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Cardiovascular health metrics among South Asian adults in the United States: Prevalence and associations with subclinical atherosclerosis

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ABSTRACT

South Asians, a fast growing ethnic group in the US, have an increased risk for cardiovascular disease compared to the general population. We examined the prevalence and distribution of the American Heart Association's Life's Simple 7 cardiovascular health (CVH) metrics using data from Mediators of Atherosclerosis in South Asians Living in America (MASALA) study, and cross-sectional associations between number of CVH metrics in the ideal range with subclinical atherosclerosis assessed using coronary artery calcium (CAC) measured using cardiac computed tomography and carotid intima media thickness (CIMT) measured using high-resolution B-mode ultrasonography. CAC was modeled as Agatston scores = 0, 1–400 and >400; CIMT was examined continuously and as internal CIMT > 1.5 mm. In the MASALA cohort (N = 875; mean age: 55 years; 53% men; living in greater San Francisco and Chicago areas; October 2010–March 2013) without prevalent coronary heart disease, no participant had all 7 metrics in ideal range; approximately 20% of the participants had at least 5 metrics in ideal range. Higher number of CVH metrics in the ideal range was inversely associated with subclinical atherosclerosis. A 1 unit increase in the number of CVH metrics in the ideal range was associated with 32% lower odds of CAC = 1–400 (vs. CAC = 0; OR = 0.68, 95% CI: 0.60, 0.78) and 28% lower odds of internal CIMT > 1.5 mm (OR = 72, 95% CI: 0.61, 0.85). These data show the prevalence of CVH metrics among South Asians in the US, and provide empirical evidence on inverse associations of meeting ideal levels for higher number of metrics and subclinical atherosclerosis.

1. Introduction

South Asians, individuals who originate from countries in the Indian sub-continent including India, Pakistan, Bangladesh, Sri Lanka and Nepal, are the sixth largest and fastest growing ethnic group in the United States (US) (Hoeffel et al., 2012). Several studies have underscored the higher risk for cardiovascular disease (CVD) morbidity and mortality among South Asians compared to other racial and ethnic groups indicating the presence of health disparities (Anand et al., 2000; Harding et al., 2008; Jose et al., 2014; Palaniappan et al., 2004). However, there have been few investigations that have focused on elucidating the reasons for the higher risk in this segment of the US population.

In 2010, the American Heart Association (AHA) Strategic Planning Task Force & Statistics Committee set a 10 year goal of improving the cardiovascular health (CVH) of *all* Americans by 20% by the year 2020; to measure progress toward the goal, the AHA defined metrics for ideal, intermediate and poor cardiovascular health for 7 modifiable health behaviors and factors, including smoking, diet, physical activity, body mass index, blood pressure, total cholesterol, and fasting glucose (Lloyd-Jones et al., 2010). As part of their annual surveillance and monitoring, the AHA jointly with the Centers for Disease Control and Prevention and the National Institutes of Health reports the newest nationally representative data on CVD and stroke statistics as well as the current status of CVH for the nation. In 2016 the AHA reported that only 18% of American adults had 5 or more of these metrics with ideal levels (Mozaffarian et al., 2015). Additionally, studies have also reported the presence of racial and ethnic disparities in the prevalence of ideal CVH

Abbreviations: AHA, American Heart Association; CVD, Cardiovascular disease; CVH, Cardiovascular health; CAC, Coronary artery calcium; CIMT, Carotid intima media thickness; BMI, Body mass index; BP, Blood pressure; FFQ, Food frequency questionnaire; LS7, Life's Simple 7; MASALA, Mediators of Atherosclerosis in South Asians Living in America; MET, Metabolic Equivalents; NHANES, National Health and Nutrition Examination Survey; NWU, Northwestern University; SHARE, Study of Health Assessment and Risk in Ethnic groups; US, United States; UCSF, University of California San Francisco.

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metrics. For example, using data from 44, 959 adults from the National Health and Nutrition Examination Survey (NHANES, 1988–1994, 1999–2004, and 2005–2010), Yang et al. (2012) reported that non-Hispanic whites tended to meet a greater number of CVH metrics as compared to other racial groups. There are, however, a dearth of available data examining the prevalence and distribution of each metric and the overall CVH score for different Asian American subgroups.

Our goal was to determine the prevalence and distribution of the AHA CVH metrics in a cohort of community dwelling, middle-aged and older South Asians in the US. In addition, we also examined the associations between the number of ideal metrics with measures of subclinical atherosclerosis. We postulated that a higher number of CVH metrics in the ideal range would be inversely associated with subclinical atherosclerosis.

2. Methods

2.1. Study population

We used data collected at baseline from the Mediators of Atherosclerosis in South Asians Living in America (MASALA) Study, a community-based sample of South Asians who were free from CVD at baseline. Details regarding recruitment have been published elsewhere (Kanaya et al., 2013). Briefly, using surname-based recruitment methods, a community-based sample of 906 South Asians (age range: 40–84 years, 46% women) were recruited between October 2010 and March 2013 from the two clinical sites including the nine counties of the San Francisco Bay Area (representing the University of California at San Francisco (UCSF) field site) and seven census tracts closest to the Northwestern University (NWU) medical center. For these analyses we excluded 31 participants with missing data for one or more components of the CVH score resulting in a sample of 875 participants. The study protocol and procedures were approved by the institutional review boards of UCSF and NWU. All study participants signed informed consent.

2.2. Measures of subclinical atherosclerosis

2.2.1. Coronary artery calcium

Cardiac CT scans were performed using a gated-cardiac CT scanner. At UCSF, the system was either the 16D scanner (Philips Medical Systems, Andover, MA) or the MSD Aquilion 64 model (Toshiba Medical Systems, Tustin, CA). At NWU, the technicians used the Sensation Cardiac 64 Scanner (Siemens Medical Solutions, Malvern, PA). All CT scans were sent in batches to the centralized reading center at Harbor-UC Los Angeles Medical Center, where they were interpreted with Rephot Imaging software. Coronary Artery Calcium (CAC) Agatston scores were reported for each of the four major coronary arteries and the summed score was used (Kanaya et al., 2014a) For all further analyses, the CAC score was modeled categorically as Agatston scores = 0, 1–400 and >400.

2.2.2. Carotid artery intima media thickness

Right and left internal and common carotid artery intima media thickness (CIMT, in mm) was assessed using high-resolution B-mode ultrasonography. These data were read at the Wake Forest University Medical Center. Wall thickness was defined using the far wall measures. For quality control, a single reader completed 25 repeat CIMT measures. The intra-class correlation coefficient for the internal carotid IMT was 0.96 and 0.78 for the common carotid IMT (Kanaya et al., 2014a). For all further analyses, CIMT was modeled on: (i) a continuous scale; and (ii) categorically for internal CIMT > 1.5 mm.

2.2.3. Cardiovascular health metrics

Cardiovascular health was operationalized using AHA Life's Simple 7 criteria (LS7) and comprised of seven health behaviors and factors including healthy diet score, physical activity, body mass index (BMI), smoking status, blood pressure, plasma total cholesterol and fasting glucose concentrations. Some of the criteria were adapted based on data available for the MASALA cohort. Specifically, 1) Diet quality: The Study of Health Assessment and Risk in Ethnic groups food frequency questionnaire (FFQ) developed and validated for South Asians in Canada was used to assess dietary intake (Kelemen et al., 2003). Participants were given 1 point for meeting each of the dietary goals. These included: i) Fruit and vegetables: ≥4.5 cups/day (potato and potato preparation and fruit and vegetable juices were excluded); ii) Fish: ≥two 3.5 oz. servings/week (excluding fried fish); iii) a fiber-to-carbohydrate ratio: ≥1.0 g fiber per 10 g carbohydrate/day; iv) no more than 36 fluid oz./week of sugar-sweetened beverages (including non-diet soda and fruit drinks); v) <1500 mg of sodium/day. 2) Physical activity: The Typical Week's Activity Survey was used to assess levels of various types of physical activity and exercise and the Metabolic Equivalents (METs) of each activity was specified by Ainsworth et al. (1999). Specifically, we used intentional exercise, including walking for exercise, dance, conditional activities and sports to calculate time spent in moderate and vigorous activities. Time spent in activities identified as either vigorous (>6 METs) or moderate (3–6 METs) were used in derivation. The average time per week spent engaged in all activities at either a vigorous or moderate level was computed for each participant and participants were then categorized based on the AHA criteria (Lloyd-Jones et al., 2010). 3) Smoking status: Smoking status was self-reported and assessed using a questionnaire (Kanaya et al., 2013). 4) BMI: Participant weight was measured on a standard balance-beam scale or a digital weighing scale, and height was measured using a stadiometer. Weight (in kg) divided by height (in meters) squared was used to calculate BMI. 5) Blood pressure: Blood pressure was measured thrice seated using an automated blood pressure monitor (V100 Vital Signs Monitor; GE Healthcare, Fairfield, CT) with the average of the last two readings used for analysis (Kanaya et al., 2013). Blood samples in the cohort were obtained after a 12-hour fast, and 6) Total cholesterol was measured using enzymatic methods, while 7) Blood sugar was measured with the use of a hexokinase method. Use of glucose, blood pressure and lipid lowering medications were all assessed using a questionnaire (Kanaya et al., 2013).

Participants were assigned a score of 1 for each metric if they met the ideal level and 0 for intermediate or poor levels. The individual metric scores were summed to derive an ideal CVH score which could range from 0 to 7 with higher scores representing better adherence to the AHA LS7 criteria. For further analyses, in addition to being modeled on a continuous scale, based on the distribution of the overall score in the cohort, we also categorized the score as having 4 or more metrics in the ideal range, followed by having 3 metrics in the ideal range and lastly having 2 or less metrics in the ideal range.

2.3. Covariates

Information on age, sex, length of residence in the US, acculturation status, education, family income, insurance type and alcohol intake was obtained using a structured interview and standard questionnaires (Kanaya et al., 2013). Participants reported highest level of education completed which was categorized as Less than high school/High school or some college/Bachelor's degree/Higher than bachelor's degree. Insurance type was classified as Government/HMO/Other/None. Length of residence in the US was self-reported and modeled on a continuous scale as years. A traditional cultural beliefs scale was used as a marker of acculturation (Mukherjea et al., 2013). Scores on this scale were categorized as strong (scores < 12), moderate (scores 12–17) or weak (scores > 17) traditional beliefs. Alcohol intake (g/day) was derived from self-report.

2.4. Statistical analysis

The prevalence of each CVH metric was examined. Baseline characteristics were reported as mean (standard deviation [SD]) for continuous variables or number (percentage) for categorical variables. Differences across the 3 categories of number of ideal metrics were examined. Unadjusted associations between socio-demographic and health characteristics were examined using *t*-tests, Kruskal-Wallis tests, or chi- squared tests as appropriate. The number of ideal metrics met was modeled on both a continuous and categorical scale. Linear and logistic regression models were used to examine the associations between number of ideal metrics met and internal and common CIMT modeled on a continuous scale or internal CIMT > 1.5 mm. For CAC, multinomial logistic regression models were used to assess the associations between number of ideal metrics and Agatston score = 0, 1–400 and >400. Sequential models were examined and covariates were determined based on preliminary univariate analyses. Final models included: age, sex, length of residence in the US, traditional cultural beliefs, insurance type, study site and alcohol intake. We also examined whether age, sex, length of residence in the US, traditional cultural beliefs, insurance type and study site modified the associations between ideal CVH and subclinical atherosclerosis. In addition we performed sensitivity analyses, wherein we assigned each CVH metric component a score of 2, 1, 0 for meeting the ideal, intermediate, poor criterion, respectively, and used the overall CVH score (which could range from 0 to 14) by summing up scores across the 7 metrics to assess the risk of subclinical atherosclerosis in the adjusted linear and logistic regression models. Analyses were performed using Stata version 13.1. (StataCorp, 2013)

3. Results

The distributions of socio-demographic and health characteristics by the number of ideal CVH metrics met are shown in Table 1. The average age (mean ± SD) of the 875 MASALA participants included in these analyses was 55 ± 9 years, included 53% men, and participants had a mean residence in the US of 27 ± 11 years. Almost 42% percent of the cohort had at least 4 of the AHA metrics in the ideal range, followed by 27.9% with 3 ideal metrics and lastly, 30% had 2 or fewer ideal metrics. Individuals with 4 or more ideal CVH metrics were more likely to be women, younger, have weaker traditional cultural beliefs (were more acculturated), more likely to have private health insurance, hold a bachelor's degree or higher, and to be seen at the UCSF study site compared to those with no >2 ideal metrics.

None of the MASALA study participants had all 7 CVH metrics in the ideal range. Approximately 20.5% of the participants had 5 or 6 ideal health metrics with some differences by age and sex: 27.4% for those aged <55 years vs. 13.2% for those ≥55 years; 14.9% for men vs. 26.6% for women (Table 2). Among the health behaviors, >80% of the MASALA study participants did not currently smoke, 65% met the ideal levels for physical activity, 44% had ideal BMI and <3% met the ideal criteria for diet quality (Fig. 1). Among the other health factors, only 56% of the participants had the ideal levels for fasting glucose, 40% for total cholesterol and 33% for blood pressure.

Using multinomial logistic regression, we examined the associations between the number of CVH metrics in the ideal range and CAC scores. For the multivariate model, a 1 unit increase in number of metrics in the ideal range was associated with a 32% lower odds of CAC = 1–400 (OR = 0.68, 95% CI: 0.60, 0.78). When modeled categorically, participants with 4 or more CVH metrics in the ideal range had significantly lower odds of CAC = 1–400 (OR = 0.30, 95% CI: 0.20, 0.46) than participants meeting the ideal levels for 2 or less of the metrics. Similar, graded and inverse associations were seen for the odds of CAC > 400 (Table 3).

For CIMT (Table 4), for the multivariate model, every additional increase in the number of CVH metrics in the ideal range was associated with a 0.02 mm and a 0.05 mm lower common and internal CIMT respectively. When modeled categorically, participants with 4 or more CVH metrics in the ideal range had 0.07 mm and 0.16 mm lower common and internal CIMT respectively, than participants meeting the ideal levels for 2 or less of the metrics. Similar protective associations

Table 1
Socio-demographic and health characteristics by the number of AHA ideal CVH metrics among MASALA study participants living in the greater San Francisco and Chicago areas in the US, 2010–2013.

	Number of ideal metrics fulfilled[a]				
	Overall	0–2	3	4–6	p-value
N	875	263	244	368	
Female, %	47.2	36.9	45.5	55.7	<0.001
Age (SD), y	55.3 (9.4)	57.1 (9.0)	56.1 (9.3)	53.5 (9.3)	<0.001
NWU site, %	45.6	51.7	45.1	41.6	0.04
Traditional cultural beliefs, % (n = 873)					0.036
- Strong	33.4	38.3	34.0	29.6	
- Intermediate	29.9	23.0	31.6	33.7	
- Weak	36.7	38.7	34.4	36.7	
Length of residence in the US (SD), y	27.4 (10.8)	28.1 (11.3)	27.9 (10.9)	26.6 (10.9)	0.182
Insurance type, %					<0.001
- Government	10.3	13.3	10.7	7.9	
- HMO	76.9	68.4	78.3	82.0	
- Other	4.7	4.6	3.3	5.7	
- None	8.1	13.7	7.8	4.4	
Education, %					<0.001
- Lower than high school	6.9	12.2	7.0	3.0	
- Higher school or some college	5.5	7.6	5.3	4.1	
- Bachelor's degree	29.1	30.0	27.9	29.3	
- Higher than bachelor's degree	58.5	50.2	59.8	63.6	
Family income ≥ $75,000, % (n = 851)	73.4	64.0	72.6	80.9	<0.001
Current smoker, %	3.2	6.8	3.3	0.5	<0.001
Physical activity, %					<0.001
- Poor	14.7	25.5	16.0	6.3	
- Intermediate	19.8	34.6	19.7	9.2	
- Ideal	65.5	39.9	64.3	84.5	
Diet quality, %					0.269
- Poor	39.1	40.7	43.0	35.3	
- Intermediate	58.5	57.8	54.5	61.7	
- Ideal	2.4	1.5	2.5	3.0	
Lipid lowering medication, %	28.3	46.8	33.6	11.7	<0.001
Blood pressure lowering medication, %	31.1	50.2	35.7	14.2	<0.001
Diabetes medication, %	16.0	33.5	16.8	3.0	<0.001
Alcohol consumption (SD), g/day	2.8 (5.9)	3.5 (6.3)	3.0 (7.1)	2.0 (4.6)	0.006
BMI (SD), kg/m^2	26.0 (4.3)	28.1 (3.7)	26.6 (5.0)	24.2 (3.4)	<0.001
Total cholesterol (SD), mg/dL	187 (36.9)	189 (41.0)	187 (39.3)	187 (31.8)	0.712
Systolic blood pressure (SD), mm Hg	124 (15.7)	130 (13.8)	127(16.3)	119 (14.6)	<0.001
Diastolic blood pressure (SD), mm Hg	73.4 (9.7)	75.8 (9.3)	74.6 (10.2)	70.9 (9.1)	<0.001
Fasting plasma glucose (SD), mg/dL[b]	103(24.7)	117(31.0)	104(24.3)	92.4 (10.5)	<0.001
CAC score, % (n = 869)					<0.001
- 0	58.0	40.9	53.3	73.2	
- 1–400	34.8	47.5	39.3	22.7	
- >400	7.2	11.6	7.4	4.1	
Common CIMT (SD, n = 874), mm	0.88 (0.23)	0.93 (0.28)	0.89 (0.21)	0.83 (0.19)	<0.001
Internal CIMT (SD, n = 873), mm	1.21 (0.44)	1.33 (0.51)	1.20 (0.43)	1.12 (0.37)	<0.001

AHA, American Heart Association; MASALA, Mediators of Atherosclerosis in South Asians Living in America; BMI, body mass index; CVH, cardiovascular health.
[a] No participant had all 7 Life's Simple 7 metrics in the ideal range.
[b] Kruskal-Wallis test.

Table 2
Distribution of ideal CVH metrics by age and sex, among MASALA study participants living in the greater San Francisco and Chicago areas in the US, 2010–2013.

No. of ideal health metrics present	Total sample [number (%)] (n = 875)	Men [number (%)]			Women [number (%)]		
		Age < 55 (n = 219)	Age ≥ 55 (n = 243)	p-value	Age < 55 (n = 225)	Age ≥ 55 (n = 188)	p-value
7	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)	
6	41 (4.7)	11 (5.0)	4 (1.7)	0.05	21 (9.3)	5 (2.7)	0.01
5	138 (15.8)	35 (16.0)	19 (7.8)	0.01	55 (24.4)	29 (15.4)	0.02
4	189 (21.6)	45 (20.6)	49 (20.2)	0.92	55 (24.4)	40 (21.3)	0.46
3	244 (27.9)	56 (25.6)	77 (31.7)	0.15	56 (24.9)	55 (29.3)	0.32
2	176 (20.1)	41 (18.7)	60 (24.7)	0.12	30 (13.3)	45 (23.9)	0.01
1	73 (8.3)	26 (11.9)	26 (10.7)	0.68	8 (3.6)	13 (6.9)	0.13
0	14 (1.6)	5 (2.3)	8 (3.3)	0.52	0 (0)	1 (0.5)	[a]

CVH, cardiovascular health; MASALA, Mediators of Atherosclerosis in South Asians Living in America.
[a] No female under 55 years when ideal health metrics = 0, therefore age-groups cannot be compared.

for number of metrics in the ideal range were observed for internal CIMT modeled on categorical scale.

Using the recommended BMI cut-points for overweight/obesity in Asians (Misra et al., 2009) 33%, 43% and 24% of the MASALA participants were classified as poor, intermediate and ideal respectively for the BMI metric. This also resulted in changes in the proportion of ideal metrics fulfilled by the participants, but the proportion meeting the ideal levels for 5 or 6 of the metrics remained at 20% and the associations with subclinical atherosclerosis persisted (data not shown).

In sensitivity analyses (Supplementary Table 1) overall CVH remained inversely associated with CAC and CIMT.

4. Discussion

This study yielded several important insights about ideal CVH and subclinical atherosclerosis among middle-aged US South Asian men and women without clinical CVD. Using the AHA metrics and definitions of ideal CVH, none of the MASALA study participants achieved ideal levels for all 7 components. Importantly, there was a graded association with the number of ideal CVH metrics with CAC and both common and internal CIMT, with a higher CVH score associated with lower levels of subclinical atherosclerosis. To our knowledge, this is the first study to examine the prevalence of CVH metrics in a large cohort of US South Asians, and to demonstrate relationships between CVH metrics and measures of subclinical atherosclerosis in this ethnic group.

Since the release of the AHA LS7 metrics in 2010, there have been several reports describing the prevalence of these health metrics in the general US population. Using data from the 2011–2012 National Health and Nutrition Examination Survey, Mozaffarian et al. (2015) reported that 0.1% of adults aged 20 years and above had ideal levels for all 7 of the health factors and behaviors. The prevalence estimates for those aged 40–59 years for meeting ideal levels for at least 5 criteria were 11% with those meeting ideal criteria for smoking status (74%), followed by fasting blood glucose (52%), physical activity (41%), blood pressure (34%), total cholesterol (34%), BMI (25%), and lastly diet quality (0.5%). This is similar to what we report in our study, wherein smoking status had the highest and diet quality had the lowest proportion of participants with the ideal levels. A lower proportion of MASALA participants also had lower ideal fasting glucose and blood pressure metrics than the US population. Interestingly, almost two-thirds of the MASALA study participants met the ideal levels for physical activity, whereas the calculated exercise levels for the cohort are quite low (median MET min/week: 1027 for men and 840 for women) (Kanaya et al., 2014b). A third of the MASALA study participants reported walking for exercise which combined with other intended exercise activities may explain the relatively high proportion of participants meeting the ideal physical activity levels.

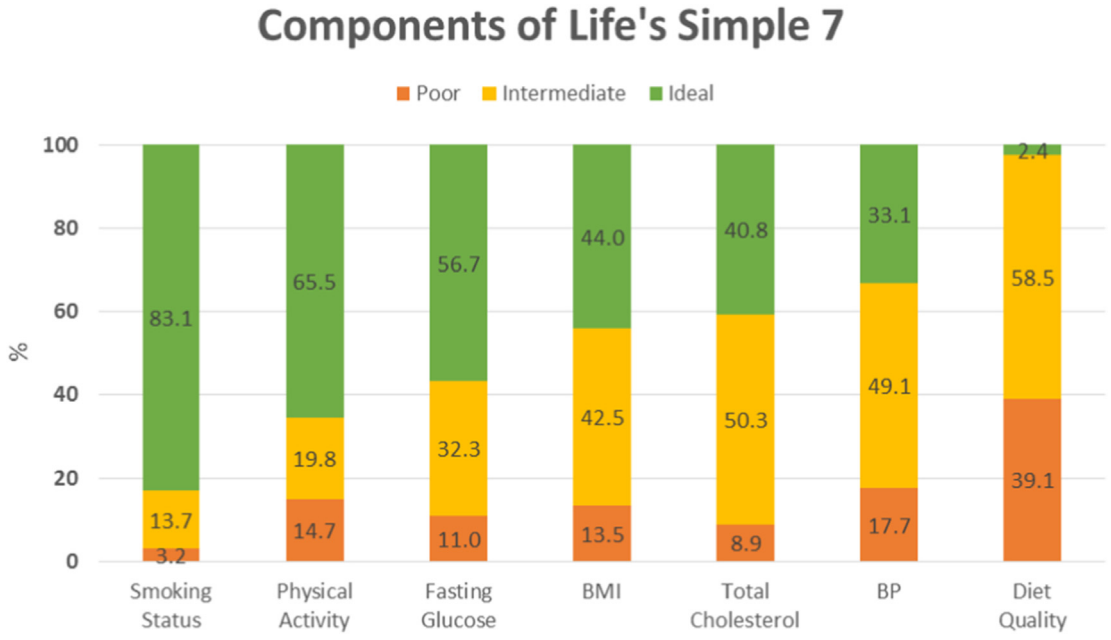

Fig. 1. Distribution of Life's Simple 7 metric in the MASALA study participants living in the greater San Francisco and Chicago areas from the US, 2010–2013. MASALA, Mediators of Atherosclerosis in South Asians Living in America.

Table 3
Odds ratios (95% CI) for associations between number of CVH metrics in the ideal range and CAC among MASALA study participants living in the greater San Francisco and Chicago areas in the US, 2010–2013.

Number of metrics in ideal range	CAC category			
	CAC 1–400 vs. CAC = 0		CAC > 400 vs. CAC = 0	
	OR	95% CI	OR	95% CI
Crude model				
Continuous	0.64	0.52, 0.72	0.58	0.47, 0.70
Categorical				
0–2	Ref		Ref	
3	0.64	0.44, 0.92	0.49	0.26, 0.93
4–6	0.27	0.19, 0.38	0.20	0.10, 0.38
Multivariate adjusted[a]				
Continuous	0.68	0.60, 0.78	0.57	0.44, 0.74
Categorical				
0–2	Ref		Ref	
3	0.65	0.42, 0.99	0.46	0.21, 1.00
4–6	0.30	0.20, 0.46	0.20	0.09, 0.44

CAC, coronary artery calcium; CVH, cardiovascular health; MASALA, Mediators of Atherosclerosis in South Asians Living in America.
[a] Multivariate model has been adjusted for sex, age, length of residence in the US, traditional cultural beliefs, insurance type, alcohol intake and study site.

In supplementary analyses we examined the distribution of the CVH metrics by a traditional cultural beliefs scale, a measure of acculturation in this cohort (Supplementary Table 2). Participants with weaker traditional beliefs were more physically active and had better diet quality. Associations of better diet quality with greater acculturation may be due to the components of diet score, which includes foods such as fish not consumed by South Asians following a vegetarian diet for religious reasons. We have previously also demonstrated that dietary intakes in the cohort differed by length of residence in the US, with largely mixed benefits (Talegawkar et al., 2016). These findings suggest that immigration and acculturation are associated with CVH behaviors in South Asians, and should be considered when planning interventions for immigrant populations.

In addition to reporting the prevalence of the CVH metrics, this study also demonstrated protective associations between the number of ideal CVH metrics and measures of subclinical atherosclerosis, including CIMT and CAC. Saleem et al. (2015) examined the cross-sectional associations between the number of ideal CVH metrics and CAC in middle-aged, predominantly non-Hispanic White patients from a clinic sample. Patients with favorable scores, defined as meeting ideal levels for 4 or more CVH metrics, had over 50% lower odds of any coronary artery calcium than patients with unfavorable (ideal levels for only 0–2 metrics) profiles and 32% lower odds with intermediate scores. More recently, Robbins et al. demonstrated similar protective associations between CVH metrics and prevalent calcified atherosclerotic plaque (defined as Agatston scores > 100) in the participants of the National Heart, Lung, and Blood Institute Family Heart Study, which was also predominantly non-Hispanic whites (Robbins et al., 2015). Among children and young adults aged 12 to 24 years from the Cardiovascular Risk in Young Finns Study cohort, an average lifetime ideal CVH index based on the arithmetic mean of the number of ideal factors and behaviors at baseline and follow-up visit was associated with a reduced risk of CAC and CIMT in middle age. CIMT and CAC are both significant and well-established predictors of future coronary heart disease events (Detrano et al., 2008; Pletcher et al., 2004; Polak et al., 2011), and are useful as surrogate markers for preventing progression and subsequent incidence of disease.

While the predictive associations between cardiovascular health operationalized using the AHA LS7 and CVD morbidity and mortality are not unexpected, there is also evidence from epidemiological investigations that in addition to its associations with heart disease, CVH is also predictive of functional status (Dhamoon et al., 2015), cognitive decline (Crichton et al., 2014; Reis et al., 2013; Thacker et al., 2014), kidney disease (Muntner et al., 2013) and cancer (Foraker et al., 2016; Rasmussen-Torvik et al., 2013). There has been a worldwide increase in the prevalence of chronic diseases (United Nations, 2011), leading to a concurrent rise in multimorbidity conditions (Garin et al., 2016; Goodman et al., 2016). Therefore, the associations between CVH and other chronic diseases and health conditions underline the public health importance of achieving the ideal levels of the LS7 metric proposed by the AHA to achieve its 2020 impact goals not just for preventing deaths from CVD and stroke but for overall health, wellbeing and longevity.

Strengths of our study include its population- South Asians in the US are a fast growing and understudied minority growing with high risk for chronic disease including heart disease. Key variables in the MASALA study including diet have been collected using culturally appropriate and/or validated instruments. The study also had several other important sociodemographic covariates to facilitate controlling for confounding. Study limitations include that the MASALA study is observational in study design with the potential for residual confounding by unmeasured factors. In addition, the participants of the MASALA study were middle-aged and older and relatively well educated which limits the generalizability of the study findings to younger and less-educated South Asians in the US or other South Asians in the diaspora.

This study provides important new information on the association between the AHA CVH metrics and subclinical atherosclerosis in US South Asians. The low prevalence of ideal CVH metrics in US South Asians is similar to what has been found in the general US population

Longitudinal follow-up of the MASALA cohort will allow further study of the relationship between the AHA CVH metrics and progression

Table 4
Regression coefficients and Odds Ratios (95% CI) for associations between the number of CVH metrics in the ideal range and CIMT among MASALA study participants living in the greater San Francisco and Chicago areas in the US, 2010–2013.

Number of metrics in ideal range	Common CIMT		Internal CIMT		Internal CIMT > 1.5 mm	
	Beta	95% CI	Beta	95% CI	OR	95% CI
Crude model						
Continuous	−0.03	−0.05, 0.02	−0.07	−0.09, −0.05	0.70	0.61, 0.81
Categorical						
0–2	Ref		Ref		Ref	
3	−0.05	−0.09, −0.004	−0.14	−0.22, −0.05	0.55	0.35, 0.85
4–6	−0.11	−0.15, −0.07	−0.21	−0.28, −0.14	0.32	0.21, 0.50
Multivariate model[a]						
Continuous	−0.02	−0.03, −0.01	−0.05	−0.07, −0.03	0.72	0.61, 0.85
Categorical						
0–2	Ref		Ref		Ref	
3	−0.04	−0.08, 0	−0.13	−0.20, −0.06	0.50	0.31, 0.80
4–6	−0.07	−0.11, −0.04	−0.16	−0.23, −0.09	0.35	0.21, 0.57

CIMT, carotid intima media thickness; MASALA, Mediators of Atherosclerosis in South Asians Living in America.
[a] Multivariate model has been adjusted for sex, age, length of residence in the US., traditional cultural beliefs score, insurance type, alcohol intake, and study site.

of subclinical atherosclerosis, incident CVD events, and mortality. Effective primordial and primary prevention interventions are needed to preserve and improve CVH in US South Asians, as well as continued research on novel and emerging risk factors (Bharmal et al., 2016; Flowers et al., 2015; Nadimpalli et al., 2016; Shah et al., 2016a; Shah et al., 2016b) that may be contributing to the high burden of CVD in South Asians.

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Conflict of interest

The authors' declare that there are no conflicts of interest.

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Appendix A. Supplementary data

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