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## The Association of Religious Affiliation with Overweight/Obesity among South Asians: The Mediators of Atherosclerosis in South Asians Living in America (MASALA) Study

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### Abstract

**Background**—Religiosity has been associated with greater body weight. Less is known about South Asian religions and associations with weight.

**Methods**—Cross-sectional analysis of the MASALA study (n=906). We examined associations between religious affiliation and overweight/obesity after controlling for age, sex, years lived in the U.S., marital status, education, insurance status, health status, and smoking. We determined whether traditional cultural beliefs, physical activity, and dietary pattern mediated this association.

**Results**—The mean BMI was 26 kg/m<sup>2</sup>. Religious affiliation was associated with overweight/obesity for Hindus (OR 2.12; 95% CI: 1.16, 3.89), Sikhs (OR 4.23; 95% CI: 1.72, 10.38), and Muslims (OR 2.79; 95% CI: 1.14, 6.80) compared with no religious affiliation. Traditional cultural beliefs (7%), dietary pattern (1%) and physical activity (1%) mediated 9% of the relationship.

**Conclusions**—Interventions designed to promote healthy lifestyle changes to reduce the burden of overweight/obesity among South Asians need to be culturally and religiously tailored.

### Keywords

overweight; obesity; religious affiliation; South Asian

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**Research involving human participants:** Informed consent was obtained from all individual participants included in the study.

## BACKGROUND

South Asians are one of the fastest growing ethnic groups in the U.S. and over 90% are foreign-born (1, 2). Compared to other racial/ethnic groups, South Asians have greater risk of obesity-related conditions, such as diabetes mellitus and coronary heart disease (3–6). Physical inactivity, diets low in fruits and vegetables, and central adiposity are believed to contribute to this disparity (3, 7–11).

Similar to other immigrant groups, South Asians may be involved in cultural and religious activities that revolve around traditional norms, such as participation in customary religious services (12–17). Religiosity among diverse racial/ethnic groups, such as Whites, African Americans, Hispanics, and Chinese Americans, has been associated with greater body weight or overweight/obesity (18–20). In a prior study, religiosity was positively associated with being overweight/obese among South Asian immigrants in the U.S., but no diet or physical activity data were available to explain this association (21).

Different religious affiliations within the heterogeneous South Asian community may affect smoking, alcohol use, and dietary practices differentially because of lifestyle prescriptions specific to each religion (22). For example, Hinduism prescribes vegetarianism, Islam prohibits alcohol or pork ingestion, and Sikhism strongly prohibits tobacco use (22–24). As immigrants increase their exposure to Western cultural practices, they may adopt the less healthy food choices found in their host country (25–29). For South Asians, this may mean reduced intake of plant foods and home-cooked meals that may increase risk for overweight/obesity and related conditions (30–32).

Using data from the Mediators in Artherosclerosis in South Asians Living in America (MASALA) study which included measures of diet, physical activity, and strength of traditional cultural beliefs, our objective was to examine the associations between religious affiliations and overweight or obese BMI among a religiously heterogeneous group of South Asians.

## METHODS

### Participants

The MASALA study is a community-based cohort investigating the prevalence and associations of cardiovascular risk factors and subclinical atherosclerosis in a population-based sample of South Asian men and women age 40–84 years (33). The MASALA study is the first prospective cohort of U.S. South Asians and was modeled on the Multi-Ethnic Study of Atherosclerosis (MESA) to allow for efficient and valid cross-ethnic comparisons (34). We enrolled 906 South Asians, free of CVD at baseline, from two geographical regions between October 2010 and March 2013.

### Data Collection

Measurements obtained at baseline included (but not limited to) sociodemographics, lifestyle factors, anthropometric measurements, oral glucose tolerance testing, brachial blood pressure, and blood samples for biochemical risk factors. Participants self-reported

religious affiliation with Hinduism, Sikhism, Islam, Jainism, Christianity, Buddhism, Zoroastrianism, or none. We classified participants who reported Buddhism and Zoroastrianism as “Other” (n=6) and those who reported more than one affiliation as “Multiple” (n=15).

BMI was calculated from measured weight and height (33). Three observations for which BMI was missing were dropped. In multivariate analysis, BMI was dichotomized using Asian BMI cutoffs as healthy (BMI < 23 kg/m<sup>2</sup>) or overweight/obese (BMI ≥ 23 kg/m<sup>2</sup>) (35, 36). We included 7 respondents categorized as underweight (BMI < 18.5 kg/m<sup>2</sup>) in the healthy BMI category. Waist and hip circumference were measured using a flexible tape measure according to a standardized protocol by certified staff. We defined South Asian abdominal obesity as obese waist circumference as ≥ 80cm in women and ≥ 90cm in men (37) and calculated the waist-to-hip ratio.

We included socio-demographic characteristics, health care access, health status, years of residence in the U.S., strength of traditional cultural beliefs, diet and physical activity as covariates in our analysis. Socio-demographics included age, sex, marital status, educational attainment, and income. Health status was gauged by self-reported health status, which has been shown to be associated with mortality in multiethnic populations (38), and cigarette smoking status. Health insurance status was used as a proxy for health care access. We calculated percentage of lifetime in the U.S. from years lived in the U.S. divided by the respondent's current age. Percentage of lifetime in the U.S. may be a better temporal measure than years lived in the U.S. because the former may better quantify the proportion of lifetime exposure to American cultural practices. Among the 19 U.S.-born respondents, we used current age for years lived in the U.S.

Using data from prior qualitative work in Asian Indians (17), we created a traditional cultural beliefs scale consisting of 7 items. The base question was “How much would you wish these traditions from South Asia would be practiced in America?” The seven items included: performing religious ceremonies; serving sweets at ceremonies; fasting on specific occasions; living in a joint family; having an arranged marriage; eating a staple diet of chapatis, rice, dal, vegetable, and yogurt; using spices for health and healing. The items were scored on a Likert scale with higher scores representing weaker traditional Indian beliefs. We analyzed tertiles of the score (<12 for strongest, 12–17 for moderate, and ≥17 representing weakest traditional beliefs). The Cronbach's alpha for this scale in the current study sample was 0.83 with similar reliability in both men and women.

Diet was assessed through an in-person food group intake using the Study of Health Assessment and Risk in Ethnic Groups (SHARE) South Asian Food Frequency Questionnaire, which was developed and validated in South Asians in Canada, and included items unique to the South Asian diet (39, 40). With principal component analysis, we have identified three distinctive dietary patterns; each respondent was assigned a factor score for each dietary pattern identified (41). The three major dietary patterns observed, named after the components with the highest factor loadings in each pattern, were: Animal protein (positive for alcohol, coffee, eggs, fish, pasta, pizza, poultry, red meat, refined grains, vegetable oil; negative for whole grain, low-fat dairy, legumes); Fried snacks, sweets and

high-fat dairy (positive for added fat, butter/ghee, fried snacks, fruit-juice, high-fat dairy, sugar-sweetened beverages, legumes, potatoes, refined grains, rice, snacks, sweets, whole grains; negative for vegetable oil and nuts); and Fruits, Vegetables, Nuts and Legumes (positive for fruit, fruit juice, legumes, low-fat dairy, vegetable oil, nuts, vegetables, whole grains). Physical activity was assessed using the Typical Week's Physical Activity Questionnaire (42) and reported as MET-minutes of physical activity per week. The "metabolic equivalent of task" (MET) is a ratio widely accepted as a replicable measure of the intensity level of a specific form of physical activity.

## Analysis

We describe the prevalence of baseline characteristics in the total sample. Multivariable logistic regression analyses were performed to estimate the odds of being classified as overweight/obese as a function of religious affiliation, adjusted for socio-demographic characteristics, health care access, health status, and percentage of lifetime in the U.S in Model 1 (n=903). Model 2 was additionally adjusted for intensity of traditional cultural beliefs, dietary pattern, and physical activity (n=888). We dichotomized marital status, educational level, health status, and health care insurance status. Age, percentage of lifetime in the U.S., and exercise MET-min per week were examined as continuous and categorical variables in the model. While income was not included in the final model (n=26 missing observations), our results with or without income were similar. Missing and refused observations were dropped from our multivariate analyses. In all models, we used "None" or no religious affiliation as the reference category.

Multivariable models were also stratified by strength of traditional cultural beliefs (weak, moderate, strong). We tested for sex-specific interactions with religious affiliation and none were found. We conducted mediation analysis using the Karlson/Holm/Breen logit regression tests to determine if traditional cultural beliefs, dietary pattern, physical activity, smoking status, immigrant status (U.S.-born or foreign-born), and/or educational attainment mediated the relationship between religious affiliation and overweight/obese BMI (43). We tested for sex- and age-specific interactions and none were found. The analysis was completed using STATA/SE (version 12.0, StataCorp, College Station, TX).

## RESULTS

The mean age of South Asians in the MASALA cohort was 55 years; most of the sample was married, well-educated, and insured (Table 1). A significant percentage of respondents had high blood cholesterol (46%), hypertension (41%), and/or diabetes (25%). On average, half of respondents' lives were spent in the U.S. The majority of respondents were affiliated with Hinduism, followed by Sikhism, Islam, Jainism, Christianity, other (Buddhism or Zoroastrianism), and multiple religions. Fifty-eight respondents reported no religious affiliation (6.4%). The age-adjusted mean BMI was 26 kg/m<sup>2</sup>, which did not differ by sex. Seventy-six percent of the sample was overweight/obese. Hindus had a mean BMI of 25.8 kg/m<sup>2</sup>, Sikhs 27.2 kg/m<sup>2</sup>, Muslims 26.7 kg/m<sup>2</sup>, Jains 25.6 kg/m<sup>2</sup>, Christians 26.4 kg/m<sup>2</sup>, other 22.9 kg/m<sup>2</sup>, multiple religions 28.4 kg/m<sup>2</sup>, and no religious affiliation 26.1 kg/m<sup>2</sup>. The figure shows the BMI categories by each religious affiliation.

In the multivariable analysis, Hindus had 2.12 greater odds of being overweight/obese than respondents with no religious affiliation (95% CI: 1.16, 3.89; Table 2). This higher odds was also observed for Sikhs (OR 4.23, 95% CI: 1.72, 10.38) and Muslims (OR 2.78, 95% CI: 1.14, 6.80) compared to those with no religious affiliation in Model 1. We found no significant associations for Jains, Christians, other or multiple religious affiliation respondents. When we additionally adjusted for traditional cultural values, physical activity, and dietary pattern in Model 2, we found similar increased likelihood for being overweight/obese among Hindus, Sikhs, and Muslims. The addition of macronutrients or substitution of dietary pattern with macronutrients did not meaningfully change the results. Percentage of lifetime in the U.S. was not significantly associated with BMI in adjusted models.

In order to understand if traditional cultural beliefs moderated the relationship between religious affiliation and overweight/obese BMI, we stratified Model 2 by traditional cultural belief score (weak, moderate, or strong). We found that among those with weak traditional beliefs, Hindus (OR 2.34), Sikhs (OR 9.17), and Jains (OR 6.44) were significantly more likely to be overweight/obese than those with no religious affiliation ( $p < 0.05$ ). No such effect of religious affiliation was found in stratified models of South Asians with strong or moderate cultural beliefs. Traditional cultural beliefs, dietary pattern, and physical activity were examined as mediators of the relationship between religious affiliation and overweight/obesity. The proportion of the total effect explained by these three variables in the mediation was 8.9%; traditional cultural beliefs contributed 6.9%, while dietary pattern and physical activity contributed 1.1% each. Smoking status, educational attainment, and immigrant status were not significant mediators.

## DISCUSSION

Risk of overweight/obese BMI was higher among respondents who affiliated with Hinduism, Sikhism, and Islam compared to those with no religious affiliation. We found minimal mediation in the relationship between religious affiliation and overweight/obesity by traditional cultural beliefs, dietary pattern, and physical activity. Adherence to traditional cultural beliefs, which included questions on diet and religious participation, may provide a deeper understanding of why religious affiliation may impact obesity risk in this population.

Our findings are somewhat consistent with a study that found highly religious South Asian Hindus and Sikhs were more likely to be overweight/obese than those who were less religious (21). In contrast to that study, we also found a significant association of being overweight/obese among Muslim South Asian immigrants living in the U.S. Religion and religiosity have been linked to increased body mass index in other non-South Asian populations (18, 20, 44–47).

We found that a proxy measure of acculturation, as measured by percentage of lifetime in the U.S., was not associated with risk for overweight/obesity. This finding is consistent with some studies that did not find an association between years in the U.S. or English proficiency with obesity (21, 48), though other studies have found a positive association with BMI among Asian American immigrants (49, 50). Dietary acculturation, or the adoption of western dietary practices, has been observed among immigrants, and one study among

Canadian South Asian immigrants found that length of residence was associated with increased consumption of fruits and vegetables and improvement in food preparation (i.e., grilling vs. deep frying), but also increased consumption of convenience foods, red meat, sugar-sweetened beverages, and eating out (51). In the MASALA sample, recent South Asian immigrants (<20 years of residence in the U.S.) were more likely to be categorized as following a Fried Snacks, Sweets and High-fat Dairy diet or Fruits and Vegetables dietary pattern in comparison to long-term resident respondents who were more likely to follow a Western dietary pattern (41). Those with stronger traditional cultural beliefs or limited English proficiency were also more likely to adhere to the Sweets and Refined Grains dietary pattern.

Religious practices around diet, physical activity, and tobacco use may possibly explain risk for increased BMI among Hindus, Sikhs, and Muslims compared to those with no religious affiliation. For example, gatherings centered on religious and/or cultural ceremonies for South Asian immigrants may involve consumption of foods high in refined sugar or saturated fat (17, 23, 52). Nicotine is an appetite suppressant, and practicing Sikhs may abstain from tobacco use, and possibly increase their risk for increased BMI (53). However, cigarette smoking was low in this population overall. Religious Muslims observe daily prayers, which some regard as daily exercise since it involves change in body position (54–56); prayers have not been shown to correlate with physical activity measures or weight changes. Cultural/religious and gender norms have also been shown to be a barrier to physical activity among South Asian women (57). In general, South Asians have reportedly low rates of physical activity, and in our sample, one-third of participants were relatively sedentary (<500 METS/min/week) (3, 58).

Our study has several limitations. Given the cross-sectional design, we are unable to draw causal inferences about religious affiliation and BMI. Measures of religiosity, such as adherence to religious tenets or practices, were not measured, and may provide further explanation for the positive association; future questionnaires will include questions on religious participation. Our sample was well-educated, which may limit capturing associations between socioeconomic status, religion, and obesity. However, the sample reflects the South Asian community in the U.S. and their distribution by religious affiliation (33). There may have been inadequate power to detect associations between religious affiliation and BMI status among Jains, Christians, other, and multiple religion groups due to small sample sizes. Some researchers may contest using Asian-specific BMI cut-offs given no mortality differences among Asians at these lower cut-points (59). We conducted sensitivity analysis using different BMI classifications (i.e., BMI  $\geq 25$  kg/m<sup>2</sup> vs. BMI < 25 kg/m<sup>2</sup> or BMI  $\geq 27.5$  or 30 kg/m<sup>2</sup> vs. BMI < 27.5 or 30 kg/m<sup>2</sup> or BMI as continuous variable) and our results remained robust. Exclusion of underweight individuals or respondents > 70 years old did not change our results. While those affiliated with Sikhism had a higher waist circumference compared to those with no religious affiliation ( $\beta=3.6$  in both models;  $p<0.05$ ), there was no significant relationship between abdominal obesity and religious affiliation (37).

The links between religion, cultural beliefs and weight in South Asian immigrants appear to be unique among other immigrant groups and deserve further exploration. The religious and

cultural community may be synonymous for some South Asian groups, and South Asians may derive social support from these communities, which may be responsible for encouraging behaviors that increase overweight/obesity risk (13). Obesity, often considered a lifestyle disease, may be influenced by religion and religious practices. For South Asians, who are at greater risk for obesity-related diseases, such as coronary heart disease and diabetes mellitus, religiously and culturally tailored interventions to promote healthy lifestyle behaviors may be especially critical.

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## Biography

Dr. Kanaya is a Professor of Medicine, Epidemiology & Biostatistics at the University of California, San Francisco. She is the principal investigator of the Mediators of Atherosclerosis in South Asians Living in America (MASALA) Study, and is an expert in cardiovascular disease and diabetes prevention. The MASALA Study is focused on examining sociocultural, behavioral, environmental and biologic risk factors of cardiovascular disease in South Asians.

## ABBREVIATIONS AND ACRONYMS

<b>BMI</b>	body mass index
<b>MASALA</b>	Mediators in Atherosclerosis in South Asians Living in America
<b>U.S.</b>	United States
<b>OR</b>	odds ratio
<b>CI</b>	confidence interval
<b>MESA</b>	Multi-Ethnic Study of Atherosclerosis
<b>IRB</b>	Institutional Review Board
<b>SHARE</b>	Study of Health Assessment and Risk in Ethnic Groups
<b>MET</b>	Metabolic Equivalent of Task

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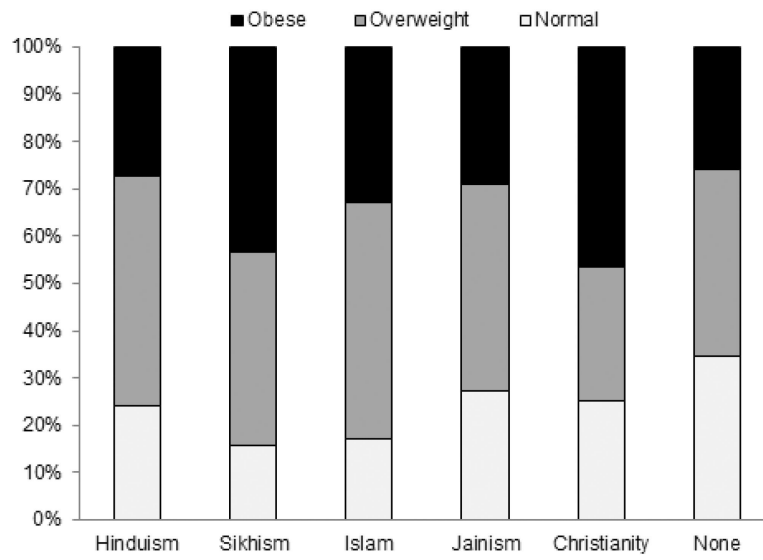


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**Figure.** BMI category by religious affiliation in MASALA (Normal BMI <math><23 \text{ kg/m}^2</math>; overweight 23–27.5  $\text{kg/m}^2</math>; obese >27.5  $\text{kg/m}^2</math>)$$

**Table 1**Characteristics of South Asians in MASALA baseline examination, 2010–2013, n=906<sup>a</sup>

Characteristic	N=906	% or mean (SD)
<i>Age (years)</i>		55.3 (9.4)
39–49y (%)	293	32.3
50–59y (%)	302	33.3
60–69y (%)	235	25.9
70–83y (%)	76	8.4
<i>Sex (%)</i>		
Male	486	53.6
Female	420	46.4
<i>Marital status (%)</i>		
Married	822	90.7
Not married	84	9.3
<i>Educational attainment (%)</i>		
< Bachelor's degree	110	12.1
≥ Bachelor's degree	796	87.9
<i>Annual household income (%)</i>		
<\$100,000	324	36.8
≥\$100,000	556	63.2
<i>Health insurance (%)</i>		
Insured	828	91.4
Not insured	78	8.5
<i>Health status (%)</i>		
Poor/fair/good	162	17.9
Very good/excellent	744	82.1
<i>Health conditions (%)</i>		
High blood cholesterol	404	45.7
Hypertension	370	40.8
Diabetes	230	25.6
<i>Smoking status (%)</i>		
Never	751	82.9
Former	124	13.7
Current	31	3.4
<i>Alcohol use (1+ drinks/week) (%)</i>		
Yes	299	33.0
No	607	67.0
<i>Exercise MET/min/week categories (%)</i>		
0–499	295	32.6
500–999	180	19.9
1000–1999	225	24.8
2000+	206	22.7

Characteristic	N=906	% or mean (SD)
<i>Dietary Pattern (%)</i>		
Animal protein	298	33.4
Fried snacks/sweets/high-fat dairy	304	34.1
Fruits/vegetables/nuts/legumes	290	32.5
Percentage of lifetime in U.S.	906	50.5 (18.0)
<i>Traditional South Asian beliefs score (%)</i>		
Strong (0–11) (%)	300	33.2
Moderate (12–16) (%)	323	35.7
Weak (17–28) (%)	281	31.1
<i>Religious affiliation (%)</i>		
Hinduism	610	67.3
Sikhism	69	7.6
Islam	64	7.1
Jainism	56	6.2
Christianity	28	3.1
Other (Buddhism, Zoroastrianism)	6	0.7
Multiple religions	15	1.7
None	58	6.4
<i>Body mass index (kg/m<sup>2</sup>)</i>	903	26.0 (4.3)
Underweight (BMI < 18.5) (%)	7	0.8
Normal (18.5 ≤ BMI < 23) (%)	210	23.6
Overweight (23 ≤ BMI < 27.5) (%)	415	46.0
Obese (BMI ≥ 27.5) (%)	271	30.0
<i>Waist circumference (cm)</i>	905	92.8 (10.3)
Obese waist cm (%)		
(≥80cm women; ≥90cm men)	905	78.3
<i>Waist to hip ratio</i>	905	0.90 (0.07)

<sup>a</sup>Column totals may not sum to 100% due to rounding error or missing observations.

**Table 2**

Adjusted odds ratios examining overweight/obesity status by religious affiliation among South Asians, MASALA baseline examination, 2010–2013<sup>a</sup>

	Unadjusted, n=903 (95% CI)	Model 1, n=903 (95% CI)	Model 2, n=888 (95% CI)
<i>Religious affiliation</i>			
None	1.00	1.00	1.00
Hinduism	1.65 (0.93, 2.93)	<b>1.95 (1.07, 3.53)</b>	<b>2.02 (1.08, 3.80)</b>
Sikhism	<b>2.78 (1.20, 6.44)</b>	<b>3.48 (1.46, 8.33)</b>	<b>3.61 (1.46, 8.89)</b>
Islam	<b>2.54 (1.09, 5.91)</b>	<b>2.54 (1.05, 6.17)</b>	<b>2.61 (1.01, 6.73)</b>
Jainism	1.40 (0.63, 3.13)	1.74 (0.76, 3.96)	1.87 (0.78, 4.46)
Christianity	1.58 (0.57, 4.35)	1.69 (0.60, 4.78)	1.68 (0.58, 4.88)
Other (Buddhism, Zoroastrianism)	0.26 (0.04, 1.56)	0.30 (0.05, 1.83)	0.41 (0.07, 2.52)
Multiple religions	3.42 (0.70, 16.68)	4.17 (0.83, 20.81)	4.51 (0.89, 22.74)
<i>Percentage lifetime U.S.</i>		1.00 (0.99, 1.00)	0.99 (0.98, 1.00)
<i>Age categories</i>			
39–49y		1.00	1.00
50–59y		0.82 (0.55, 1.22)	0.83 (0.55, 1.25)
60–69y		0.69 (0.45, 1.06)	0.69 (0.45, 1.06)
70–83y		<b>0.47 (0.26, 0.85)</b>	<b>0.48 (0.26, 0.87)</b>
<i>Sex</i>			
Male		1.00	1.00
Female		1.04 (0.74, 1.47)	1.04 (0.73, 1.47)
<i>Marital Status</i>			
Not married		1.00	1.00
Married		0.59 (0.32, 1.09)	0.58 (0.31, 1.08)
<i>Educational attainment</i>			
< Bachelor's degree		1.00	1.00
≥ Bachelor's degree		0.93 (0.55, 1.58)	1.00 (0.58, 1.73)
<i>Health insurance</i>			
Not insured		1.00	1.00
Insured		0.70 (0.36, 1.35)	0.78 (0.39, 1.58)
<i>Health status</i>			
Poor/fair/good		1.00	1.00
Very good/excellent		0.90 (0.59, 1.37)	0.93 (0.61, 1.44)
<i>Smoking status</i>			
Never		1.00	1.00
Former		1.41 (0.86, 2.31)	1.44 (0.86, 2.40)
Current		1.53 (0.56, 4.19)	1.80 (0.59, 5.48)
<i>Cultural beliefs</i>			
Strong			1.00
Moderate			0.71 (0.47, 1.05)



	Unadjusted, n=903 (95% CI)	Model 1, n=903 (95% CI)	Model 2, n=888 (95% CI)
Weak			0.86 (0.55, 1.34)
<i>Exercise (MET/min/week)</i>			
0-499			1.00
500-999			<b>0.62 (0.39, 0.98)</b>
1000-1999			0.82 (0.52, 1.30)
2000+			0.69 (0.44, 1.10)
<i>Dietary Pattern</i>			
Animal protein			1.00
Fried snacks/ Sweets			1.23 (0.80, 1.91)
Fruits & Vegetables			1.08 (0.70, 1.65)

<sup>a</sup>Bold font when p<0.05

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