Published in final edited form as:
Nutr Metab Cardiovasc Dis. 2013 June ; 23(6): 528–535. doi:10.1016/j.numecd.2011.12.005.

Dietary Patterns and Their Association with Cardiovascular Risk Factors in a Population Undergoing Lifestyle Changes: The Strong Heart Study

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Abstract

Background and Aims—Rates of cardiovascular disease (CVD) are disproportionately high in American Indians (AI), and changes in lifestyle may be responsible. It is not known whether diverse dietary patterns exist in this population and whether the patterns are associated with CVD risk factors. This article describes the relationships between dietary patterns and CVD risk factors in this high-risk population.

Methods and Results—Nutrition data were collected via food frequency questionnaire from 3438 Strong Heart Study (SHS) participants, ≥ age 15 y. All participants were members of 94 extended families. The final sample consisted of 3172 men and women. Diet patterns were ascertained using factor analysis with the principal component factoring method. We derived four predominant dietary patterns: Western, traditional AI/Mexican, healthy, and unhealthy. Participants following the Western pattern had higher LDL cholesterol (LDL-C) ($p<0.001$), slightly higher systolic blood pressure (BP) ($p<0.001$), lower HDL cholesterol (HDL-C) ($p<0.001$), and slightly lower homeostasis model assessment estimates of insulin resistance

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(HOMA-IR) in the lowest vs. highest deciles of adherence to this pattern ($p<0.001$). The traditional diet was associated with higher HDL-C ($p<0.001$), but higher body mass index (BMI) ($p<0.001$) and HOMA-IR ($p<0.001$). Followers of the healthy pattern had lower systolic BP, LDL-C, BMI, and HOMA-IR in increasing deciles ($p<0.001$). The unhealthy pattern was associated with higher LDL-C.

Conclusions—Dietary patterns reflect the changing lifestyle of AI and several of the patterns are associated with CVD risk factors. Evolving methods of food preparation have made the traditional pattern less healthy.

Keywords

cardiovascular risk; dietary patterns; lifestyle; Strong Heart Study

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INTRODUCTION

American Indian (AI) lifestyles have been undergoing major changes in patterns of physical activity and diet. These changes are likely contributing to the increasing prevalence of obesity, diabetes, and cardiovascular disease (CVD) in AI.[1,2,3,4,5]

Nutritional analyses in this population have focused on individual nutrients.[6,7] Such analyses may not address interactions among nutrients and may overlook micronutrients. Dietary pattern analyses better reflect the relationships between overall diet and disease risk.[8,9,10,11] While CVD risk factors disproportionately affect AI communities,[2,12] no systematic analyses of dietary patterns and their relation to CVD risk factors in AI have been conducted.

The Strong Heart Study (SHS) is the largest, longest longitudinal study of CVD and its risk factors in AI. In this article, SHS data will be used to examine the relationships among dietary patterns and CVD risk factors in this rural, high-risk population.

METHODS

Study population

The current analyses were based on risk factor measurements and nutrition data, collected via food frequency questionnaire (FFQ), from the 3438 participants of the fourth SHS exam (2003). A Block FFQ was used, with the addition of foods commonly consumed by this population.[13] All participants resided in AI communities in Arizona, Oklahoma, and North and South Dakota and provided informed consent. The SHS was approved by the Indian Health Service, all participating institutional review boards, and the AI communities. Participants were from 94 extended families and were ≥15 yrs of age. We excluded men with energy consumption <600 (n=70) or >8000 kcal/d (1 kcal=4.187 kJ) (n=43), women with >6000 kcal/d (n=80), individuals who left more than 10% of the FFQ items blank (n=47), and those missing nutrient data (n=26). The final sample consisted of 3172 men and women.

Measurements

SHS methods have been described.[12,14] Dietary information was collected via a Block FFQ.[12] This FFQ was used to evaluate food consumption during the previous year[15,16] and ascertained consumption of 119 food items, including traditional foods and foods commonly available in SHS communities.[17] The Block FFQ utilizes the Nutrition Data System for Research Database Version 4.06_34 (Minneapolis, MN).[17,18] Foods from the FFQ were classified into 27 groups based on nutrient profiles or culinary usage. Foods that did not fit into a group or that seemed to represent distinctive dietary behaviors were entered separately for the factor analysis.

SHS anthropometric and laboratory methods have been described.[12,14] Participants were considered hypertensive if they had systolic blood pressure (BP) ≥140 mmHg, diastolic BP≥90 mmHg,[19] and/or were taking BP medication at the time of the interview.

Blood samples were obtained following a 12-h overnight fast for glucose measurement and a lipid panel (total cholesterol, total triglyceride, HDL cholesterol [HDL-C], and LDL cholesterol [LDL-C]). Insulin was measured by radioimmunoassay.[12] Diabetes was defined according to American Diabetes Association criteria.[20] Homeostasis model assessment estimates of insulin resistance (HOMA-IR)[21] were calculated with the equation *[Fasting insulin (FI) (µU/ml) · FG (mmol/l)]/22.5*.

Current drinking was defined as having had an alcoholic drink within the last year. We did not use this variable in the multivariate models because alcohol intake was included in the FFQ and thus in the dietary patterns. Self-reported smoking status was categorized as current or former smoker or as never smoked. Physical activity data were collected using Accusplit AE120 pedometers (steps/d). Participants wore the pedometer on the hip during waking hours for 7 consecutive days (5 weekdays, 2 weekend days), except while bathing or swimming. Participants with ≥ 3 days of pedometer data were included in the analysis.[22,23,24]

Statistical analysis

Baseline demographic characteristics are presented as means and standard deviations for continuous variables (geometric means and 95% CI for those not normally distributed) or as numbers and percentages for categorical variables Intercooled Stata 9.2 (Stata Corp, College Station, TX) was used to conduct all analyses. Factor analysis [25] was applied to the 27 food groups derived from the FFQ data, using the Nutrition Data System for Research Database Version 4.06_34.[18] The amount of daily intake from each of the 27 groups was measured in grams for each individual. A factor analysis using the principal component factoring method[26] was used to compute a factor score for each diet pattern. Factors were rotated by an orthogonal transformation method (Varimax) to achieve a simpler structure with greater interpretability. The number of factors to be retained was decided by applying the Kaiser-Guttman rule (eigenvalue > 1) and evaluating the scree plot. Eight factors had an eigenvalue >1. Using a combination of both criteria, the first four factors were retained; total variance explained was 38%. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.86. KMO takes values between 0 and 1; small values mean that overall the variables have too little in common to warrant a factor analysis.[26] According to KMO classification, 0.86 indicates that the factor analysis was appropriate for the 27 food groups. To efficiently use all available data, the analyses were conducted on the entire population, but the patterns remained similar when stratified by geographic area.

Associations among dietary patterns, mean nutrient intake, and demographic and lifestyle variables were examined across quintiles of each factor using means ± standard deviations for continuous variables or numbers (percentages) for categorical variables. The first quintile represents the participants least adherent to the pattern; the fifth quintile represents those most adherent. Quintiles 1, 3, and 5 are presented in the tables. Bivariate relationships were evaluated using chi-square tests for categorical variables and a nonparametric trend test by the quintiles of each dietary pattern ("nptrend" in Stata), an extension of the Wilcoxon rank-sum test for trend across ordered groups.

The relationships between each CVD risk factor and dietary pattern were examined using multivariate ordinary least squares (OLS) regression analyses adjusted for age, gender, total energy intake, anti-hypertension medication, lipid-lowering medication, physical activity, and diabetes status. Adjusted means of the risk factors were provided for each dietary pattern in a separate model. Scores for each pattern were categorized into deciles and included in the models as linear trend variables with values 1 to 10. A value of 1 on a pattern indicated the least adherence to the pattern and a value of 10 indicated the most adherence to the pattern, when all participants were ranked based on their actual scores. *P (OLS)* was used to report the P-values for the estimated coefficients of the dietary pattern variables in the OLS models. A significant P-value (P<0.05) suggests that the pattern is significantly associated with a given risk factor, adjusting for included covariates. The direction of the associations can be inferred from the direction of the changes in the adjusted means computed while holding constant all covariates at their means for all deciles. Only deciles 1 and 10 are presented in the risk factor table.

P-values for trends in the adjusted means also are presented. This test is nonparametric and less strict in its assumptions. It is useful in evaluating trends when the average linear changes are not statistically and/or clinically significant.

The family relatedness in the SHS could lead to biased inference, because the correlation between observations within families may violate the independence assumption of the OLS models. We, therefore, ran population-averaged generalized estimation equation (GEE) models for panel data, treating each extended family as a panel whose observations were correlated with each other. These analyses were conducted using the xtgee command in Stata, with normal family and identity link functions and exchangeable correlation structure between observations within families. The results did not change, except for weakly significant relationships between triglyceride and the traditional and healthy diets, which became non-significant; thus, we present only the results of the OLS models.

RESULTS

Basic characteristics of the participants are presented (Table 1). More women than men participated in the study; mean body mass index (BMI) was 32 kg/m^2, insulin concentrations were high, and 23% had diabetes. Percentages of energy derived from total fat, saturated fatty acid (SFA), trans fatty acid, and sugar were higher and fiber and n-3 intake were lower than recommended.[27]

The factor loading matrix for the four dietary patterns is provided (Table 2). Participants following Factor 1, the Western pattern, consumed more fast food, snack chips, fried potatoes, prepared main dishes, sweet beverages, and animal fats. Factor 2, the traditional AI/Mexican pattern, scored high in traditional foods, dry beans, Mexican foods, stew, meats, processed meats, alcoholic beverages, and store-bought hydrogenated vegetable fats. This pattern reflected a combination of AI and Mexican foods prepared in traditional ways and foods that are popular in the communities but prepared using current cooking methods and store-bought ingredients. Factor 3, the healthy pattern, was based on purchased food that reflected an attempt to follow dietary advice. Participants following this pattern consumed fruits, vegetables, fish, hot cereal, dark bread, whole grain cereals, and lower fat milk. Factor 4, the unhealthy pattern was correlated with coffee, tea, candy bars, sugar, syrup, animal fats, sweetened grains, doughnuts, cookies, pies, cakes, ice cream, and non-dairy creamer.

Univariate relationships among the dietary patterns, lifestyle, and demographic variables are presented (Table 3). The Western pattern was associated with male gender, younger age, and lower BMI and waist circumference. The traditional AI/Mexican diet was associated with male gender, higher BMI and waist circumference, less education, and more smoking. The healthy diet was associated with older age, slightly lower BMI, more education, and significantly less smoking. The unhealthy diet was associated with older age, male gender, and smoking.

Participants who scored higher on the Western pattern had lower percentages of energy intake from carbohydrates and significantly higher percentages from fats and added sugar (Table 4). Fiber density was markedly lower in the fifth quintile of this pattern. The traditional AI/Mexican diet pattern was associated with a higher percentage of energy from protein and fats and a lower percentage of energy from both simple and added sugar. Both fiber and cholesterol density were high. Participants following the healthy diet had higher percentages of energy from carbohydrate and protein and lower percentages from added sugar and fat, except for a higher percentage of polyunsaturated fatty acid. They also had higher fiber density intake and lower cholesterol density in increasing quintiles. Participants in the fifth quintile of the unhealthy diet had significantly lower percentages of energy from protein and higher percentages of fat and added sugar. This pattern was related positively to cholesterol and negatively to fiber.

Adjusted means of risk factors by the deciles of dietary patterns are presented (Table 5). Participants following the Western pattern had higher LDL-C (P=0.001) and slightly higher systolic BP (P=0.001), lower HDL-C (P=0.001), and slightly lower HOMA-IR (P<0.001) in increasing deciles. Followers of the traditional diet had significantly higher HDL-C (P<0.001) but higher triglycerides (P=0.001), BMI (P=0.001), and HOMA-IR (P=0.001). Followers of the healthy pattern had lower SBP (P=0.001), LDL-C (P=0.001), triglyceride (P=0.001), BMI (P=0.001), and HOMA-IR (P=0.001) in increasing deciles. Followers of the unhealthy pattern had higher LDL-C (P<0.001across deciles). All other trends in risk factors involved differences too small to be clinically meaningful. Further adjustment for smoking status did not change the results.

DISCUSSION

The current analysis is the first systematic examination of dietary patterns in a population-based sample of AI. We found four patterns: a Western pattern; a traditional AI/Mexican pattern reflecting foods historically consumed by this population, but not necessarily prepared in a traditional manner; a healthy pattern; and an unhealthy pattern. These patterns were significantly associated with CVD risk factors, including LDL-C, BP, BMI, and insulin resistance. The healthy pattern was associated with fewer risk factors, while the Western and unhealthy patterns generally had adverse associations. The traditional diet showed mixed results, having beneficial associations with HDL-C but adverse associations with triglyceride, obesity, and BP.

The principal nutritional concern in AI communities is no longer malnutrition and/or starvation, but overweight and obesity, as traditional foods are replaced by energy-dense convenience foods, and physical activity is reduced.[28,29] A large number of AI appear to be following an unhealthy diet that is largely devoid of nutritious food. Historically, AI consumed nuts, fruits, berries, roots, and wild game. Many AI were farmers who expended energy growing crops, such as beans, squash, and whole grains. These foods are richer in nutrients and less energy dense than purchased fast food. [30] These changes in lifestyle and eating patterns may partially explain the increase in obesity and diabetes rates. AI, long thought to have inherent protection from (CVD),[31] now have rates higher than U.S. whites.[2]

Today's traditional diet differs from the past pattern, now consisting of store-bought traditional and Mexican foods and farm-bred meat. Mexican and AI foods are similar, although methods of preparation differ, as AI blended their traditional foods with foods brought by the Spaniards. The higher protein, fat, and cholesterol intake in increasing quintiles of this diet reflect high intake of meat. Additionally, cooking methods now include frying in added hydrogenated fat and sodium. The higher fiber density and lower percentage of energy from carbohydrate and added sugar, however, reflect a high intake of plants. Taken as a whole, these relations could explain the observed association of the traditional pattern with higher BMI, HOMA-IR, and BP. Alternatively, these findings could reflect residual confounding, because the traditional pattern is associated with smoking and male gender, characteristics associated with a higher risk-factor profile.

The Western and unhealthy patterns reflect less accessibility to or less understanding of nutrition. The Western diet is associated with higher LDL-C, triglyceride, and BP and lower HDL-C; these associations likely reflect the increase in saturated and trans fats and added sugar in increasing quintiles. This pattern was associated with lower HOMA-IR, however. The latter may be due to residual confounding probably reflecting the younger age of adherents to this pattern.

The healthy diet pattern was followed more frequently by older persons, more often women, who were less likely to smoke. As individuals age or become overweight, they may have health problems that prompt dietary changes. This pattern had the most favorable risk-factor profile in increasing deciles, despite the older age of its adherents. The lower cholesterol density with increasing deciles may reflect consumption of lower fat milk, lean meat, and poultry. The increasing fiber density may reflect higher intake of fruits, vegetables, dark bread, and hot cereal. These intakes are also reflected by the lower percentage of added sugar and no change in total sugar in increasing quintiles of this pattern. These findings are consistent with the lower BMI, triglyceride, LDL-C, systolic BP, and HOMA-IR in increasing deciles of this pattern. These results indicate that dietary improvement is possible even within the limits of food availability in AI communities.

A fourth diet, the unhealthy pattern, was characterized by a high percentage of energy from SFA and cholesterol in increasing quintiles, reflecting consumption of store-bought animal fats. The rising percentage of added sugar in increasing quintiles of this pattern reflects consumption of candy bars, sugar, and syrup. The low-fiber density across increasing quintiles is consistent with the low intake of fruits and vegetables. LDL-C is higher in increasing deciles of this pattern. This pattern is particularly alarming, because it is probably the result of older age and increasing accessibility to fast food. This pattern has the potential for more adverse health effects with continued use.

The decreased activity accompanying these dietary patterns could also explain the associations with risk factors. These analyses were limited by the use of pedometer measurements to assess physical activity. These measurements are not a precise activity assessment and may have confounded the results. Also, in comparing risk factors between individuals with high and low scores on each pattern, the differences were relatively small. Thus, although nutrition and lack of physical activity have a role in the development of CVD risk factors, and ultimately CVD events in this population, other factors are important.

This study’s strengths include the large, population-based sample; dietary instrument validated for use in this population; and standardized methods for collecting risk factor data. This study was limited by its cross-sectional design; associations between dietary patterns and CVD risk factors must be interpreted with caution, given the possibility of reverse causation. The food frequency data analysis may have been flawed by use of a single recipe or food for all consumers. Inaccuracy may have been introduced by grouping prepared traditional AI/Mexican food, cooked in store-bought hydrogenated vegetable fat, with homemade food cooked with other fats. Furthermore, food sources are limited in these rural AI communities and thus the staple foods consumed may differ in nutrient content from the reference foods used for the nutritional computations. Finally, factor analysis is an exploratory method, and the interpretation of the factors is subjective.

In summary, identification of dietary patterns reflecting differing AI lifestyles affords a tool to elucidate associations with CVD risk factors. CVD risk factors were significantly associated with the diet patterns. While the Western pattern was clearly linked with CVD risk factors, evolving methods of preparing traditional foods have made that pattern unhealthy also. These results may be useful for those providing nutritional counseling and encouraging availability of healthy food choices. These results also will be used in longitudinal analyses examining the nutritional determinants of chronic diseases in this population.

Acknowledgments

The Strong Heart Study is supported by grants (UO1HL-41642, U01HL-41652, UO1HL-41654, U01-HL65520, and U01-HL65521) from the National Heart, Lung, and Blood Institute. The opinions expressed in this paper are those of the author(s) and do not necessarily reflect the views of the Indian Health Service. We gratefully acknowledge Rachel Schaperow, MedStar Health Research Institute, for editing the manuscript.

This project has been funded in whole or in part with Federal funds (Grant # UL1RR031975) from the National Center for Research Resources (NCRR) and the National Center for Advancing Translational Sciences (NCATS), National Institutes of Health (NIH), through the Clinical and Translational Science Awards Program (CTSA), a trademark of DHHS, part of the Roadmap Initiative, "Re-Engineering the Clinical Research Enterprise."

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Abbreviations

AI	American Indian
BMI	body mass index
BP	blood pressure
CVD	cardiovascular disease
FFQ	food frequency questionnaire
HDL-C	high-density lipoprotein cholesterol
HOMA-IR	homeostasis model assessment estimate of insulin resistance
LDL-C	low-density lipoprotein cholesterol
KMO	Kaiser-Meyer-Olkin
OLS	ordinary least squares
SHS	Strong Heart Study

TABLE 1

Characteristics of the participants

Variables	**All (N=3172) Mean (SD)**
Demograpic and lifestyle	
Gender (male %, N)	40 (1285)
Age	40 (17)
BMI (kg/m^2)	32 (8)
Waist circumference (cm)	105 (19)
Education (y)	12 (2)
Current smoker (%, N) *	45 (1072)
Hypertension (%, N)	34 (1078)
Diabetes (%, N)	23 (724)
Nutrient Intake	
Fiber (g/1000kcal)	7.6 (2.6)
Cholesterol (mg/1000kcal)	130 (55)
Total energy intake (Kcal)	2464 (1318)
Carbohydrate, % energy	48 (9)
Total sugar (g)	149 (91)
Total added sugar (g)	90 (64)
Added sugar, % total sugar	58 (15)
Total sugar, % energy	25 (10)
Total added sugar, % energy	15 (8)
Protein, % energy	13 (3)
Total fat, % energy	39 (7)
Saturated fat, % energy	12 (2)
MUFA, % energy	15 (3)
PUFA, % energy	9 (2)
Trans fat, % energy	1.6 (0.6)
(n-3) fatty acids, % energy	0.9 (0.4)
(n-6) fatty acids, % energy	7.6 (2.1)
Biomarkers	
Plasma glucose (mg/dL)	114 (53)
HDL-cholesterol (mg/dL)	51 (15)
LDL-cholesterol (mg/dL)	98 (29)
Non-HDL-cholesterol (mg/dL)	130 (36)
Triglycerides (mg/dL) **	141
Insulin	18.4 (20)
Hemoglobin A1c (%) (N=1421)	6.7 (2)

[1] Data are presented as means ± standard deviations for continuous variables and as numbers and percentages for categorical variables.

[2] Hypertension was defined as systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg, and/or taking blood pressure medication.

* Available sample size = 2403.

[**] Geometric mean (95% CI) is given for skewed variables. The arithmetic mean for triglyceride was 168, with a range of 28-5323 and a SD of 172. The arithmetic mean for urine albumin creatinine ratio was 90, with a range of 1-9756 and a SD of 547.

TABLE 2

Factor loading matrix for the four dietary patterns[1]

Variables	Food items	Factor 1 (western)	Factor 2 (traditional)	Factor 3 (healthy)	Factor 4 (unhealthy)
F1	Meats, processed meats, and poultry	0.4750	0.4764		
F2	Fish			0.3207	
F3	Stew		0.5129		
F4	Milk, cheese, ice cream, non-dairy creamer				0.3012
F5	Eggs		0.3262		0.3572
F6	Store-bought animal fats	0.3401			0.5106
F7	Store-bought hydrogenated vegetable fats		0.3139		0.3766
F8	Store-bought non- hydrogenated vegetable fats	0.3438			
F9	Beverages	0.5376			
F10	Store-bought fruits, vegetables, and lettuce salad			0.5247	
F11	Dry beans		0.6756		
F12	French fries or fried potatoes	0.5794			
F13	White bread, pasta, cold cereal, pilot bread	0.4367		0.3441	0.3192
F14	Sweetened grains, doughnuts, cookies, pies, cakes	0.3879		0.3224	0.3955
F15	Hot cereal			0.5006	
F16	Snack chips	0.6410			
F17	Candy bars, sugar, syrup				0.6626
F18	Coffee, tea				0.7083
F19	Lower fat milks			0.4889	
F20	Dark bread, whole grain and ready-to-eat cereal			0.5068	
F21	Fast food	0.7031			
F22	Healthier products, such as low-fat salty snacks and meat substitutes, including soy			0.4852	
F23	Prepared main dishes	0.5497	0.3541		
F24	Alcoholic beverages		0.3756		
F25	Traditional foods		0.7215		
F26	Mexican foods	0.4271	0.6162		
F27	Lean meat/poultry	0.3440		0.4368	

[1] Empty cells indicate loadings < 0.30.

TABLE 3

Demographic and Lifestyle Variables by Quintile of Dietary Pattern

Dietary Pattern	**Female n (%)**	**Age (y)**	**BMI (kg/m^2)**	**Waist circumference (cm)**	**Education (y)**	**Current smoker n (%)**
Western						
Q1	433(23)	53(16)	32(7)	106(16)	11.8(2.6)	192(18)
Q3	382(20)	37(16)	32(8)	104(19)	11.9(2.3)	207(19)
Q5	316(17)	31(12)	31(8)	103(20)	11.7(2.3)	229(21)
P-value	<0.001	<0.001	0.01	<0.001	0.06	0.78
Traditional						
Q1	437(23)	38(18)	30(7)	98(17)	12.2(2.4)	193(18)
Q3	377(20)	41(18)	33(8)	106(18)	12.0(2.4)	201(19)
Q5	296(16)	38(14)	35(9)	110(19)	11.2(2.0)	241(23)
P-value	<0.001	0.69	<0.001	<0.001	<0.001	0.001
Healthy						
Q1	347(18)	35(12)	33(8)	105(19)	11.5(2.0)	285(27)
Q3	397(21)	40(17)	32(7)	104(17)	11.9(2.5)	200(19)
Q5	369(19)	43(19)	32(8)	103(18)	12.0(2.4)	177(17)
P-value	0.008	<0.001	0.01	0.07	<0.001	<0.001
Unhealthy						
Q1	384(20)	32(14)	32(8)	102(19)	11.8(2.2)	175(16)
Q3	394(21)	41(17)	33(8)	107(18)	12.1(2.3)	165(15)
Q5	344(18)	43(16)	32(8)	104(18)	11.7(2.4)	295(28)
P-value	<0.001	<0.001	0.50	0.02	0.32	<0.001

Note: Unadjusted distributions of the means (SD) for continuous variables and the number of observations (%) for categorical variables are presented for the first, third, and fifth quintiles of the dietary pattern scores. A chi-square test was used for categorical variables. A nonparametric trend test (nptrend command in Stata) was used for continuous variables.

TABLE 4

Mean dietary intake (% energy) by quintile of dietary pattern

Dietary Pattern	Carbohydrate	Total sugar	Total added sugar	Protein	Sat. fat	Trans fat	MUFA	PUFA	Fiber density	Cholesterol density	Total intake (kcal)
Western											
Q1	49.6	24.7	12.5	13.6	11.5	1.6	14.4	8.4	9.0	142	1543(809)
Q3	48.2	25.5	15.6	13.0	11.7	1.6	14.9	8.6	7.3	129	2192(878)
Q5	46.8	23.4	15.1	13.5	11.8	1.7	15.4	8.5	6.9	121	4064(1266)
P for trend	<0.001	0.17	<0.001	0.09	0.005	<0.001	<0.001	0.052	<0.001	<0.001	<0.001
Traditional											
Q1	53.4	31.3	20.5	12.0	10.7	1.5	13.6	8.1	6.9	100	2253(1234)
Q3	47.6	24.4	13.8	13.4	11.8	1.6	15.1	8.7	7.7	126	2078(978)
Q5	44.6	19.8	11.3	13.9	12.2	1.7	15.8	8.6	8.2	138	3615(1414)
P for trend	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	< 0.001	<0.001	<0.001	<0.001	<0.001
Healthy											
Q1	46.5	25.6	18.4	11.6	11.8	1.7	15.2	8.2	6.0	137	2493(1228)
Q3	48.9	25.1	14.4	13.9	11.6	1.6	14.8	8.6	7.7	127	2144(1181)
Q5	50.1	24.8	12.0	14.7	11.2	1.5	14.3	8.4	9.3	123	3218(1472)
P for trend	<0.001	0.48	<0.001	<0.001	<0.001	<0.001	<0.001	0.098	<0.001	0.012	<0.001
Unhealthy											
Q1	49.0	25.2	14.2	13.8	11.0	1.6(	14.1	8.0(	7.8	115	2100(1218)
Q3	48.4	24.4	14.2	13.1	11.6	1.6	15.0	8.8	7.9	129	2180(1059)
Q5	48.3	25.5	16.6	12.3	12.0	1.7	15.2	8.7)	7.0	133	3428(1425)
P for trend	0.34	0.23	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

TABLE 5

Adjusted means of risk factors by decile of dietary pattern[1]

Dietary Pattern	**SBP (mmHg)**	**LDL-C (mg/dL)**	**HDL-C (mg/dL)**	**Triglyceride[2](mg/dL)**	**BMI (kg/m^2)**	**HOMA-IR[2] score**
Western						
D1	122.0	95.1	52.2	140	32.8	3.1
D10	123.5	101.5	49.4	143	31.8	2.7
Ptrend(OLS)	<.001 (0.23)	.001(0.01)	<.001(0.02)	<.001(0.67)	<.001(0.12)	<.001(0.06)
Traditional						
D1	122.5	99.6	49.9	137	29.9	2.5
D10	122.9	97.0	51.7	146	34.7	3.4
Ptrend(OLS)	<.001(0.59)	0.45(0.14)	<.001(0.04)	<.001(0.05)	<.001(<.001)	<.001(<.001)
Healthy						
D1	124.3	102.6	51.8	145	33.5	3.1
D10	121.1	94.0	49.8	138	31.1	2.7
Ptrend(OLS)	0.20(<.001)	<.001(<.001)	<.001(0.018)	<.001(0.07)	<.001(<.001)	<.001(0.01)
Unhealthy						
D1	122.9	96.0	51.3	141	32.7	2.8
D10	122.5	100.6	50.4	142	31.9	2.9
Ptrend(OLS)	<.001(0.66)	<.001(0.012)	0.01(0.31)	<.001(0.89)	<.001(0.11)	<.001(0.69)

[1] Adjusted means are presented. All models were adjusted for age, gender, total energy intake, hypertension treatment, lipid medications, diabetes status, and physical activity.

[2] Triglyceride and HOMA-IR variables were log-transformed before running the ordinary linear regression models. The log-transformed means were then converted to their usual scale for illustrative purposes.