.0 (27.3, 28.6)[yz]	**29.6 (28.8, 30.3)**[x]
Framingham coronary heart disease risk score	5.0	*4.43 (4.1, 4.7)*[x]	4.62 (4.2, 5.0)[x]	**5.20 (4.8, 5.6)**[y]	4.64 (4.4, 4.9)[x]	4.87 (4.6, 5.1)[x]

[a]The sample is restricted to men who attended exams 3 and 7 and had complete risk factor data at both exams.

[b]Hypertension treatment is defined as use of antihypertensive medication and elevated blood pressure: systolic blood pressure >120 mm Hg, diastolic blood pressure 80 mm Hg (7). Lipid treatment is defined as use of any anticholesterol medication and elevated lipids: total cholesterol >5.2 mmol/L, low-density lipoprotein-cholesterol >2.6 mmol/L, high-density lipoprotein cholesterol <1.0 mmol/L, and triglyceride >1.7 mmol/L (4). Overweight is defined as BMI 25 to 29.9; obesity is defined as BMI ≥30; overweight or obese is defined as BMI >25 (6). Diabetes is defined as fasting blood glucose level of ≥7 mmol/L (34). Physical activity index scores range from 24 (total bed rest) to 120 (33). Coronary heart disease risk score is the 10-year risk of developing coronary heart disease: the risk factors considered are age (≥45 y for men), hypertension (systolic blood pressure ≥140 mm Hg, diastolic blood pressure ≥90 mm Hg, or use of antihypertensive medication), smoking, diabetes, elevated cholesterol (total cholesterol >240 mg/dL or low-density lipoprotein cholesterol 6.24 mmol/L), and high-density lipoprotein cholesterol <0.9 mmol/L. One point was given for each risk factor, for a possible score of 0 to 7 points (35).

[c]CI=confidence interval.

[d]To convert mmol/L cholesterol to mg/dL, multiply mmol/L by 38.6. To convert mg/dL cholesterol to mmol/L, multiply mg/dL by 0.026. Cholesterol of 5.00 mmol/L=193 mg/dL.

[e]To convert mmol/L triglyceride to mg/dL, multiply mmol/L by 88.6. To convert mg/dL triglyceride to mmol/L, multiply mg/dL by 0.0113. Triglyceride of 1.80 mmol/L=159 mg/dL.

[f]To convert mmol/L glucose to mg/dL, multiply mmol/L by 18.0. To convert mg/dL glucose to mmol/L, multiply mg/dL by 0.0555. Glucose of 6.0 mmol/L=108 mg/dL.

[xyz]Means with differing superscript letters are significantly different from each other ($P<.05$); means in bold are the highest; means in italics are the lowest.

Table 5. Mean age and age-adjusted cardiovascular risk factor levels of Framingham Offspring-Spouse men, 1998-2001 (n=1,319)[a]

Risk factor[b]	All men (n=1,319)	Transition to heart healthy (n=274)	Higher starch (n=143)	Average male (n=178)	Lower variety (n=398)	Empty calorie (n=326)
		←		*mean (95% CI[c])*		→
Age (y)	61.7	61.4	62.6	64.0	62.1	59.8
Systolic blood pressure (mm Hg)	128.3	129.1 (127.1, 131.1)	128.7 (126.0, 131.5)	**129.7 (127.2, 132.2)**	128.6 (126.9, 130.2)	*126.2 (124.4, 128.0)*
Diastolic blood pressure (mm Hg)	75.5	75.2 (74.1, 76.3)	76.1 (74.5, 77.6)	**76.6 (75.2, 78.0)**	76.1 (75.1, 77.0)	*74.1 (73.1, 75.2)*
Hypertension treatment (%)	37.2	36.5	34.4	**42.2**	*34.3*	35.6
Total cholesterol (mmol/L)[d]	5.00	4.93 (4.8, 5.0)	5.01 (4.9, 5.2)	**5.07 (4.9, 5.2)**	4.96 (4.9, 5.1)	*4.93 (4.8, 5.0)*
High-density lipoprotein cholesterol (mmol/L)	1.20	**1.20 (1.1, 1.2)**	1.18 (1.1, 1.2)	*1.15 (1.1, 1.2)*	1.17 (1.1, 1.2)	1.18 (1.1, 1.2)
Low-density lipoprotein cholesterol (mmol/L)	3.10	*3.02 (2.9, 3.1)*	**3.13 (3.0, 3.3)**	3.11 (3.0, 3.2)	3.05 (3.0, 3.1)	3.03 (2.9, 3.1)
Triglyceride (mmol/L)[e]	1.60	1.63 (1.5, 1.8)	*1.51 (1.3, 1.7)*	**1.76 (1.6, 1.9)**	1.63 (1.5, 1.7)	1.60 (1.5, 1.7)
Lipid treatment (%)	25.7	25.9[xz]	21.1[xz]	**32.8**[x]	24.3[yz]	*22.7*[xz]
Body mass index (BMI)	28.7	28.8 (28.2, 29.3)[xy]	*28.1 (27.4, 28.9)*[y]	**29.7 (29.0, 30.3)**[x]	29.0 (28.5, 29.4)[xy]	28.2 (27.7, 28.7)[y]
Overweight (%)	47.94	*45.87*	49.26	**55.52**	47.22	45.90
Obese (%)	32.67	30.90	30.18	**35.21**	35.16	*30.00*
Overweight or obese (%)	80.6	77.1[x]	79.8[xy]	**90.6**[z]	82.7[xy]	*76.1*[y]
Glucose (mmol/L)[f]	6.00	**6.17 (6.0, 6.4)**	*5.84 (5.7, 6.1)*	6.09 (5.8, 6.3)	6.00 (5.8, 6.2)	5.96 (5.8, 6.1)
Diabetes (%)	16.2	**18.3**	*9.9*	13.8	16.8	14.5
Smoking (%)	12.1	*6.2*[xz]	12.1[yz]	10.1[yz]	9.5[x]	**17.7**[y]
Physical activity index	31.3	31.3 (30.4, 32.3)	30.9 (29.6, 32.2)	*30.4 (29.2, 31.5)*	**31.6 (30.9, 32.4)**	31.4 (30.6, 32.3)
Framingham coronary heart disease risk score	6.3	*6.11 (5.8, 6.4)*	6.31 (5.9, 6.7)	**6.64 (6.3, 7.0)**	6.34 (6.1, 6.6)	6.38 (6.1, 6.6)

[a]The sample is restricted to men who attended exams 3 and 7 and had complete risk factor data at both exams.

[b]Hypertension treatment is defined as use of antihypertensive medication and elevated blood pressure: systolic blood pressure >120 mm Hg, diastolic blood pressure 80 mm Hg (7). Lipid treatment is defined as use of any anticholesterol medication and elevated lipids: total cholesterol >5.2 mmol/L, low-density lipoprotein cholesterol >2.6 mmol/L, high-density lipoprotein cholesterol <1.0 mmol/L, and triglyceride >1.7 mmol/L (4). Overweight is defined as BMI 25 to 29.9; obesity is defined as BMI >30; overweight or obese is defined as BMI >25 (6). Diabetes is defined as fasting blood glucose level of ≥7 mmol/L (34). Physical activity index scores range from 24 (total bed rest) to 120 (33). Coronary heart disease risk score is the 10-year risk of developing coronary heart disease: the risk factors considered are age (≥45 y for men), hypertension (systolic blood pressure ≥140 mm Hg, diastolic blood pressure ≥90 mm Hg, or use of antihypertensive medication), smoking, diabetes, elevated cholesterol (cholesterol >6.24 mmol/L or low-density lipoprotein-cholesterol ≥4.2 mmol/L), and high-density lipoprotein cholesterol <0.91 mmol/L. One point was given for each risk factor, for a possible score of 0 to 7 points (35).

[c]CI=confidence interval.

[d]To convert mmol/L cholesterol to mg/dL, multiply mmol/L by 38.6. To convert mg/dL cholesterol to mmol/L, multiply mg/dL by 0.026. Cholesterol of 5.00 mmol/L=193 mg/dL.

[e]To convert mmol/L triglyceride to mg/dL, multiply mmol/L by 88.6. To convert mg/dL triglyceride to mmol/L, multiply mg/dL by 0.0113. Triglyceride of 1.80 mmol/L=159 mg/dL.

[f]To convert mmol/L glucose to mg/dL, multiply mmol/L by 18.0. To convert mg/dL glucose to mmol/L, multiply mg/dL by 0.0555. Glucose of 6.0 mmol/L=108 mg/dL.

[xyz]Means with differing superscript letters are significantly different from each other ($P<.05$); means in bold are the highest; means in italics are the lowest.

emphasized, and visible fat consumption could be targeted for reduction. Among those with the Average Male dietary pattern, a key strategy might be to lower fat intake by improving food preparation methods, reducing firm vegetable fats, and selecting leaner animal protein foods. Fruits and vegetables could also be discussed as more healthful alternative choices.

A key message for men with the Lower Variety pattern is increasing consumption of a broader range of foods, including fruits, vegetables, whole grains, and lean animal and vegetable protein foods. Men with the Empty Calorie eating pattern could be guided to select lower-fat meats and low- and nonfat dairy products, to utilize lower-fat cooking methods and ingredients, and to emphasize micronutrient dense snack and meal choices.

The dietary patterns reported here also suggest that certain common nutritional goals may be important to promote health and reduce chronic disease risk in all adult men. There were high rates of overweight and obesity, 76% to 91%, as well as diabetes, 10% to 18%, at follow-up. On average, blood pressure and plasma lipid levels also exceeded expert guidelines in all male subgroups. These characteristics suggest that most men might benefit from weight reduction; however, the dietary patterns suggest that methods of weight management in men ought to consider the distinct food preferences and choices of the male subgroups.

Recent research on the efficacy of targeted approaches to lifestyle behavior change (44,45) support the implementation of more focused, food-based nutrition interventions. For example, investigators have successfully utilized approaches that target a person's readiness to change his or her personal health-related behavior, including physical activity (45). In a similar vein, the dietary patterns of male subgroups could be used to develop targeted educational/motivational strategies for nutrition behavior change.

The characterization of dietary patterns in men in this report is consistent with emerging cross-sectional and longitudinal research in other populations as well as other established cohorts of men. Huijbregts and colleagues (46) applied cluster analysis to a dietary history methodology and characterized four dietary patterns of men aged 70 to 89 years who were involved in the Zutphen Elderly Study: high alcohol and low carbohydrate intake; higher intakes of saturated and monounsaturated fats and cholesterol; higher intakes of polyunsaturated fats and fiber and relatively lower saturated and monounsaturated fats, energy, and cholesterol (the "healthy dietary pattern"); and high intakes of oligosaccharides. In cross-sectional analyses, the healthy dietary pattern was associated with more favorable levels of cardiovascular risk factors. Farchi and colleagues (47) identified four dietary patterns of middle-aged men in rural Italy and demonstrated a 4.7-fold lower risk for coronary heart disease mortality among men with more favorable nutrient intake (particularly, higher polyunsaturated fat intake). Dietary patterns of women have also been characterized and explored in relationships to disease risk and outcomes (15,16,48).

It is a limitation of this research that our observations were established in a cohort of men, the majority of whom are white residents of a western Boston suburban community. This may limit the generalizability of our findings. Nonetheless, we note that the Framingham models of CVD risk have been replicated and confirmed in many domestic and international populations (49-52). Our data encourage further research on dietary patterns of men and their relationships with nutrient consumption and chronic disease risk. It also is important to demonstrate in future research that nutritional interventions that target the distinct habitual dietary patterns of men can promote long-term changes in eating behaviors and improve chronic disease morbidity and mortality.

CONCLUSIONS

This research identifies comprehensive, habitual dietary patterns of adult men and demonstrates their association with high and varying levels of nutritional risk and chronic disease morbidity. These relationships suggest that preventive nutrition intervention strategies might be enhanced if the unique male dietary patterns were recognized and utilized as a framework within which to initiate and guide targeted changes in eating behavior for long-term health promotion. Indeed, the unique and nonoverlapping nature of the male dietary patterns observed in Framingham suggests that each male subgroup might benefit from nutrition intervention strategies that address its unique dietary pattern and related chronic disease risk profile.

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