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Acculturation and Subclinical Atherosclerosis among U.S. South Asians: Findings from the MASALA study

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Abstract

Objective—Longer duration of residence among immigrants to the United States, a proxy measure of acculturation, has been associated with higher subclinical atherosclerosis. South Asian immigrants are the second fastest growing immigrant group in the U.S. but little is known about the effects of acculturation with atherosclerosis in this high cardiovascular risk population.

Methods—We conducted a cross-sectional analysis using data from a community-based cohort called the Mediators of Atherosclerosis in South Asians Living in America (MASALA) study. Participants (n=900) were between ages of 40–84 years and had no existing cardiovascular disease. We developed a multi-dimensional measure of acculturation in South Asians, called traditional cultural beliefs, and measured other proxy measures of acculturation to determine whether they were associated with higher levels of subclinical atherosclerosis after controlling for socioeconomic, behavior/lifestyle, and cardiovascular risk factors.

Results—Mean duration of residence in the U.S. was 27±11 years and tertiles of strength of traditional cultural beliefs were examined. Longer duration of U.S. residence was associated with higher levels of coronary artery calcium even after adjustment for covariates and lifestyle mediators. The novel measure of strength of traditional cultural beliefs was associated with lower common carotid intima media thickness among those with moderate traditional beliefs only.

Conclusions—These findings support the need for better conceptualization and measurement of how migration influences cultural beliefs and practices, and their subsequent influence on health behaviors and cardiovascular disease risk.

Keywords

Atherosclerosis; Acculturation; Athnicity

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Introduction

South Asian immigrants (individuals from India, Pakistan, Bangladesh, Sri Lanka and Nepal) comprise the second largest Asian subgroup in the United States, having grown by 81% between Census 2000 and 2010, with approximately 3.4 million U.S. residents currently [1]. Similar to other immigrants, South Asians undergo cultural changes after migration to the U.S. “Acculturation” has been defined as a process where members of one group adopt the attitudes, values, customs, beliefs and behaviors of another culture [2,3]. Acculturation to the U.S. in other immigrant groups such as Japanese and Mexicans has been shown to adversely affect health behaviors and lead to higher rates of obesity, diabetes, hypertension and heart disease [4,5]. Longer duration of residence in the U.S. among immigrants, a surrogate marker for acculturation, has also been associated with higher levels of subclinical atherosclerosis among Latinos, African Americans and Chinese Americans in the Multi-Ethnic Study of Atherosclerosis (MESA) [6–8]. Very few studies have measured acculturation and its association with atherosclerosis or cardiovascular disease among U.S. South Asians. Literature on the South Asian diaspora suggests that South Asian immigrants retain a strong sense of cultural and ethnic identity [9,10]. Anthropologists working with migrant groups have sometimes pointed to a persistence of cultural differences [11], which contrasts with ideas about acculturation. In particular, South Asians have been noted to hold onto core values and practices at home (e.g. eating South Asian food, traditional family structure) while easily adapting to interactions, language, and etiquette outside the home [12,13]. These findings suggest that the traditional proxy measures of acculturation which have been used in epidemiologic research, such as years in the U.S. or English language use [14], may not adequately capture the multidimensionality of culture and acculturation on the health of South Asian immigrants.

We previously developed a scale to measure traditional cultural beliefs using qualitative methods [15] and have tested it in a pilot study of Asian Indians [16]. We administered this traditional cultural beliefs scale and other demographic, communication, social interactions, and dietary practice questions to capture specific domains of acculturation in a large community-based cohort of U.S. South Asians. We aimed to 1) determine associations between different measures of acculturation and subclinical atherosclerosis among U.S. South Asians, and 2) investigate whether the association between the traditional cultural beliefs scale is stronger than the proxy measures of acculturation for atherosclerosis. We determined whether this more comprehensive set of measures of acculturation were associated with higher levels of subclinical atherosclerosis after controlling for socioeconomic, behavior/lifestyle, and cardiovascular risk factors. We hypothesized that the traditional cultural beliefs scale which is linked to specific behaviors would be more closely associated with atherosclerosis outcomes rather than other proxy measures of acculturation.

Material and Methods

Study sample

The MASALA study is a community-based cohort of South Asian men and women from two clinical sites (San Francisco Bay Area at the University of California, San Francisco (UCSF) and the greater Chicago area at Northwestern University (NWU)). All visits were

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conducted by trained bilingual study staff and all consent forms were translated into Hindi and Urdu. The baseline examination was conducted from October 2010 through March 2013, and a total of 906 participants were enrolled. The institutional review boards of UCSF and NWU approved the MASALA study protocol.

Eligibility Criteria

Study methods have been previously reported [17]. Briefly, to be eligible for the MASALA study, participants had to (1) self-identify with South Asian ethnicity, (2) be between ages of 40 and 84 years, and (3) be able to speak and/or read English, Hindi or Urdu, the main languages spoken by immigrants from South Asia. We used identical exclusion criteria to MESA [18] which included having a physician diagnosed heart attack, stroke or transient ischemic attack, heart failure, angina, using nitroglycerin, or having had a cardiovascular procedure such as coronary artery bypass graft surgery, angioplasty, valve replacement, pacemaker or defibrillator implantation, or any surgery on the heart or arteries. Those with current atrial fibrillation or in active treatment for cancer were excluded. Those with life expectancy < 5 years due to a serious medical illness, impaired cognitive ability as judged by the reviewer, plans to move out of the study region in the next 5 years, or those living in a nursing home or waiting to enter a nursing home were also excluded. Due to CT scanner limitations, those weighing over 300 lbs. were excluded.

Traditional Cultural Beliefs and other Acculturation measures

Since there are no validated multidimensional instruments to measure acculturation among South Asians, we attempted to capture several specific domains of acculturation including language use and fluency, social connections, dietary preferences, and cultural beliefs. We also collected data on nativity, years of residence in the U.S., and calculated percent of life spent in the U.S. (years of residence in the U.S./age).

Using data from prior qualitative work in Asian Indians [15], 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 chapattis, rice, daal, 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. Preliminary description of this continuous scale showed a U-shaped association with cIMT outcomes. Therefore, 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.

Covariates

We gathered information on participant’s demographic data (sex, age, and clinical site). These variables were included in all multivariate models.

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Potential mediators

Mediators considered were total caloric intake, total physical activity, exercise, tobacco and alcohol use, waist circumference, fasting glucose, systolic blood pressure, LDL-cholesterol, HDL-cholesterol, and cholesterol lowering medication use which have all been associated with atherosclerosis in this study population [19].

Total caloric intake over the previous year was assessed using the Study of Health Assessment and Risk in Ethnic Groups (SHARE) food frequency questionnaire, which was created and validated among South Asians in Canada [20]. Total physical activity and total exercise in MET-min/week were assessed using the Typical Week's Physical Activity Questionnaire [21]. Total physical activity included intentional exercise, occupational activities, volunteer activities, household chores, yardwork, child/adult care, transportation, and leisure activities. Intentional exercise included walking for exercise, dancing, team sports, dual sports, individual activities, moderate conditioning activities, and heavy conditioning activities. Tobacco use and alcohol consumption were determined by questionnaires.

Seated resting blood pressure was measured three times using an automated blood pressure monitor (V100 Vital sign monitor, GE Medical Systems, Fairfield, CT) and the average of the last two readings used for analysis. Hypertension was defined as self-reported treatment for hypertension or a systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg. Participant weight was measured on a standard balance beam scale or digital weighing scale and height using a stadiometer. Waist circumference was measured using a flexible tape measure tape at the site of maximum circumference midway between the lower ribs and the anterior superior iliac spine.

After a requested 12 hour fast, blood tests were obtained. Fasting plasma glucose was measured by the glucose oxidase method; total cholesterol, triglycerides, and high-density lipoprotein (HDL) cholesterol were measured by enzymatic methods (Quest, San Jose, CA) and low-density lipoprotein (LDL) cholesterol was calculated [22]. Diabetes was classified if a participant was using a glucose-lowering medication or had a fasting plasma glucose ≥126 mg/dl. Impaired fasting glucose was defined for those with fasting glucose between 100–125 mg/dl, and normal glucose was <100 mg/dl [23]. Fasting serum samples were batched for insulin measured by the sandwich immunoassay method (Roche Elecsys 2010, Roche Diagnostics, Indianapolis, IN).

Subclinical Atherosclerosis measures

Carotid intima media thickness—High-resolution B-mode ultrasonography was conducted for measurement of right and left internal and common carotid artery intima-media thickness (cIMT). Complete details of the protocol have been published and vascular technicians at both study sites were trained and certified on the scanning protocol by the reading center [17]. Briefly, the vascular technician located the bifurcation of the carotid artery, and identified the maximal wall thickening in the near or far wall, in the carotid bulb or internal carotid artery. We measured maximum cIMT in each of 8 arterial segments from each side: the near and far wall images were analyzed from the lateral view of the common

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carotid artery and the anterior, lateral and posterior views of the bifurcation or the internal carotid artery. Each of these images was collected in a specified order and recorded and the digitized data were mailed to the Ward A. Riley Ultrasound Reading Center at Wake Forest School of Medicine for wall-thickness measurements. The maximum CIMT of the far wall for each of the segments was measured using standardized protocol.

Coronary artery calcium Agatston scores—Cardiac CT scans were performed using a gated-cardiac CT scanner, as previously described [17]. Participants were examined in the supine position and a scout image was taken to determine the level of the carina and the first scan was set 1 cm below the carina. Scanning was performed from superior to inferior, and a total of 46 images were obtained with 3.0-mm slice thickness. All CT scans were sent in batches to the Reading Center at Harbor–UCLA Medical Center, where they were read with Rephot Imaging software according to published methods [24]. Coronary artery calcium Agatston scores were reported for each of the four major coronary arteries and the summed score was used.

Statistical Analyses

Baseline characteristics were compared using *t*-tests for continuous variables and chi-squared tests of homogeneity for categorical variables. We checked the correlation between the continuous duration of residence in the U.S. variable with the traditional cultural beliefs variable using Pearson correlation.

We used a continuous outcome measure for cIMT and a categorical measure for CAC given the highly skewed distribution of CAC. Linear regression models were used to examine the unadjusted association between the acculturation predictors, covariates, and the continuous cIMT outcomes; results are presented as betas (change in mean cIMT) with 95% confidence intervals (CIs) for the given unit of change in the predictor or covariate. Multinomial logistic regression models were used to examine the unadjusted association between the acculturation predictors, covariates, and the categorical CAC outcome (CAC = 0 [referent], 1–400, and >400), with results presented as relative risk ratios (RRR) and 95% CIs.

Linear regression (cIMT outcomes) and multinomial logistic regression (categorical CAC outcome) were used to determine which acculturation measures were significantly associated with the atherosclerosis outcomes at $p<0.20$ after adjustment for age, sex, and site which produced the “acculturation model”. We determined the age, sex, and site-adjusted association between each significant acculturation measure and each potential mediator. Mediators which were associated with at least one of the acculturation measures at $p<0.20$ were entered into a full multivariable model. We tested the interaction between sex and significant acculturation measures prior to adding the mediators to determine whether the effect of acculturation on atherosclerosis outcomes differed for men and women.

All analyses were conducted in SAS version 9.3 (SAS Institute, Cary, NC) and Stata version 12.1 (Stata Corporation, College Station, TX).

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Results

Of the 906 participants enrolled in the MASALA study, a total of 900 had cIMT measures and from this subgroup, a total of 894 had available CAC measures. Table 1 shows the acculturation and atherosclerosis characteristics of the participants. Approximately 98% of participants were foreign-born and had lived in the U.S. for an average of 27 years. While there was no difference in the mean years or percent of life lived in the U.S. by sex, more women spoke English poorly or not at all compared to men. Significantly more men reported eating only or mostly South Asian food at home, shopping more frequently at South Asian markets, and having only or mostly South Asian friends than women. The median score on the traditional cultural beliefs scale did not differ by sex, but was slightly more skewed to the right (weaker beliefs) among women than men. Mean cIMT values and median CAC scores were significantly higher for men than women.

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Table 2 shows the bivariate results for each of the two continuous cIMT outcomes and the categorical CAC outcome with the acculturation measures and other potential socioeconomic, lifestyle and cardiovascular disease risk factors. More years of residence in the U.S. (or percent life in the U.S.) was associated with higher cIMT and CAC values. Other proxies of acculturation, such as language proficiency and friend and food preferences, did not have strong associations with atherosclerosis. Those who ate South Asian food equally as much as other food in restaurants had somewhat higher cIMT values than those eating either just South Asian or other foods in restaurants. Having traditional cultural beliefs in the moderate range was associated with lower common cIMT levels than having weaker beliefs. There was also a trend for stronger traditional cultural beliefs to be associated with higher odds of CAC in the moderate range (1–400 score). The correlation between years of residence in the U.S. and the traditional cultural beliefs score was low (Pearson r=0.22).

Discussion

In a community-based sample of middle-older aged South Asians, we found that a longer duration of residence in the U.S. was associated with higher levels of subclinical atherosclerosis. This direct effect of U.S. residence remained robust with coronary artery calcium after further adjustment for covariates and lifestyle mediators. Another multi-

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dimensional measure of acculturation developed among South Asians, strength of traditional cultural beliefs, was associated with lower common carotid intima media thickness among those with moderate traditional beliefs only. These findings highlight alternative ways to measure cultural factors in epidemiologic research and their potential influence on cardiovascular disease risk.

Several studies have examined the effect of duration of residence in the U.S. as a proxy measure for acculturation and atherosclerosis. In MESA, years of residence in the U.S. was positively associated with the presence and amount of coronary artery calcium in Chinese, African Americans, and Latinos and this association were not accounted for by smoking, BMI, LDL and HDL-cholesterol, hypertension, and diabetes [6]. Longer residence in the U.S. was also associated with more carotid plaque [7] and higher coronary and thoracic calcium among Latinos [8]. A few studies have examined the effect of duration of residence with atherosclerosis and/ or cardiovascular disease prevalence among South Asians finding similar positive associations [25–27]. In the Canadian SHARE study, longer duration of residence in Canada was independently associated with cardiovascular disease prevalence among South Asians after adjusting for conventional risk factors, novel biomarkers and carotid atherosclerosis [25]. Similarly, we found that longer residence in the U.S. was associated with higher CAC levels even after adjusting for explanatory lifestyle behaviors and other risk factors. It is possible that other unhealthy lifestyle factors that we failed to measure adequately, including psychological stressors or environmental factors, may explain this association.

An important finding of this study is that South Asians who had moderate scores on the traditional cultural beliefs scale, possibly reflecting a bicultural affiliation, had lower common carotid intima media thickness compared to those with stronger or weaker traditional beliefs. The use of the traditional cultural beliefs scale demonstrated nuances that were not apparent when using proxy measures such as duration of residence or English language proficiency. This is particularly true for the South Asians in the MASALA study because the majority had lived in the U.S. for more than 27 years and spoke English well, suggesting this group was highly acculturated. However, the cultural beliefs scale allowed us to capture a more multidimensional picture of South Asians' cultural traditions, beliefs, and identity. The concept of biculturalism, which represents affiliation with both one's heritage culture and the host culture, and was originally derived by social scientists focusing on cultural behaviors such as language use, choice of friends, media preferences [28] but has more recently included cultural practices, values, and identifications [29]. Biculturalism, which has been measured as fluency in both a native language and in English, has been associated with lower rates of obesity in Asians in California [30] and in Latinos [31,32]. However, we are not aware of other studies measuring biculturalism using multidimensional tools and atherosclerosis in South Asians or other ethnic groups. We hypothesize that healthier lifestyle behaviors retained from the native culture and adopted from the host culture account for some of this beneficial effect; however the association was not explained by our measured lifestyle factors. Additionally, attitudes towards or knowledge about disease risk and prevention in the moderate traditional cultural beliefs group may be explanatory factors which were not measured in our study.

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While we had a large community-based sample of South Asians with several measures of socioeconomic status, conventional risk factors, lifestyle factors, and atherosclerosis we were limited in a single assessment of a few selected cultural factors in this cohort. Ideally, the measurement of cultural beliefs at several time intervals over the immigration time period and assessment of change would be a better method to truly capture the effect of acculturation on any outcome. The traditional cultural beliefs scale was originally developed in an Asian Indian sample of primarily Hindu and Sikh participants [15], and may not adequately measure traditional cultural beliefs in other South Asian groups or those of other religious affiliation. Moreover, the South Asians included in MASALA were recruited from two geographic locations in the U.S. and the high socioeconomic attainment of this cohort as described previously [17] limit the generalizability of these findings to all immigrant South Asians. We may have missed the full range of acculturation in our sample, for example not having enough limited English proficient participants, and therefore may have underestimated the expected associations in all U.S. South Asians.

In conclusion, longer duration of residence in the U.S. was associated with higher CAC scores and having moderate traditional beliefs was associated with lower common cIMT in South Asians. These findings support the need for better conceptualization and measurement of how migration influences cultural beliefs and practices, and their subsequent influence on health behaviors and disease risk.

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List of Abbreviations

BMI	Body mass index
CAC	Coronary artery calcium
CI	Confidence interval
cIMT	Carotid intima-media thickness
CT	Computed tomography
HDL	High density lipoprotein
LDL	Low density lipoprotein
MASALA	Mediators of Atherosclerosis in South Asians Living in America
NWU	Northwestern University
RRR	Relative risk ratio
SHARE	Study of Health Assessment and Risk in Ethnic groupsl
UCSF	University of California, San Francisco
US	United States

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Table 1

Baseline characteristics of the MASALA study participants, 2010–2013*

	Overall n=900
Age, years	55 ± 9
NWU study site	410 (46)
Years lived in the U.S.	27 ± 11
Percent of life in the U.S.	50 ± 18
Speaks English poorly or not at all	31 (3)
Food eaten at home:	
Mostly/only other types of foods	66 (7)
Equally South Asian/other	354 (39)
Mostly/only South Asian	480 (53)
Food eaten at restaurants:	
Mostly/only other types of foods	369 (41)
Equally South Asian/other	375 (42)
Mostly/only South Asian	156 (17)
Frequency of eating out at social/cultural/religious events:	
<Once per week	505 (56)
Once per week	297 (33)
2–3 times per week	98 (11)
Frequency of shopping at South Asian markets:	
Almost never/never	15 (2)
<Once per month	118 (13)
Once or twice per month	300 (33)
Once or more per week	467 (52)
Race/ethnicity of friends:	
Mostly/only other than South Asian	90 (10)
Equally South Asian/other	322 (36)
Mostly/only South Asian	488 (54)
Traditional cultural beliefs scale (range 0–28):	
Weak beliefs (≥17)	333 (37)
Moderate beliefs (12–17)	268 (30)
Strong beliefs (<12)	297 (33)
Common cIMT, mm	0.88 ± 0.23
Internal cIMT, mm	1.21 ± 0.45
CAC score	0 (0 – 45)
CAC score category:	
0	517 (58)
1–400	313 (35)

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	Overall n=900
>400	64 (7)

* n (%) or mean ± SD is displayed; median (interquartile range) is shown for skewed variables

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Table 2

Bivariate association between all covariates and atherosclerosis outcomes, MASALA study, 2010–2013

	Common Carotid IMT*		Internal Carotid IMT*		CAC category (ref. CAC=0)			
					CAC 1–400		CAC >400	
	β (95% CI)	*p*	β (95% CI)	*p*	RRR (95% CI)	*p*	RRR (95% CI)	*p*
Age, per 10 years	0.10 (0.09 – 0.12)	<0.001	0.20 (0.17 – 0.23)	<0.001	2.60 (2.17–3.12)	<0.001	7.04 (4.85–10.22)	<0.001
Male sex	0.08 (0.05 – 0.11)	<0.001	0.13 (0.07 – 0.18)	<0.001	3.96 (2.93–5.36)	<0.001	7.70 (3.93–15.09)	<0.001
NWU study site	−0.12 (−0.15 to −0.09)	<0.001	−0.21 (−0.27 to −0.15)	<0.001	1.37 (1.03–1.82)	0.03	0.91 (0.54–1.54)	0.72
Years in the U.S., per year	0.004 (0.003–0.005)	<0.001	0.008 (0.005 – 0.01)	<0.001	1.04 (1.03–1.06)	<0.001	1.09 (1.06–1.12)	<0.001
Percent of life in the U.S.:								
≥80%	-		-		-	0.01†	-	0.008†
60–79%	0.13 (0.06 – 0.21)	<0.001	0.30 (0.15 – 0.44)	<0.001	-	-	-	-
40–59%	0.07 (0.001 – 0.14)	0.05	0.17 (0.04 – 0.31)	0.01	0.80 (0.57–1.12)	0.19	0.50 (0.28–0.91)	0.02
20–39%	0.07 (−0.001 to 0.15)	0.05	0.10 (−0.04 to 0.25)	0.16	0.55 (0.36–0.84)	0.005	0.34 (0.15–0.76)	0.009
0–19%	0.09 (0.002 – 0.18)	0.04	0.25 (0.07 – 0.42)	0.006	0.68 (0.36–1.28)	0.23	0.41 (0.12–1.44)	0.16
Speaks English poorly/not at all	0.04 (−0.04 to 0.13)	0.30	0.11 (−0.05 to 0.27)	0.17	0.78 (0.35–1.74)	0.54	1.29 (0.37–4.48)	0.69
Food eaten at home:								
Mostly/only other	-	-	-	-	-		-	
Equally SA/other	−0.008 (−0.07 to 0.05)	0.79	0.05 (−0.06 to 0.17)	0.37	1.08 (0.61–1.91)	0.80	1.12 (0.41–3.07)	0.82
Mostly/only SA	−0.009 (−0.07 to 0.05)	0.78	0.09 (−0.03 to 0.20)	0.14	1.23 (0.70–2.16)	0.46	0.89 (0.33–2.42)	0.82
Food eaten at restaurants:								
Mostly/only other	-	-	-	-	-		-	
Equally SA/other	0.03 (0.001 – 0.07)	0.04	0.07 (0.008 – 0.14)	0.03	1.11 (0.81–1.51)	0.51	1.11 (0.64–1.94)	0.72
Mostly/only SA	0.01 (−0.03 to 0.06)	0.49	0.04 (−0.04 to 0.12)	0.34	1.34 (0.90–1.99)	0.15	0.78 (0.34–1.78)	0.55
Frequency of eating out at social/cultural/religious events:								
<Once per week	-	-	-	0.03†	-		-	
Once per week	−0.02 (−0.06 to 0.008)	0.14	−0.04 (−0.11 to 0.02)	0.20	0.83 (0.61–1.13)	0.24	0.62 (0.33-1.13)	0.12
2–3 times per week	−0.03 (−0.08 to 0.02)	0.20	−0.10 (−0.20 to −0.006)	0.04	0.89 (0.56–1.42)	0.62	0.98 (0.43–2.20)	0.96
Frequency of shopping at South Asian markets:								

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	Common Carotid IMT*		Internal Carotid IMT*		CAC category (ref. CAC=0)			
					CAC 1–400		CAC >400	
	β (95% CI)	*p*	β (95% CI)	*p*	RRR (95% CI)	*p*	RRR (95% CI)	*p*
Almost never/never	-	-	-	-	-		-	
<Once per month	0.01 (−0.11 to 0.14)	0.81	0.06 (−0.18 to 0.30)	0.61	2.29 (0.60–8.72)	0.22	2.06 (0.24–17.49)	0.51
Once or twice per month	0.03 (−0.09 to 0.15)	0.67	0.04 (−0.19 to 0.28)	0.71	1.93 (0.53–7.09)	0.32	1.14 (0.14–9.28)	0.91
Once or more per week	0.03 (−0.09 to 0.14)	0.67	0.09 (−0.14 to 0.32)	0.45	2.46 (0.68–8.94)	0.17	1.36 (0.17–10.92)	0.77
Ethnicity of friends: Mostly/only other		-	-	-	-		-	
Equally SA/other	−0.004 (−0.06 to 0.05)	0.88	0.02 (−0.09 to 0.12)	0.75	1.14 (0.69–1.90)	0.61	0.96 (0.39–2.37)	0.94
Mostly/only SA	−0.02 (−0.07 to 0.03)	0.46	0.03 (−0.07 to 0.13)	0.60	1.14 (0.70–1.86)	0.60	0.94 (0.40–2.23)	0.89
Traditional cultural beliefs:								
Weak beliefs	-	-	-	-	-	0.04†	-	
Moderate beliefs	−0.05 (−0.09 to −0.02)	0.003	0.01 (−0.06 to 0.08)	0.72	1.22 (0.86–1.73)	0.26	0.69 (0.36–1.35)	0.28
Strong beliefs	−0.03 (−0.06 to 0.007)	0.11	0.01 (−0.06 to 0.08)	0.78	1.42 (1.01–1.99)	0.04	0.90 (0.49–1.65)	0.73
Education, ≥Bachelor's degree	−0.05 (−0.09 to −0.002)	0.04	−0.08 (−0.17 to 0.01)	0.07	0.93 (0.61–1.42)	0.74	1.11 (0.48–2.54)	0.81
Family income, ≥$75,000	−0.03 (−0.06 to 0.006)	0.11	−0.07 (−0.14 to −0.004)	0.04	0.55 (0.40–0.75)	<0.001	0.44 (0.25–0.78)	0.005
Current smoker	0.09 (0.01 – 0.18)	0.03	0.02 (−0.14 to 0.18)	0.81	1.97 (0.90–4.32)	0.09	2.81 (0.88–8.97)	0.08
Alcohol: No consumption	-	<0.001†	-	-	-	0.02†	-	0.04†
1–7 drinks/week	0.04 (0.005 – 0.07)	0.02	0.01 (−0.05 to 0.08)	0.66	1.24 (0.91–1.70)	0.18	1.45 (0.82–2.56)	0.20
>7 drinks/week	0.16 (0.09 – 0.24)	<0.001	0.16 (0.02 – 0.30)	0.03	2.28 (1.15–4.50)	0.02	2.98 (1.04–8.60)	0.04
Total physical activity, per −4086 MET-min/wk	0.02 (0.001 – 0.03)	0.04	0.02 (−0.004 to 0.05)	0.09	1.41 (1.21–1.66)	<0.001	1.60 (1.17–2.19)	0.003
Total exercise, per −1329 MET-min/week	−0.002 (−0.02 to 0.01)	0.84	−0.004 (−0.03 to 0.03)	0.81	1.02 (0.89–1.18)	0.76	1.03 (0.79–1.34)	0.81
Total caloric intake, per 504 kcal/day	0.02 (0.002 – 0.03)	0.03	0.005 (−0.02 to 0.03)	0.73	1.04 (0.91–1.20)	0.56	1.00 (0.77–1.31)	0.97
BMI, per 5 kg/m2	0.03 (0.01 – 0.04)	0.003	0.05 (0.02 – 0.08)	0.003	1.12 (0.95–1.32)	0.18	1.16 (0.87–1.55)	0.31
Waist circumference, per 10 cm	0.04 (0.02 – 0.05)	<0.001	0.07 (0.05 – 0.10)	<0.001	1.53 (1.32–1.77)	<0.001	1.73 (1.35–2.23)	<0.001
Systolic blood pressure, per 10 mmHg	0.04 (0.03 – 0.05)	<0.001	0.06 (0.04 – 0.08)	<0.001	1.35 (1.22–1.48)	<0.001	1.67 (1.43–1.95)	<0.001
Diastolic blood pressure, per 10 mmHg	0.01 (−0.001 to 0.03)	0.07	−0.02 (−0.05 to 0.01)	0.22	1.16 (1.00–1.34)	0.04	1.28 (0.99–1.67)	0.06
Diabetes category: Normal	-	0.004†	-	<0.001†	-	<0.001†	-	<0.001†
Pre-diabetes	0.01 (−0.03 to 0.04)	0.60	0.02 (−0.05 to 0.09)	0.60	1.77 (1.26–2.49)	0.001	1.77 (0.88–3.57)	0.11
Diabetes	0.06 (0.02 – 0.10)	0.003	0.17 (0.10 – 0.24)	<0.001	3.29 (2.28–4.75)	<0.001	5.48 (2.85–10.52)	<0.001

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	Common Carotid IMT*		Internal Carotid IMT*		CAC category (ref. CAC=0)			
					CAC 1–400		CAC >400	
	β (95% CI)	*p*	β (95% CI)	*p*	RRR (95% CI)	*p*	RRR (95% CI)	*p*
Fasting glucose, per 24 mg/dl	0.02 (0.01 – 0.04)	0.005	0.08 (0.05 – 0.11)	<0.001	1.63 (1.37–1.94)	<0.001	1.93 (1.54–2.41)	<0.001
Fasting insulin, per 16 μU/ml	0.01 (−0.003 to 0.03)	0.11	0.03 (0.002 – 0.06)	0.03	1.26 (0.99–1.59)	0.06	1.33 (1.03–1.73)	0.03
Total cholesterol, per 37 mg/dl	−0.004 (−0.02 to 0.01)	0.59	−0.03 (−0.06 to−0.003)	0.03	0.73 (0.63–0.84)	<0.001	0.61 (0.46–0.80)	0.001
LDL-cholesterol, per 32 mg/dl	0.002 (−0.01 to 0.02)	0.79	−0.03 (−0.06 to 0.002)	0.07	0.74 (0.64–0.86)	<0.001	0.66 (0.50–0.88)	0.004
HDL-cholesterol, per −13 mg/dL	0.02 (0.001 – 0.03)	0.03	0.02 (−0.01 to 0.05)	0.15	1.25 (1.08–1.45)	0.003	1.05 (0.81–1.36)	0.71
Triglycerides, per 71 mg/dL	−0.005 (−0.02 to 0.01)	0.52	−0.001 (−0.03 to 0.03)	0.94	1.04 (0.91–1.20)	0.54	0.74 (0.52–1.05)	0.09
Cholesterol med use	0.06 (0.03 – 0.10)	<0.001	0.15 (0.08 – 0.21)	<0.001	2.99 (2.18–4.11)	<0.001	5.03 (2.94–8.63)	<0.001

*mean common cIMT was 0.88 ± 0.23 and mean internal cIMT was 1.21 ± 0.45 mm

†significant p-values for trend across categories

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Table 3

Multivariate association with acculturation measures and atherosclerosis after adjusting for all covariates

	Common CIMT*		CAC Category (reference = 0)			
			CAC 1-400		CAC >400	
	β (95% CI)	*p-value*	RRR (95% CI)	*p-value*	RRR (95% CI)	*p-value*
Acculturation model:						
Traditional cultural beliefs: Weak (ref.)						
Moderate beliefs	−0.05 (−0.08 to −0.02)	0.004	-	-	-	-
Strong beliefs	−0.02 (−0.05 to 0.01)	0.26				
Years lived in the US, per 1 year	-	-	1.02 (1.00–1.03)	0.03	1.04 (1.01–1.07)	0.01
Age, per 10 years	0.10 (0.09 – 0.11)	<0.001	2.56 (2.08–3.15)	<0.001	6.27 (4.21–9.36)	<0.001
Male sex	0.07 (0.04 – 0.10)	<0.001	4.57 (3.27–6.40)	<0.001	9.53 (4.59–19.78)	<0.001
NWU study site	−0.12 (−0.15 to −0.10)	<0.001	1.26 (0.91–1.74)	0.16	0.87 (0.47–1.59)	0.64
Multivariate model:						
Traditional cultural beliefs: Weak (ref.)						
Moderate beliefs	−0.04 (−0.08 to −0.01)	0.007	-	-	-	-
Strong beliefs	−0.02 (−0.05 to 0.01)	0.22				
Years lived in the US, per 1 year	-	-	1.02 (1.00–1.04)	0.02	1.04 (1.00–1.07)	0.02
Age, per 10 years	0.10 (0.09 – 0.12)	<0.001	2.44 (1.97–3.03)	<0.001	6.65 (4.30–10.30)	<0.001
Male sex	0.02 (−0.006 to 0.06)	0.12	4.10 (2.72–6.18)	<0.001	11.09 (4.65–26.48)	<0.001
NWU study site	−0.12 (−0.14 to −0.09)	<0.001	1.23 (0.88–1.73)	0.22	0.76 (0.40–1.45)	0.41
Alcohol use: None (ref.)						
1–7 drinks/week	0.02 (−0.009 to 0.05)	0.16	0.83 (0.56–1.23)	0.35	0.74 (0.36–1.52)	0.41
>7 drinks/week	0.09 (0.02 – 0.15)	0.007	0.88 (0.38–2.03)	0.77	0.58 (0.15–2.28)	0.44
Waist circumference, per 10 cm	0.02 (0.01 – 0.04)	<0.001	1.30 (1.09–1.55)	0.003	1.64 (1.17–2.29)	0.004
HDL-cholesterol, per −13 mg/dl	0.01 (−0.0009 to 0.03)	0.07	1.04 (0.85–1.26)	0.71	0.79 (0.55–1.13)	0.20
Cholesterol medication use	0.009 (−0.02 to 0.04)	0.54	2.28 (1.58–3.29)	<0.001	3.74 (1.95–7.17)	<0.001
Total Exercise, per −1329 MET-min/wk	0.004 (−0.01 to 0.02)	0.59	1.07 (0.89–1.28)	0.47	1.23 (0.89–1.70)	0.21
Total Caloric intake, per 504 kcal/day	0.008 (−0.005 to 0.02)	0.22	0.96 (0.81–1.13)	0.61	0.85 (0.60–1.19)	0.33

Variables not included in the model are noted with a – mark.

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* mean common cIMT was 0.88 ± 0.23