Dietary Patterns of Hispanic Elders Are Associated with Acculturation and Obesity[1]

Hai Lin, Odilia I. Bermudez and Katherine L. Tucker[2]

Jean Mayer U.S. Department of Agriculture Human Nutrition Research Center on Aging, Tufts University, Boston, MA 02111

ABSTRACT The association of dietary patterns and obesity, particularly in Hispanics, is relatively poorly understood. This large U.S. population subgroup has a high prevalence of obesity and associated chronic conditions, and Hispanics are changing their dietary practices as they acculturate. Our objectives were *1*) to identify dietary patterns among elderly Hispanics in Massachusetts, compared with those of non-Hispanic whites; *2*) to associate dietary patterns with acculturation; and *3*) to associate dietary patterns with total and central obesity. We used a representative sample of 449 Puerto Rican and 133 Dominican elders and a neighborhood-based sample of 243 non-Hispanic white elders, aged 60 to 92 y, from the cross-sectional Massachusetts Hispanic Elders Study. Obesity and central obesity were assessed with BMI (kg/m^2) and waist circumference measurement, respectively. Acculturation was assessed by evaluating language use. Usual diet was assessed with a food frequency questionnaire specifically designed for use with this population. Dietary patterns were defined by cluster analysis of food group variables. We identified five clusters of individuals by dietary pattern, with proportionately greater energy intake from *1*) fruit and breakfast cereal, *2*) starchy vegetables, *3*) rice, *4*) whole milk and *5*) sweets, respectively. Hispanics were less likely to follow the fruit and cereal or sweets patterns, and more likely to follow the starchy vegetables or milk patterns, than were non-Hispanic whites. Only Hispanics followed the rice pattern. Among Hispanics, acculturation was positively associated with the fruit and cereal pattern, and negatively with the rice pattern. Total and central obesity were positively associated with the rice pattern. Longitudinal studies are needed to clarify the causal nature of these associations. J. Nutr. 133: 3651–3657, 2003.

KEY WORDS: • *Dietary patterns* • *cluster analysis* • *elderly* • *Hispanic* • *Puerto Rican*

Many studies have examined the association between the intake of individual nutrients or foods and the risk of chronic disease, but only recently has attention focused on the relationship of overall dietary patterns to health risk. Conceptually, people do not eat isolated nutrients, but rather meals composed of a variety of foods, with complex combinations of nutrients that may interact (1). Dietary pattern analysis is useful because it provides a basis from which to make recommendations on eating practices (2). In clinical studies, changes in dietary patterns appear to lower blood pressure more effectively than single-nutrient supplementation (3,4).

The identification of eating patterns that may contribute to the current epidemic of obesity is of great importance. However, how dietary patterns may contribute to obesity, particularly among ethnic minority groups, is little understood. Hispanics comprise the largest minority population in the United States (5), and the Hispanic population continues to grow rapidly (6). We have previously shown that elderly Hispanics living in Massachusetts have a higher prevalence of obesity (7), diabetes (8), systolic hypertension (9) and physical disability (10) than a neighborhood-based sample of non-Hispanic white elders. We have also noted that the diets of these Hispanic elders tend to be high in refined grains (11).

Diets high in refined grains may affect the development of insulin resistance (12). Conversely, improvements in cardiovascular health and healthier body weights have been observed among those consuming diets based on fruit and vegetables, low fat foods or nutrient-dense foods (13). In the Baltimore Longitudinal Study of Aging, a dietary pattern characterized by elevated consumption of fruit, vegetables, low fat dairy products and whole grains was associated with smaller gains in BMI and waist circumference (14).

Individual dietary patterns reflect interactions of biology, culture, food availability, education and lifestyle. Despite shared ancestry and common language, the U.S. Hispanic population has a diversity of dietary traditions and eating practices. Moreover, because of variation in time of migration, there is an ongoing transition from traditional to more "Americanized" diets. The current study, therefore, was designed to examine the major dietary patterns of Puerto Rican and Dominican elders, the two most common Hispanic groups living in Massachusetts, compared with non-Hispanic white elders; to identify how acculturation is associated with dietary patterns; and to assess the association among those dietary patterns with total and central obesity.

[1] Supported in part by NIA grant AG10425–05 and by the U.S. Department of Agriculture, Agricultural Research Service, under agreement number 58–1950-9–001.
[2] To whom correspondence should be addressed.
E-mail: katherine.tucker@tufts.edu.

Manuscript received 25 June 2003. Initial review completed 26 July 2003. Revision accepted 8 September 2003.

MATERIALS AND METHODS

Subjects. The sampling of the subjects for this study has been described elsewhere (8). In brief, 1030 subjects aged 60 to 92 y participated in the Massachusetts Hispanic Elderly Study (MAHES), a statewide survey conducted between 1993 and 1997 with a representative sample of Hispanic elders. For this analysis, we included 449 Hispanics from Puerto Rico and 133 from the Dominican Republic, along with 243 non-Hispanic whites selected from the same neighborhoods. Because they were neighborhood based, the socioeconomic indicators for the non-Hispanic white elders were closer to those of the population of Hispanic elders than would have been seen with a random sample of non-Hispanic whites (8). The remaining 205 subjects belonged to other Hispanic groups (Cubans, Mexican-Americans, Central and South Americans) with diverse customs and numbers too small to draw meaningful conclusions. Therefore, they were excluded from this analysis. Subjects with implausible energy intakes (<2.51 or >16.74 MJ; $n = 52$) were also excluded. No subject was excluded for health reasons. The study was conducted with the approval of the Institutional Review Board at Tufts–New England Medical Center in Boston, and all subjects gave informed consent.

Assessment of dietary patterns. Usual dietary intake was assessed with a specially designed 118-item food frequency questionnaire (FFQ) (15). The FFQ reference period was the preceding three months. The FFQs were scanned (Opscan5, National Computer Systems, St. Paul, MN) and transferred to electronic files. The Minnesota Nutrient Data System, program 2.8, version 25 (NDS, University of Minnesota, Minneapolis, MN) was used to calculate the nutrient intake profiles. Intake from dietary supplements, obtained through a detailed inventory of the products reported by the study subjects, was also included on the FFQ. We created a dichotomous variable (yes/no) for dietary supplement use for use in this analysis.

The 118 food items in the FFQ were collapsed into 32 food groups (see Appendix). Foods were categorized by nutrient profile, cooking method and frequency of use. For example, we retained rice as an independent group because it is a staple food in Caribbean Hispanic diets. Individual energy intake contribution was calculated for each of the 32 food groups and used for the cluster analysis. Standardization as percent energy allowed description of food choices proportional to intake while avoiding biased grouping due to variation in body size and energy requirement.

We performed cluster analysis to group study subjects by similarity of eating patterns, using SAS PROC FASTCLUS (SAS version 8.0, SAS Institute, Cary, NC). This procedure performs a disjoint cluster analysis on the basis of Euclidean distances computed from contributing variables. Cluster seeds are first assigned at approximate cluster locations. The Euclidean distance from each subject to each cluster center is calculated, and the subject is assigned to the nearest cluster center. The seeds are then replaced within the revised clusters, and the distance calculation and assignment are repeated in an iterative process until no further changes occur.

Cluster analysis is sensitive to extreme outliers. Energy contribution values that were ≥5 SD from the mean of a food group variable were removed from the clustering analysis, as has been done previously (14,16). Outliers were also identified if there were fewer than five members in a cluster (17). Applying both criteria, a total of 108 outliers (13.1%) were identified and removed temporarily. The remaining 717 eligible subjects were used for the overall cluster generation. Once the set of cluster centers was determined, the outliers were added back into the analysis and assigned to the cluster centers closest to their variable set.

A series of cluster analyses, with 3 to 8 clusters specified, was performed to identify the most meaningful set of patterns (18). The ratio of between- and within-cluster variance for each set of clusters was examined to assess group separation (16). A five-cluster scheme was selected for its distinct dietary composition and nutritional implications. These five clusters were identified as sweets, whole milk, rice, starchy vegetables, and fruit and breakfast cereals, after the food groups that contributed relatively higher proportions of dietary energy to each cluster relative to the others.

Sociodemographic and lifestyle data. Data on age, education, income, family size, self-reported level of physical activity and cigarette smoking were collected by standardized questionnaire for all subjects. Smoking was dichotomized as current smoker versus nonsmoker. Alcohol use was dichotomized as current drinker versus nondrinker. An income/poverty ratio was calculated based on household income and the poverty threshold specified by the U. S. Census Bureau, which varied with the number of persons in the family, the age of the reference person and the month and year in which the family was interviewed (19). A cutoff of 1.0 was used to classify subjects as above or below this poverty threshold.

Acculturation. Acculturation data for Hispanics were obtained with a set of questions on the usage of English and/or Spanish for speaking, reading and writing. We constructed an acculturation score as the mean of these three language variables, each with a range of 1.0 (using only Spanish) to 5.0 (using only English) (11).

Obesity measures. Anthropometric measurements included weight (kg), height (m) and waist circumference (cm). General obesity was measured with the body mass index (BMI, kg/m^2), calculated from height and weight. Height of those unable to stand and those with stooped posture (30% of subjects) was estimated from knee height, using published equations developed for Caribbean Hispanics and for non-Hispanic whites (20,21). Central obesity was measured as the waist circumference.

Statistical analysis. Comparisons across individuals in the five dietary pattern groups were tested using general linear models for continuous variables and logistic regression models for categorical variables, with adjustment for age and sex. SAS (version 8.0, SAS Institute) was used for all analyses. Significance tests were two-sided with the level of significance set at $P < 0.05$.

The association of ethnicity with each of the dietary patterns was determined by multiple logistic regression analysis. For Hispanics only, logistic regression models were used to estimate the association between acculturation score and each dietary pattern (vs. others), adjusting for sex, age, family size and smoking status. Associations with central and total obesity were similarly tested, by adding waist circumference and BMI, respectively, to these models.

RESULTS

Average energy contributions from specific food groups differed across groups of individuals classified by dietary pattern (**Table 1**). Subjects in the fruit and breakfast cereal cluster obtained energy from diversified food sources, with relatively higher percentages from breakfast cereal, low fat milk, citrus and other fruits and vegetables (2%), compared with all other dietary patterns. Conversely, elders in this pattern obtained the lowest energy contributions from added fats, meats and soft drinks.

Subjects in the starchy vegetables cluster obtained a substantially higher percentage of total energy from starchy vegetables than subjects in any other dietary pattern. Cassava, yautia, white yam, green banana, and plantain contributed almost 10% of total energy intake. Rice and poultry contributed 12 and 8%, respectively, whereas milk and pasta intakes were lower than in other dietary patterns.

Subjects in the rice cluster obtained high percentages of total energy from rice (23%); added fats, mainly cooking oil (12%); beans (7%) and poultry (8%). Subjects in this cluster obtained the lowest energy contributions from breakfast cereal, dairy products, sweets, fruits, eggs, processed meats, fish, sweet baked goods, breads and potatoes of any dietary pattern.

Subjects in the milk cluster obtained a relatively large percentage of total energy from whole milk (>20%). Rice also contributed substantially to the total energy intake. Subjects obtained relatively low contributions from low fat milk, pasta, vegetables, meat and alcohol.

Subjects in the sweets cluster obtained relatively high contributions of total energy from grain products, including baked sweets, bread and pasta. Subjects also obtained relatively high

TABLE 1

Energy contribution of food groups to total energy intakes of elder Hispanics and non-Hispanic whites in Massachusetts by dietary pattern[1]

Food group[2]	Dietary pattern: Fruit and cereal (n = 170)	Starchy vegetables (n = 174)	Rice (n = 170)	Milk (n = 138)	Sweets (n = 173)
Rice	5.0 ± 4.7	12.2 ± 4.0	22.7 ± 4.8	10.1 ± 6.0	2.7 ± 3.8
Breakfast cereal	12.9 ± 8.1	4.3 ± 4.3	2.4 ± 3.5	5.8 ± 5.2	4.8 ± 4.7
Whole milk	4.1 ± 4.2	3.7 ± 3.9	5.6 ± 5.7	20.3 ± 7.5	3.9 ± 4.7
Low fat milk	7.7 ± 9.6	2.2 ± 3.8	2.0 ± 4.0	0.2 ± 0.7	2.2 ± 3.1
Sweet baked goods	2.3 ± 3.0	1.6 ± 2.7	1.0 ± 1.9	2.5 ± 3.9	10.4 ± 9.4
Bread	6.9 ± 4.7	5.6 ± 4.5	4.4 ± 3.9	5.2 ± 4.4	9.0 ± 6.6
Pasta	3.4 ± 4.1	1.5 ± 2.0	1.9 ± 3.2	1.6 ± 2.3	4.6 ± 5.7
Starchy vegetables	1.5 ± 2.4	9.9 ± 7.6	4.6 ± 4.7	3.6 ± 3.9	0.7 ± 1.8
Citrus fruit	5.0 ± 6.2	4.1 ± 4.0	2.4 ± 3.4	3.2 ± 3.3	3.0 ± 3.0
Other fruit	7.3 ± 5.2	6.7 ± 5.7	3.3 ± 3.2	3.7 ± 3.2	4.4 ± 4.6
Beans/legumes	2.4 ± 2.3	4.9 ± 3.3	6.7 ± 4.2	3.4 ± 2.8	2.1 ± 3.3
Other dairy products	3.7 ± 5.3	2.4 ± 2.9	1.5 ± 2.1	3.0 ± 4.2	3.2 ± 3.7
Candy and sugars	1.9 ± 3.1	1.8 ± 3.1	1.7 ± 4.0	2.2 ± 2.9	3.9 ± 6.1
Added fat and oil	5.3 ± 3.6	8.2 ± 3.4	12.4 ± 2.9	7.1 ± 3.2	6.2 ± 4.4
Poultry	5.7 ± 4.2	8.0 ± 5.5	8.0 ± 5.4	5.7 ± 4.9	4.0 ± 3.5
Other vegetables	2.4 ± 2.0	2.3 ± 1.5	2.2 ± 1.6	1.6 ± 1.1	1.8 ± 1.3
Eggs	1.2 ± 1.6	1.3 ± 1.7	1.1 ± 2.3	1.5 ± 1.9	2.4 ± 3.1
Meat	3.6 ± 3.1	4.6 ± 3.7	4.5 ± 3.8	3.6 ± 3.0	6.2 ± 4.4
Processed meat	1.7 ± 2.4	1.6 ± 2.3	1.3 ± 1.9	1.7 ± 1.9	3.4 ± 4.1
Potatoes	3.3 ± 3.2	3.4 ± 3.0	2.2 ± 2.1	3.0 ± 2.6	4.8 ± 4.9
Dairy desserts	2.3 ± 3.9	1.0 ± 2.4	1.0 ± 2.5	1.7 ± 3.0	3.4 ± 4.6
Soft drinks	1.5 ± 3.5	2.2 ± 3.5	2.8 ± 3.8	3.8 ± 5.1	3.0 ± 4.9
Alcohol	1.6 ± 6.2	1.1 ± 5.0	0.5 ± 2.2	0.4 ± 1.4	2.6 ± 7.9

[1] Values expressed as percentages. Values are means ± SEM.
[2] Variables included in the clustering but that contributed <2% energy to any pattern include diet drinks, coffee and tea, other grains, soups, salty snacks, fish and green and orange vegetables.

contributions from meat, potatoes, candy and sugars, dairy desserts, processed meat, eggs, and alcohol. Subjects in this cluster obtained the lowest energy contributions from beans, starchy vegetables, poultry and rice of any dietary pattern.

Nutrient intake by dietary pattern. Total fat intake as a proportion of energy intake was significantly higher in the whole milk (33.8%) and sweets (35.1%) dietary patterns, compared with the fruit and cereal pattern (28.2%) (**Table 2**).

TABLE 2

Energy and macronutrient intakes, prevalence of selected "at-risk" nutrient intakes and consumption of dietary supplements of elder Hispanics and non-Hispanic whites in Massachusetts by dietary pattern[1]

Dietary component	Dietary pattern: Fruit and cereal (n = 170)	Starchy vegetables (n = 174)	Rice (n = 170)	Milk (n = 138)	Sweets (n = 173)
Energy, *MJ/d*	6,921 ± 208	7,363 ± 203	6,995 ± 208	7,353 ± 227[a]	7,900 ± 205[b]
Total fat, %	28.2 ± 0.4	29.1 ± 0.4	30.7 ± 0.4[b]	33.8 ± 0.5[b]	35.1 ± 0.4[b]
Saturated fat, %	10.1 ± 0.21	8.5 ± 0.21[b]	8.6 ± 0.21[b]	13.1 ± 0.23[b]	12.5 ± 0.21[b]
Protein, %	17.3 ± 0.25	15.8 ± 0.24[b]	15.5 ± 0.25[b]	16.0 ± 0.27[b]	15.4 ± 0.24[b]
Carbohydrate, %	55.0 ± 0.58	55.9 ± 0.57	54.0 ± 0.58	51.0 ± 0.64[b]	49.0 ± 0.57[b]
Alcohol, %	1.7 ± 0.33	0.8 ± 0.32	0.5 ± 0.33[c]	0.4 ± 0.36[c]	2.1 ± 0.32
Cholesterol, *mg/d*	196.9 ± 9.6	203.3 ± 9.4	174.6 ± 9.6	257.9 ± 10.5[b]	290.7 ± 9.5[b]
Fiber, *g/d*	19.5 ± 0.6	19.2 ± 0.6	16.3 ± 0.6[c]	14.1 ± 0.7[b]	17.1 ± 0.6[a]
Prevalence of selected "at-risk" intakes[3]					
Total fat > 30% energy, %	34.7	45.4[a]	57.6[b]	77.5[b]	76.3[b]
Saturated fat > 10% energy, %	48.8	24.1[c]	27.1[c]	88.4[b]	76.9[b]
Cholesterol > 300 mg/d, %	10.6	17.2	9.4	29.7[b]	37.0[b]
Fiber < 25 g/d, %	78.8	76.4	88.8	92.7[a]	86.7[c]
Dietary supplement, %	54.7	41.4	34.7[c]	34.8[c]	48.0

[1] Values are means ± SEM. Means were adjusted for age and sex. Comparisons across clusters were tested with general linear models for each group with the fruit and cereal group as the reference. Superscript letters indicate differing *P*-values: $^aP < 0.05$; $^bP < 0.001$; $^cP < 0.01$.
[2] Values expressed as percentage above or below specified cutoff point as indicated. Comparisons across clusters were tested with χ^2 analysis for each group with the fruit and cereal group as the reference. Superscript letters indicate differing *P*-values: $^aP < 0.05$; $^bP < 0.001$; $^cP < 0.01$.

TABLE 3

Ethnic distribution of elder Hispanics and non-Hispanic whites in Massachusetts by dietary pattern[1]

	Dietary pattern				
Ethnic group	Fruit and cereal (n = 170)	Starchy vegetables (n = 174)	Rice (n = 170)	Milk (n = 138)	Sweets (n = 173)
Puerto Rican	14.5	26.5[a]	26.3[a]	25.6[a]	7.1[a]
Dominican	10.5	39.1[a]	39.1[a]	7.5	3.8
Non-Hispanic white	37.5	1.2[a]	0.0	5.4[a]	56.0[a]

[1] Values expressed as percentages. Comparisons across clusters were adjusted for age and sex and tested by logistic regression analysis, with the fruit and cereal group as the reference. Superscript letter indicates $P < 0.001$.

Saturated fat intake as a proportion of energy intake was higher in the whole milk (13.1%) and sweets (12.5%) patterns and lower in the starchy vegetables (8.5%) and rice (8.6%) patterns, compared with the fruit and cereal pattern (10.1%; $P < 0.001$). Average protein intake as a proportion of energy intake was highest in the fruit and cereal pattern (17.3%; $P < 0.001$), compared with other dietary patterns (15.4 to 16%).

Adjusting for ethnicity, age, sex and total energy intake, subjects consuming the whole milk and the sweets dietary patterns were more likely than subjects consuming the fruit and cereal pattern to ingest levels of total fat (>30% of total energy intake), saturated fat (>10% of total energy intake), cholesterol (>300 mg/d) and dietary fiber (<25 g/d) indicative of elevated risk for health complications (Table 2). About 55% of subjects in the fruit and cereals cluster consumed dietary supplements, whereas lower proportions (35%; $P < 0.01$) of subjects in the rice and whole milk dietary clusters consumed supplements.

Ethnicity and dietary patterns. All subjects consuming the rice dietary pattern were Hispanic, including 26% of the Puerto Rican and 39% of the Dominican samples (**Table 3**). Dominicans were equally divided between the starchy vegetables and rice patterns. Puerto Ricans were more evenly distributed across three patterns: rice, starchy vegetables and milk. Hispanics were less likely than non-Hispanic whites to consume the fruit and cereal dietary pattern (14.5% of Puerto Ricans and 10.5% of Dominicans vs. 37.5% of non-Hispanic whites; $P < 0.001$). A majority (56%) of the non-Hispanic white subjects consumed the sweets dietary pattern.

Acculturation and dietary patterns in Hispanic elders. Hispanic subjects in the sweets dietary cluster were oldest, followed by the Hispanics in the whole milk cluster; both of these groups were significantly older than Hispanics in the fruit and cereal cluster after adjusting for ethnicity (Puerto Rican vs. Dominican) and sex ($P < 0.05$) (**Table 4**). Women comprised 71% of subjects in the fruit and cereal dietary cluster, greater than the proportion of women in the starchy vegetables (56%, $P < 0.05$) and sweets (53%, $P < 0.001$) clusters. Subjects in the rice dietary cluster lived in larger households than those in the fruit and cereal cluster, (2.8 and 1.8 persons, respectively; $P < 0.001$) and had fewer years of education (4.2 and 9.1 y, respectively; $P < 0.001$). A majority (>60%) of subjects in the rice and starchy vegetables clusters were below the poverty level. The fruit and cereal cluster had the lowest proportion of current smokers (17%), lower than the sweets pattern (28%, $P < 0.05$); the whole milk cluster had the lowest proportion of current alcohol drinkers (13%), lower than the sweets cluster (26%).

Hispanic subjects in the rice dietary cluster had the lowest average acculturation score, adjusted for age and sex (1.8), followed by those in the sweets, starchy vegetables and whole milk clusters (2.0 to 2.1) (**Fig. 1**). These average scores were all lower than that of subjects in the fruit and cereal cluster (2.5, $P < 0.05$ to 0.001). Hispanic subjects in the rice cluster were less acculturated than those in other clusters, adjusting for age, sex, family size and smoking status [odds ratio (OR) = 0.71 (0.59 to 0.85), $P < 0.05$], whereas subjects in the fruit

TABLE 4

Socioeconomic and demographic characteristics of elder Hispanics in Massachusetts by dietary pattern[1]

	Dietary pattern				
Characteristic	Fruit and cereal (n = 19)	Starchy vegetables (n = 171)	Rice (n = 170)	Milk (n = 125)	Sweets (n = 37)
Age,[2] *y*	70.1 ± 7.4	68.6 ± 6.6	68.0 ± 7.0	70.8 ± 7.6[a]	72.7 ± 8.4[a]
Sex,[3] *% female*	71.2	56.3[a]	65.3	58.0	53.2[b]
Family size,[4] *n*	1.8 ± 1.1	2.5 ± 1.6	2.8 ± 1.7[b]	2.0 ± 1.3	1.8 ± 1.2
Education,[2] *y*	9.1 ± 5.3	4.8 ± 4.0[a]	4.2 ± 3.8[b]	5.2 ± 4.3	10.0 ± 4.5
Below poverty threshold,[4] %	34.7	60.1[a]	62.9[c]	55.1	34.7[a]
Current smoker,[4] %	16.5	14.4	14.7	21.0	27.5[a]
Current drinker,[4] %	26.1	24.1	24.1	13.4[c]	35.4

[1] Values are as indicated by characteristic. Comparisons across clusters were tested with logistic regression analysis for categorical values and general linear models for continuous dependent variables, with the fruit and cereal group as the reference. Superscript letters indicate differing *P*-values: [a]$P < 0.05$; [b]$P < 0.001$; [c]$P < 0.01$.
[2] Values are means ± SEM, adjusted for sex and ethnicity (Puerto Rican vs. Dominican).
[3] Adjusted for age and ethnicity (Puerto Rican vs. Dominican).
[4] Adjusted for age, sex and ethnicity (Puerto Rican vs. Dominican).

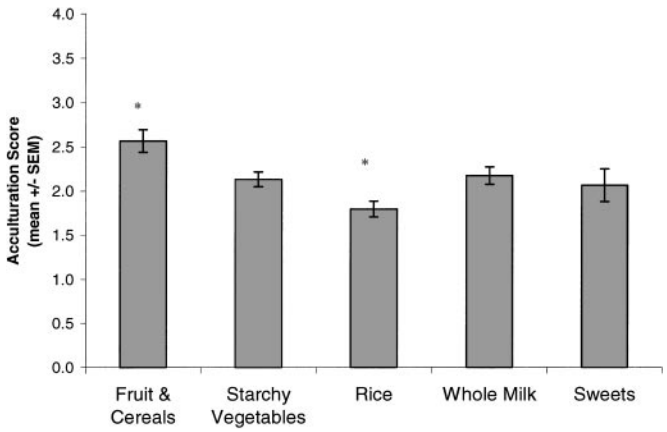

FIGURE 1 Acculturation score by dietary pattern among Hispanic elders in Massachusetts. Values are means ± SEM (see Table 4 for *n*). Asterisks indicate difference from other patterns combined ($P < 0.05$), adjusted for age, sex, family size and smoking status. Likelihood of being in the fruit and vegetable pattern/acculturation score unit: odds ratio (OR) = 1.44 (range 1.17 to 1.77). Likelihood of being in the rice pattern/acculturation score unit: OR = 0.71 (range 0.59 to 0.85).

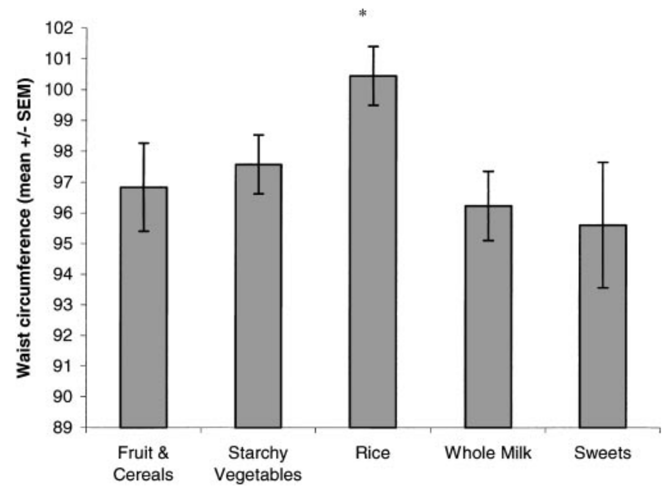

FIGURE 3 Waist circumference (cm) by dietary pattern among Hispanic elders in Massachusetts. Values are means ± SEM (see Table 4 for *n*). Asterisks indicate difference from other patterns combined ($P < 0.05$), adjusted for age, sex, family size and smoking status. Likelihood of being in the rice pattern/cm: odds ratio(OR) = 1.03 (range1.01 to 1.04).

and cereal cluster were more acculturated than those in other clusters [OR = 1.44 (1.17 to 1.77), $P < 0.05$].

Relationship between dietary patterns and obesity in Hispanic elders. Hispanic elders consuming the rice dietary pattern had greater BMI (**Fig. 2**) and waist circumference (**Fig. 3**) scores, compared with the other groups. The BMI was greater for the rice cluster than for other clusters [OR = 1.05 (1.02 to 1.09), $P < 0.05$]. In contrast, those consuming the milk dietary pattern had lower BMI scores compared with the other groups [OR = 0.95 (0.91–0.99), $P < 0.05$]. Subjects in the rice dietary cluster also had greater waist circumference scores than those in the fruit and cereal cluster (100 and 97 cm, respectively; $P < 0.05$). Waist circumference scores remained greater in the rice cluster in multivariate models [OR = 1.03 (1.01 to 1.04), $P < 0.05$].

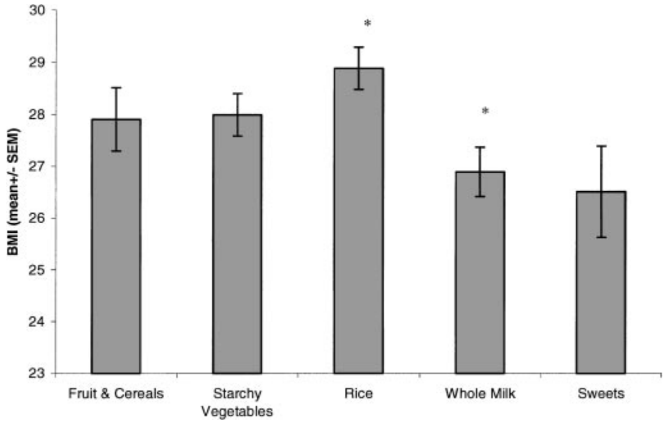

FIGURE 2 Body mass index (BMI) by dietary pattern among Hispanic elders in Massachusetts. Values are means ± SEM (see Table 4 for *n*). Asterisks indicate difference from other patterns combined ($P < 0.05$), adjusted for age, sex, family size and smoking status. Likelihood of being in the rice pattern/BMI unit: odds ratio (OR) = 1.05 (range 1.02 to 1.09). Likelihood of being in the milk pattern/BMI unit: OR = 0.95 (range 0.91 to 0.99).

DISCUSSION

Several studies have examined dietary patterns of elderly groups (22–26). However, less is known about the dietary choices of Hispanic elders. This study used cluster analysis to assess the dietary patterns of Hispanic and non-Hispanic white elders in Massachusetts. Five distinctive dietary patterns were derived. Puerto Rican elders tended to consume diets with large energy contributions from starchy vegetables, rice or whole milk. Dominican elders were most likely to consume diets in the starchy vegetables or rice patterns, but not the whole milk pattern. In contrast, non-Hispanic white elders living in the same neighborhoods were most likely to consume diets in either the sweets pattern or the fruit and breakfast cereal pattern.

Dietary patterns are highly determined by cultural influences on perceptions, beliefs and attitudes about foods. Such cultural constructs may not always be congruent with scientific knowledge regarding the safety or nutritional value of foods (27). As people from more traditional societies enter a new community with greater food availability, there is often a "nutrition transition," with assimilation of the mainstream culture's dietary patterns. In the case of the mainstream diet in the United States, this generally means more total and saturated fatty acids, and less complex carbohydrates (11,28).

Earlier food consumption studies with Puerto Rican subjects showed that rice, beans and starchy roots ("viandas") constitute the dietary staples of this population group (29,30). We found that the acculturation scores of Hispanic immigrants (Puerto Ricans and Dominicans) differed significantly across dietary patterns; those who consumed the fruit and breakfast cereal dietary pattern were most acculturated. The rice dietary pattern consisted mainly of rice, beans, poultry and oil, all traditional Caribbean Hispanic foods. Not surprisingly, Hispanic elders who consumed this traditional diet tended to be less acculturated than those who consumed the other food patterns.

Recognition of the influence of cultural factors on dietary patterns is important in better understanding the factors that both enhance and inhibit consumption of healthy diets among Hispanic elders. The diets of more acculturated elderly Hispanics in the United States tend to more closely resemble the macronutrient profile of non-Hispanic whites than do the diets of those less acculturated (11). A number of studies have examined diet and acculturation in Mexican Americans. Mexican American women born in the United States, or those more acculturated to the United States, adopted more atherogenic diets (e.g., more fat and less fiber) than women born in Mexico or less acculturated to the United States (31,32). Furthermore, first-generation Mexican American women had significantly higher intakes of protein, calcium, vitamin A, vitamin C and folic acid than women in the second generation (33).

The association of the rice dietary pattern with total and central obesity, as defined by larger BMI and waist circumference scores, respectively, was an important finding of the present study. The rice dietary pattern was high in refined grains, with rice as the main source of energy. This diet was also relatively high in fat (cooking oils were the second main source of energy), which may predispose elders to obesity. Furthermore, individuals grouped in the rice dietary pattern consumed few fruits and vegetables in the present study. Dietary patterns that emphasize fruit and vegetables may have beneficial effects on cardiovascular health and have been associated with healthier body weights (13).

Causality between the obesity indicators and consumption of the rice dietary pattern could not be determined because of the cross-sectional nature of this study. However, significant associations with both BMI and waist circumference remained after adjusting for age, sex, poverty, education, family size and acculturation level. Other studies have also identified associations between dietary patterns and obesity. In one study of over 500 adults, those consuming a soft drink dietary pattern had higher BMI scores than those who consumed skim milk or meat and cheese patterns (18). Using factor analysis to determine food patterns, Maskarinec found a significant association between obesity and a meat-based dietary pattern in a multiethnic group of women (34). Recently, a dietary pattern high in fruit, vegetables, low fat dairy and whole grains was associated with smaller 3-y gains in BMI and waist circumference among adults, compared with other dietary patterns (14).

The known health risks associated with total obesity, and particularly with abdominal obesity, are well documented (35,36). Obesity affects physical functioning (37), impairs quality of life (38), increases mortality (39) and elevates use of health care resources (40). Increasing proportions of older adults are overweight or obese (41). We previously reported a high prevalence of total and central obesity in this study population of Hispanic elders (7).

Abdominal obesity, characterized by accumulation of visceral fat mass and insulin resistance, is followed by metabolic abnormalities that are risk factors for cardiovascular disease, diabetes and stroke (42). Body composition influences the response of the hypothalamic-pituitary-adrenal axis to meals with different carbohydrate content, and it has been suggested that the hyperactivation that occurs with the intake of large amounts of carbohydrates may contribute to insulin resistance and associated hyperinsulinemia, particularly in women with abdominal obesity (43,44).

In conclusion, the majority of the Puerto Rican and Dominican elders in this study group consumed diets with relatively large energy contributions from either rice or starchy root crops. Those with higher acculturation scores appeared to adopt a more diverse and nutrient-rich fruit and breakfast cereal diet. The association of the rice dietary pattern with obesity suggests a need for further research on the consequences of this dietary pattern and for the development of culturally appropriate dietary interventions for this rapidly growing subset of the U.S. population.

ACKNOWLEDGMENTS

The authors gratefully acknowledge Janice Maras and Peter Bakun for their assistance with the dietary data.

LITERATURE CITED

1. Randall, E., Marshall, J., Brasure, J. & Graham, S. (1992) Dietary patterns and colon cancer in western New York. Nutr. Cancer 18: 265–276.

2. Committee on Diet and Health, NRC. (1989) Diet and Halth: Implications for Reducing Chronic Disease Risk. Report of the Committee on Diet and Health, Food and Nutrition Board, Commission on Life Sciences. National Academy Press, Washington, D.C.

3. Appel, L., Moore, T. & Obarzanek, E., Vollmer, W. M., Svetkey, L. P., Sacks, F. M., Bray, G. A., Vogt, T. M., Cutler, J. A., Windhauser, M. M., Lin, P. H. & Karanja, N. (1997) A clinical trial of the effects of dietary patterns on blood pressure. N. Engl. J. Med. 336: 1117–1124.

4. The Trials of Hypertension Prevention Collaborative Research Group (1992) The effects of nonpharmacologic interventions on blood pressure of persons with high normal levels. J. Am. Med. Assoc. 267: 1213–1220.

5. Brooks, K., Fessler, B. J., Bastian, H. & Alarcón, G. S. (2001) Sociocultural issues in clinical research. Arthritis Rheum. 45: 203–207.

6. U. S. Census Bureau (2001) Population by Race and Hispanic or Latino Origin for the United States: 1990 and 2000. U. S. Census Bureau. http://www.census.gov/population/cen2000/phc-t1/tab03.pdf. Accessed June 23, 2002.

7. Bermudez, O. I. & Tucker, K. L. (2001) Total and central obesity among elderly Hispanics and the association with type 2 diabetes. Obes. Res. 9: 443–451.

8. Tucker, K., Bermudez, O. & Castaneda, C. (2000) Type 2 diabetes is prevalent and poorly controlled among Hispanic elders of Caribbean origin. Am. J. Pub. Health 90: 1288–1293.

9. Lin, H., Bermudez, O. I., Falcon, L. M. & Tucker, K. L. (2002) Hypertension among Hispanic elders of a Caribbean origin in Massachusetts. Ethn. Dis. 12: 499–507.

10. Tucker, K. L., Falcon, L. M., Bianchi, L. A., Cacho, E. & Bermudez, O. I. (2000) Self-reported prevalence and health correlates of functional limitation and disability among Massachusetts elderly Puerto Ricans, Dominicans, and a non-Hispanic white neighborhood comparison group. J. Gerontol. 55A: M90–M97.

11. Bermudez, O. I., Falcon, L. M. & Tucker, K. L. (2000) Intake and food sources of macronutrients among older Hispanic adults: Association with ethnicity, acculturation and length of residence in the United States. J. Am. Diet. Assoc. 100: 665–673.

12. Liu, S., Stampfer, M. J., Hu, F. B., Giovannucci, E., Rimm, E., Manson, J. E., Hennekens, C. H. & Willett, W. C. (1999) Whole-grain consumption and risk of coronary heart disease: results from the Nurses' Health Study. Am. J. Clin. Nutr. 70: 412–419.

13. Fung, T. T., Rimm, E. B., Spiegelman, D., Rifai, N., Tofler, G. H., Willett, W. C. & Hu, F. B. (2001) Association between dietary patterns and plasma biomarkers of obesity and cardiovascular disease risk. Am. J. Clin. Nutr. 73: 61–67.

14. Newby, P. K., Muller, D., Hallfrisch, J., Qiao, N., Andres, R. & Tucker, K. L. (2003) Dietary patterns and changes in body mass index and waist circumference in adults. Am. J. Clin. Nutr. 77: 1417–1425.

15. Tucker, K. L., Bianchi, L., Maras, J. & Bermudez, O. I. (1998) Adaptation of a food frequency questionnaire to assess diets of Puerto Rican and non-Hispanic adults. Am. J. Epidemiol. 148: 507–518.

16. Chen, H., Ward, M. H., Graubard, B. I., Heineman, E. F., Markin, R. M., Potischman, N. A., Russell, R. M., Weisenburger, D. D. & Tucker, K. L. (2002) Dietary patterns and adenocarcinoma of the esophagus and distal stomach. Am. J. Clin. Nutr. 75: 137–144.

17. SAS Institute (1999) SAS/STAT User's Guide, Version 8. SAS Institute, Cary, NC.

18. Wirfalt, A. K. & Jeffery, R. W. (1997) Using cluster analysis to examine dietary patterns: nutrient intakes, gender, and weight status differ across food pattern clusters. J. Am. Diet. Assoc. 97: 272–279.

19. U. S. Census Bureau (1999) Poverty Thresholds: 1980–1997. Current Population Survey. http://www.census.gov/hhes/poverty/threshld.html. Accessed May 20, 1999.

20. Bermudez, O. I., Becker, E. K. & Tucker, K. L. (1999) Development of gender-specific equations for correction of stature of frail elderly Hispanics living in the Northeastern United States. Am. J. Clin. Nutr. 69: 992–998.

21. Chumlea, W. C., Roche, A. F. & Steinbaugh, M. L. (1985) Estimating stature from knee height for persons 60 to 90 years of age. J. Am. Geriatr. Soc. 33: 116–119.

22. Nube, M., Kok, F. J., Vandenbroucke, J. P., van der Heide-Wessel, C. & van der Heide, R. M. (1987) Scoring of prudent dietary habits and its relation to 25-year survival. J. Am. Diet. Assoc. 87: 171–175.

23. Trichopoulou, A., Kouris-Blazos, A., Vassilakou, T., Gnardellis, C., Polychronopoulos, E., Venizelos, M., Lagiou, P., Wahlqvist, M. L. & Trichopoulos, D.

(1995) Diet and survival of elderly Greeks: a link to the past. Am. J. Clin. Nutr. 61: 1346S–1350S.

24. Kant, A. K., Schatzkin, A., Harris, T. B., Ziegler, R. G. & Block, G. (1993) Dietary diversity and subsequent mortality in the First National Health and Nutrition Survey Epidemiologic Follow-up Study. Am. J. Clin. Nutr. 57: 434–440.

25. Farchi, G., Fidanza, F., Grossi, P., Lancia, A., Mariotti, S. & Menotti, A. (1995) Relationship between eating patterns meeting recommendations and subsequent mortality in 20 years. Eur. J. Clin. Nutr. 49: 408–419.

26. Huijbregts, P. P., Feskens, E. J., Rasanen, L., Alberti-Fidanza, A., Mutanen, M., Fidanza, F. & Kromhout, D. (1995) Dietary intake in five ageing cohorts of men in Finland, Italy and The Netherlands. Eur. J. Clin. Nutr. 49: 852–860.

27. Nestle, M., Wing, R., Birch, L., DiSogra, L., Drewnowski, A., Middleton, S., Sigman-Grant, M., Sobal, J., Winston, M. & Economos, C. (1998) Behavioral and social influences on food choice. Nutr. Rev. 56 (5, pt. II): S50–S74.

28. Bermudez, O. I., Velez-Carrasco, W., Schaefer, E. J. & Tucker, K. L. (2002) Dietary and plasma lipid, lipoprotein, and apolipoprotein profiles among elderly Hispanics and non-Hispanics and their association with diabetes. Am. J. Clin. Nutr. 76: 1214–1221.

29. Samolsky, S., Dunker, K. & Hynak-Hankinson, M. T. (1990) Feeding the Hispanic hospital patient: cultural considerations. J. Am. Diet. Assoc. 90: 1707–1710.

30. Sanjur, D. (1982) Social and Cultural Perspectives in Nutrition. Prentice-Hall, Englewood Cliffs, NJ.

31. Winkleby, M. A., Albright, C. L., Howard-Pitney, B., Lin, J. & Fortmann, S. P. (1994) Hispanic/white differences in dietary fat intake among low educated adults and children. Prev. Med. 23: 465–473.

32. Dixon, L. B., Sundquist, J. & Winkleby, M. (2000) Differences in energy, nutrient, and food intakes in a US sample of Mexican-American women and men: findings from the Third National Health and Nutrition Examination Survey, 1988–1994. Am. J. Epidemiol. 152: 548–557.

33. Guendelman, S. & Abrams, B. (1995) Dietary intake among Mexican-American women: generational differences and a comparison with white non-Hispanic women. Am. J. Public. Health 85: 20–25.

34. Maskarinec, G., Novotny, R. & Tasaki, K. (2000) Dietary patterns are associated with body mass index in multiethnic women. J. Nutr. 130: 3068–3072.

35. National Institutes of Health/National Heart, Lung, and Blood Institute (1998) Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report. National Institutes of Health, Bethesda, MD.

36. Must, A., Spadano, J., Coakley, E. H., Field, A. E., Colditz, G. & Dietz, W. H. (1999) The disease burden associated with overweight and obesity. J. Am. Med. Assoc. 282: 1523–1529.

37. Friedmann, J. M., Elasy, T. & Jensen, G. L. (2001) The relationship between body mass index and self-reported functional limitation among older adults: a gender difference. J. Am. Geriatr. Soc. 49: 398–403.

38. Ford, E. S., Moriarty, D. G., Zack, M. M., Mokdad, A. H. & Chapman, D. P. (2001) Self-reported body mass index and health-related quality of life: findings from the Behavioral Risk Factor Surveillance System. Obes. Res. 9: 21–31.

39. Calle, E. E., Thun, M. J., Petrelli, J. M., Rodriguez, C. & Heath, C. W., Jr. (1999) Body-mass index and mortality in a prospective cohort of U. S. adults. N. Engl. J. Med. 341: 1097–1105.

40. Wolf, A. M. & Colditz, G. A. (1998) Current estimates of the economic cost of obesity in the United States. Obes. Res. 6: 97–106.

41. Flegal, K. M., Carroll, M. D., Kuczmarski, R. J. & Johnson, C. L. (1998) Overweight and obesity in the United States: prevalence and trends, 1960–1994. Int. J. Obes. 22: 39–47.

42. Bjorntorp, P. (1997) Stress and cardiovascular disease. Acta Physiol. Scand. Suppl. 640: 144–148.

43. Vicennati, V., Vottero, A., Friedman, C. & Papanicolaou, D. A. (2002) Hormonal regulation of interleukin-6 production in human adipocytes. Int. J. Obes. Relat. Metab. Disord. 26: 905–911.

44. Vicennati, V. & Pasquali, R. (2000) Abnormalities of the hypothalamic-pituitary-adrenal axis in nondepressed women with abdominal obesity and relations with insulin resistance: evidence for a central and a peripheral alteration. J. Clin. Endocrinol. Metab. 85: 4093–4098.

APPENDIX

Food groupings used in the dietary pattern analysis

Food or food group	Food item
Low fat dairy	1 or 2% low fat milk, skim milk, low fat cheese or cottage cheese
Whole milk	Whole milk
Rice	Rice
Breakfast cereal	Cold cereal (regular or fortified), granola cereal, hot cereal (regular or fortified), other high fiber cereal, oat or bran cereal
Bread	Flour, wheat bread, white bread
Pasta	Pasta (mixed dishes), pasta (plain noodles)
Other grains	Grains (prepared), tortilla (Corn)
Potatoes	Fried potatoes (French fries), mashed potatoes, potato salad, boiled or baked potatoes
Beans/legumes	Beans, bean/legume mixed dishes, peas
Dark green and orange vegetables	Broccoli, Brussels sprouts, orange vegetables, sweet potatoes, parsley, mustard greens, turnip greens, collards, winter squash
Starchy vegetables	Malanga, yautia, white yam, cassava, breadfruit, green banana, green or ripe plantain
Other vegetables	Allium (onion, shallots, leeks), corn, mixed vegetables, other cruciferous (cauliflower), other vegetables, tomatoes and tomato products, lettuce (iceberg only)
Citrus fruit	Citrus fruit juices; grapefruit, oranges, other citrus fruits
Other fruit	Apricot, banana, berries, dried fruit, mango, melons, nectar, other fruit juices, other fruits
Candy and sugar	Gelatin, sugars, syrups, jams, candies
Added fat and oil	Regular or low fat butter, margarine or mayonnaise; olive, corn, or other vegetable oils; regular salad dressings; miscellaneous fats
Eggs	Eggs
Poultry	Chicken or turkey (with or without skin; broiled, baked or fried)
Meat	Beef, pork, organ meat (regular or lean); mixed dishes with meat; Hispanic meat turnovers
Processed meat	Processed meats (regular or low fat)
Fish	Fish, including dry salted codfish, canned tuna and sardines, shellfish
Sweet baked goods	Cakes, cookies, corn bread, doughnuts, muffins (regular), pies, crisps and cobblers
Salty snacks	Chips, popcorn, crackers
Diet drinks	Diet soft drinks
Soft drinks	Fruit and soft drinks (fortified or nonfortified)
Coffee and tea	Coffee and tea (with or without caffeine)
Alcohol	Beer (regular), liquor, wine (red or white)
Nuts and seeds	Nuts, peanuts, peanut butter
Soups	Homemade soup (cream- or water-based); tomato, vegetable or other soup (cream- or water-based)
Dairy desserts	Frozen yogurt (regular), ice cream (regular), ice milk, sherbet, custard, pudding, cheesecake
Other dairy products	Regular cheese, regular cottage cheese, cream (half and half), heavy cream, yogurt
Miscellaneous	Garlic, condiments, spices, salt, salad dressing (low fat), water