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Journal
Journal of the Academy of Nutrition and Dietetics, 114(2)

ISSN
2212-2672

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Publication Date
2014-02-01

DOI
10.1016/j.jand.2013.09.021

Peer reviewed

Published in final edited form as:
J Acad Nutr Diet. 2014 February ; 114(2): 238–243. doi:10.1016/j.jand.2013.09.021.

Dietary Patterns in Asian Indians in the United States: An Analysis of the Metabolic Syndrome and Atherosclerosis in South Asians Living in America Study (MASALA)

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Abstract

Dietary patterns contribute to cardiovascular disease (CVD) risk. Asian Indians have earlier onset, more severe and prevalent CVD than many other racial/ethnic groups. We aimed to characterize dietary patterns in Asian Indians living in the United States and examine associations with cardio-metabolic risk factors. 150 Asian Indians, aged 45–84 years, without known cardiovascular disease, living in the San Francisco Bay area between August 2006 and October 2007 were enrolled into the Metabolic Syndrome and Atherosclerosis in South Asians Living in America (MASALA) study. A food frequency questionnaire validated in Asian Indians, fasting blood samples, and CT scans were obtained on all participants. Principal component analysis with varimax rotation was used to determine prevalent dietary patterns. Linear regression analyses were performed for associations between dietary patterns and metabolic factors, adjusting initially for age and sex, then additionally for BMI, income, education, MET-minutes of exercise, alcohol consumption, and smoking. Two distinct dietary patterns were identified that we termed "Western," and "Vegetarian." Compared with the Western diet, the Vegetarian diet was associated with lower HOMA-IR (−1.12; p=0.05) and lower HDL (−4.77, p=0.09). Given that the Western and Vegetarian patterns were each associated with adverse metabolic changes, healthful dietary choices may help Asian Indians improve risk factors for CVD.

Keywords

South Asian; dietary patterns; metabolic syndrome; cardiovascular disease; nutrition

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INTRODUCTION

Diet is a strong, modifiable risk factor for cardiovascular disease (CVD) and type 2 Diabetes (T2DM). Prior research have shown that "Western" dietary patterns with strong components of refined carbohydrates and red meat, can lead to increased rates of CVD and metabolic syndrome, while those high in whole grains, legumes, nuts and vegetable intake such as the "Prudent" or "Mediterranean" patterns appear to be protective. [1–5] Dietary patterns vary by ethnicity, and may change with migration to a new environment[6,7]. To date, there has been little investigation into dietary patterns in different immigrant ethnic groups in the United States.

Asian Indians are at higher risk for more severe, earlier onset CVD than many other racial or ethnic groups. [8] Coronary heart disease is the leading cause of death in Asian Indians in the United States, and occurs 10 years earlier in this high-risk ethnic group than in other ethnicities. [8,9] Metabolic syndrome and diabetes often occurs at a relatively low BMI, and are integral and independent risk factors for CVD in this population. [10–14] Components of the metabolic syndrome, such as waist circumference, lipid levels and regulation of glucose and insulin significantly contribute to the risk for CVD in this population. Furthermore, the actions of adipose cells and the quantity and patterning of body fat are newer, nontraditional risk factors which are of significance in a population in which standard BMI may not be an optimal indicator of risk. [10,11,15,16]

Given the well-recognized link between diet and metabolic syndrome, an important first step is to identify prevalent dietary patterns in Asian Indians in the United States. This investigation was an exploratory analysis of the associations of dietary patterns with components of the metabolic syndrome, lipids, hormones, cytokines produced by adipose tissue, and subcutaneous and visceral fat content in participants of the Metabolic Syndrome and Atherosclerosis in South Asians Living in America (MASALA) pilot study.

MATERIALS AND METHODS

This analysis was a cross-sectional investigation of 150 Asian Indians living in the San Francisco Bay area who participated in the MASALA pilot cohort. The detailed methods have been described elsewhere. [17] Briefly, this was a pilot study with a prospective cohort design, and we enrolled community-dwelling individuals from August 2006-October 2007. Participants self-identified as Asian Indian ethnicity, were aged 45–84 years, had no known cardiovascular disease. Those on nitroglycerin, with active cancer, with impaired cognitive ability, a life expectancy less than 5 years, who lived in a nursing home, or who had plans to relocate were excluded. The University of California, San Francisco, Institutional Review Board approved the study protocol and all study participants provided written informed consent.

Each participant underwent in-person interviews to determine age, sex, medical history and smoking status. Food group intake was collected with the Study of Health Assessment and Risk in Ethnic (SHARE) groups South Asian Food Frequency Questionnaire, which was developed and validated in South Asians in Canada.[18] This food frequency questionnaire included 163 items, with 61 items unique to the Asian Indian diet, and assessed usual eating habits, frequency and serving sizes over the past 12 months.[19] Individual food items from the SHARE food frequency questionnaire were grouped into 29 predefined subgroups reflecting likeness, underlying nutrient composition and culinary usage in the Asian Indian diet. Several foods (e.g. coffee) were kept as individual categories given their high reported intake.

Weight was determined using a digital scale, height with a stadiometer, and waist circumference using a measuring tape halfway between the lower ribs and the anterior superior iliac spine, at the site of greatest circumference. Dual-energy X-ray absorptiometry was used to determine percent body lean and fat mass. Abdominal and subcutaneous fat mass, and hepatic liver-to-spleen attenuation ratio (values of <1 represented higher amounts of hepatic fat) was measured using computed tomography.[15]

Blood samples were obtained after a requested 12-hour fast. Fasting glucose was measured using a glucose oxidase method, and insulin using a radioimmunoassay (Linco, St. Louis, MO). Total cholesterol, HDL cholesterol and triglycerides were measured using enzymatic methods, and LDL cholesterol was calculated using the Friedewald formula. [20] An oral glucose tolerance test was performed, in which participants consumed a 75g oral glucose solution, and blood samples for plasma glucose and insulin were taken after 120 minutes. HOMA-IR (Homeostasis Model Assessment –Insulin resistance), an assessment of insulin resistance, was calculated as: [Glucose(mmol/L) x Insulin(uIU/L)/22.5].[21] The Insulin Sensitivity Index (ISI), a dynamic measure of insulin sensitivity, was also calculated as: 10,000/square root of [fasting glucose x fasting insulin] x [mean glucose x mean insulin during OGTT]).[22] Total adiponectin was measured in duplicate via a radioimmunoassay (Linco, St. Charles, MO) with intra-assay coefficient of variation of 4.7%.

Statistical methods

Principal components analysis with varimax rotation was used to identify the most prevalent groupings of these major food group categories in our population.[23] After identifying two patterns that explained the majority of variance, we named these patterns according to their major components and similarity with patterns prevalent in existing literature (i.e. "Western" and "Vegetarian"). [24,25] Each participant was assigned a factor score for each dietary pattern based on the correlation of his or her food frequency questionnaire data with the food groupings in the two prevalent patterns. One dietary pattern was chosen for each participant based on the highest factor score. In a sensitivity analysis, we assigned a dietary pattern only to those participants with a factor score in the upper half of one dietary pattern and the lower half of the other dietary pattern, and used this subset of participants for further analyses of associations.

Baseline characteristics of the MASALA participants were compared by dietary pattern using chi-square test and analysis of variance (ANOVA) where appropriate. Linear regression analyses were used to determine associations of assigned dietary pattern with pre-specified metabolic outcomes. Age, BMI, number of alcoholic drinks per week, MET-minutes of exercise per week were modeled as continuous covariates; sex, education, income, smoking were categorical variables. Model 1 adjusted for age and sex. Model 2 additionally adjusted for BMI, income, education, METs of exercise per week, alcoholic drinks per week, and smoking. Testing for sex and age-specific interaction was completed and none found. The analysis was completed using STATA (version 11, College Station, TX, USA).

RESULTS AND DISCUSSION

Asian Indians in the United States in the MASALA study population were found to have two distinct dietary patterns. Using principal component analysis of completed food frequency questionnaires for all 150 participants, 2 dietary patterns were extracted (Table 1), which represent a total of 22.8% of the total variance in dietary pattern. The two dietary patterns observed were characterized as: "Western" and "Vegetarian." The Western dietary pattern included major nonvegetarian components besides dairy products, as well as fried snacks, high-fat dairy, pizza and potatoes. Prominent foods in the Vegetarian diet were sugar-sweetened beverages, rice and snacks.

Table 2 shows characteristics of participants by dietary pattern. All but two of the participants immigrated to the United States from India. Those consuming the Western dietary pattern also drank more alcohol per week (5.6 vs 2.3 drinks per week; p=0.01), and had lived in the United States for approximately 6 more years (26.5 vs 20.8 years; p=0.03) than their Vegetarian pattern counterparts. There was a trend towards a larger proportion of women consuming the Vegetarian dietary pattern, however this did not attain statistical significance (p=0.07). There were no differences in age, BMI, income, level of education, exercise, cigarette smoking, diabetes status or traditional Indian beliefs by dietary pattern.

The Vegetarian pattern was associated with a lower fasting glucose and HOMA-IR than the “Western” diet. HOMA-IR is a marker of insulin resistance, which it an independent risk factor for cardiovascular disease. [21,26,27] In multivariate regression analyses, we adjusted for age and sex in Model 1, and additionally adjusted for BMI, income, education, MET-minutes of exercise per week, alcoholic drinks per week, and smoking in Model 2. In comparison with the Western diet, the Vegetarian diet was associated with a lower HOMA-IR (−1.12; p=0.05) in the fully adjusted Model 2. Fasting glucose in Model 1 (−6.78; p=0.08) and Model 2 (−9.08; p=0.08) and fasting insulin in the fully adjusted model (−3.16; p=0.08) were both lower in those consuming the Vegetarian diet, however these results did not achieve significance. The Insulin Sensitivity Index (ISI) trended higher with consumption of the Vegetarian dietary pattern (Model 2: 1.03; p=0.06), suggesting improved insulin sensitivity than seen in the Western pattern. (Table 4) In sensitivity analyses, in which participants were analyzed as adhering to the Western dietary pattern only if their factor scores fell in the upper half of the Western dietary pattern and the lower half of the Vegetarian dietary pattern and vice versa. In these analyses, those adhering to the Vegetarian dietary pattern again had lower fasting glucose (−17.01, p=0.02) and HOMA-IR (−0.53, p=0.02).

Investigations within the MASALA study population [17,19], as well as larger cohorts have shown that higher intake of animal protein, specifically red and processed meats may be associated with diabetes and metabolic syndrome. [3,28–31] These findings suggest that those study participants consuming the Western dietary pattern may have abnormalities in glucose tolerance more often than their Vegetarian counterparts. Notably, however, there was no difference in diagnosis of diabetes or metabolic syndrome between those adhering to each dietary pattern.

The Western dietary pattern predominated among the Asian Indians who had lived in the United States for longer than an average of 20 years and was unique in including non-vegetarian foods as major components. In a separate investigation of Asian Indians and dietary patterns in the UK, a direct correlation between their “Mixed” pattern, which included high amounts of animal protein and Western snack foods, and risk of metabolic syndrome was found [24]. In this UK sample, greater time elapsed since immigration to the UK resulted in a reduced likelihood of vegetarianism, and an increase in the consumption of caffeinated beverages, including tea, coffee and sugar-sweetened beverages. [24]

Diets high in refined carbohydrates have been associated with a poorer risk profile for CVD. [32] Sugar-sweetened beverages and added sweeteners, have been associated specifically with a decrease in HDL. [33–36] The Vegetarian dietary pattern included sugar-sweetened beverages and rice as major components. Those adhering to the “Vegetarian” pattern had a lower HDL (−4.95; p=0.02) in Model 1, which approached significance in the fully adjusted model (−4.77, p=0.09). (Table 4) This dietary profile suggests that a diet may not be healthful simply by virtue of excluding animal-based protein, and that the "Vegetarian" diet presented within our study may also have detrimental metabolic effects.

Our study has several limitations. Given that our investigation is cross-sectional, we capture only dietary data from one year prior to our survey. Those currently following one dietary pattern may have recently altered their dietary habits, and metabolic outcomes may be subject to reverse causality. However, our results are supported by existing data and have biologic plausibility. Additionally, our sample size may not be adequate to elucidate all between-pattern differences in metabolic outcomes. Still, this remains the first characterization of dietary patterns in Asian Indians living in the United States, and presents useful information on consumption in an understudied population.

CONCLUSIONS

In this initial characterization of dietary patterns of Asian Indians in the United States, we found two distinct dietary patterns, both of which were associated with known metabolic risk factors. Future analyses on a larger sample population, as part of a longitudinal cohort, will provide important insights into the associations of dietary patterns in Asian Indians and incident CVD risk factors.

Acknowledgments

The authors thank the other investigators, the staff, and the participants of the MASALA study for their valuable contributions.

BLINDED FUNDING DISCLOSURE

The first author is supported by Training Grant NIH T32HL007180. The MASALA study was funded by K23 HL080026-01, the University of California, San Francisco Research Evaluation and Allocation Committee, and by NIH/NCRR UCSF-CTSI Grant Number UL1 RR024131-01. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Heart, Lung, And Blood Institute or the National Institutes of Health.

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Table 1

Factor loadings of food groups in the two principal dietary patterns identified in participants of the MASALA study[a]

Food grouping	Western	Vegetarian
	Added fat, coffee, eggs, fish, fried snacks, high- fat dairy, pizza, potatoes, poultry, red meat	**Sugar drinks, legumes, nuts, rice, snacks**
Variance Explained	11.8%	10.4%
Added fat	0.24	-
Alcohol	-	−0.12
Butter/ghee	-	-
Coffee	0.30	-
Eggs	0.24	-
fFsh	0.33	-
Fried snacks	0.22	-
Fruit	-	-
High-fat dairy	0.29	-
Sugar-sweetened beverages	-	0.41
Legumes	-	0.30
Low-fat dairy	-	-
Low sugar drinks	-	-
Nuts	-	0.23
Pasta	-	-
Pizza	0.30	-
Potatoes	0.22	-
Poultry	0.38	-
Red meat	0.29	-
Refined grains	-	-
Rice	-	0.47
Snacks	-	0.42
Sweets	-	-
Tea	-	-
Vegetable oil	-	-
Vegetables	-	-

[a]Positive loadings <0.20 and negative loadings > −0.10 designated by (−) for simplicity.

Table 2

Basic Characteristics by Dietary Pattern

Mean (SD)	Western (n=59)	Vegetarian (n=91)	p-value
Age (years)	55.8 (7.25)	58.1 (8.46)	0.09
Sex (% female)	41	56	0.07
BMI (kg/m^2)	26.6 (5.10)	25.8 (4.33)	0.30
Drinks per week	5.60 (6.99)	2.26 (3.99)	0.01*
Smoking (%)[a]	22	13	0.10
Education (No.)			0.84
≤ high school	6	12	
≤ Bachelor’s degree	7	30	
> Bachelor’s degree	46	45	
Family income (No.)			0.65
≤ $40,000	9	8	
$40,000–99,999	15	7	
≥ $100,000	35	14	
MET-minutes of exercise/week	2196 (2814)	1985 (2012)	0.59
Diabetes			0.29
None	18	33	
IFG or IGT[b]	22	34	
DM	19	24	
Years in the USA	26.5 (9.1)	20.8 (12.1)	0.03*
Indian Beliefs			0.08
Weak	24	23	
Intermediate	21	33	
Strong	14	35	

[a] smoked 100 cig in lifetime

[b] IFG: impaired fasting glucose; IGT: impaired glucose tolerance

* $p<0.05$

Table 3

Between-pattern differences in associations of metabolic outcomes with dietary pattern, parameter estimate [95% CI]

Outcome	"Vegetarian"			
	Total Sample Population (N=150)		Sensitivity Analysis (N=56)	
	Model 1[a]	Model 2[b]	Model 1[a]	Model 2[b]
Fasting glucose (mg/dL)	−6.78 [−14.45,0.884]	−9.08 [−19.14, 0.98]	−17.01* [−30.98, −3.05]	−24.13 [−54.34, −6.07]
2-hour glucose (mg/dL)	−7.87 [−33.66,17.91]	−20.51 [−53.48,12.47]	−35.91 [−83.72, 11.91]	−83.43 [−184.0, 17.16]
Fasting insulin (μU/mL)	−1.21 [−5.61,3.19]	−3.164 [−6.681,0.352]	−3.89 [−8.361, 0.573]	−3.93 [−11.94, 4.071]
2-hour insulin (μU/mL)	−22.64 [−60.39,15.10]	−36.52 [−79.36,6.327]	−30.83 [−101.0, 39.35]	−40.76 [−180.6, 99.04]
HOMA-IR	−0.42 [−1.84,0.99]	−1.12* [−2.241,0.00202]	−1.53* [−2.854, −0.212]	−1.57 [−3.870, 0.735]
LS attenuation ratio (HU)	−0.0072 [−0.088,0.074]	−0.0423 [−0.142,0.0576]	−0.0248 [−0.162, 0.112]	−0.0851 [−0.309, 0.139]
Visceral fat area (cm^2)	−9.66 [−27.41,8.094]	0.403 [−19.92,20.72]	−24.44 [−50.00, 1.127]	−15.32 [−65.08, 34.45]
Total cholesterol (mg/dL)	−7.20 [−18.49,4.10]	0.563 [−14.26,15.39]	3.559 [−13.09, 20.21]	−10.10 [−45.04, 24.85]
Triglycerides (mg/dL)	4.32 [−16.50,25.14]	6.670 [−21.85,35.19]	−9.178 [−38.11, 19.75]	−1.377 [−62.86, 60.11]
VLDL (mg/dL)	0.85 [−3.33,5.03]	1.156 [−4.597,6.908]	−1.902 [−7.680, 3.876]	−0.401 [−12.62, 11.82]
LDL (mg/dL)	−3.46 [−13.80,6.89]	3.152 [−10.17,16.48]	8.02 [−7.515, 23.56]	0.74 [−30.89, 32.37]
HDL (mg/dL)	−4.95* [−9.18, −0.73]	−4.821 [−10.61,0.966]	−2.63 [−9.539, 4.276]	−10.45 [−23.32, 2.407]
Waist-hip ratio (cm)	−0.0084 [−0.0287,0.0120]	−0.0152 [−0.0357,0.00534]	−0.019 [−0.052, 0.014]	−0.0033 [−0.059, 0.052]
Total Adiponectin (μg/mL)	0.0125 [−1.51,1.54]	0.0297 [−2.184,2.243]	2.63 [−0.16, 5.43]	1.90 [−4.231, 8.03]
ISI (Insulin Sensitivity Index)	0.41 [−0.40,1.22]	1.030 [−0.0337,2.093]	0.58 [−0.57, 1.73]	1.81 [−0.485, 4.11]

[*] $p \leq 0.05$

[a] Adjusted for age and sex.

[b] Adjusted for age, sex, income, METS of exercise per week, income, education, number of alcoholic drinks per week, smoked 100 cigarettes in lifetime.