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Authors

Chevli, Parag A
Aladin, Amer I
Kanaya, Alka M
[et al.](#)

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Alcohol Consumption and Subclinical Atherosclerosis among South Asians: Findings from the Mediators of Atherosclerosis in South Asians Living in America (MASALA) study

Parag A. Chevli, MD¹, Amer I. Aladin, MD², Alka M. Kanaya, MD⁴, Namratha R. Kandula, MD³, Diego Malaver, MSA², David M. Herrington, MD, MHS²

¹Department of Internal Medicine, Section on Hospital Medicine, Wake Forest School of Medicine

²Department of Internal Medicine, Section on Cardiovascular Medicine, Wake Forest School of Medicine

³Department of Medicine, Northwestern University Feinberg School of Medicine

⁴Department of Medicine, University of California San Francisco

Abstract

Background: South Asians are the second fastest growing ethnic group in the United States, and they have a high risk for cardiovascular disease (CVD). Moderate alcohol consumption has been associated with lower CVD risk in some race/ethnic groups, but the association of alcohol consumption and atherosclerosis in South Asians has not been investigated.

Methods: We used data from 906 South Asian participants who participated in the Mediators of Atherosclerosis in South Asians Living in America (MASALA) cohort (2010-2012). Alcohol consumption was ascertained via questionnaire, coronary artery calcium (CAC) was measured with computed tomography, and common carotid artery intima-media thickness (cIMT) was measured using B-mode ultrasonography. We used multivariable regression models to examine cross-sectional associations of alcohol consumption with the presence and amount of CAC and cIMT.

Results: Compared with never drinkers, participants consuming 4-7 drinks/week had a 63% decreased odds of any CAC after adjusting for potential confounders and mediators. Participants consuming 4-7 drinks/week had significantly lower odds of CAC score between 1-300 [OR (95% CI): 0.34 (0.16-0.72)]. A similar inverse association was seen for the odds of CAC>300 [OR (95% CI): 0.28 (0.07-0.97)]. Alcohol consumption of >7 drinks/week was associated with a 0.096 mm increase in common-cIMT.

Corresponding Author: Parag Anilkumar Chevli MBBS, Wake Forest School of Medicine, Medical Center Blvd, Winston Salem, NC 27157, Tel: 336-713-5215 Fax: 336-716-0030, pchevli@wakehealth.edu.

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Conflicts of Interest

The authors declared they do not have anything to disclose regarding conflict of interest with respect to this manuscript

Conclusion: There was an inverse association between the amount of alcohol intake and CAC among South Asians while a positive association was found between alcohol consumption and common-cIMT. Long-term follow-up of the MASALA cohort will examine prospective associations of alcohol intake with the progression of subclinical atherosclerosis, incident CVD events, and mortality.

Keywords

South Asian; Alcohol; Subclinical atherosclerosis; Coronary artery calcium

Introduction

South Asians – individuals with ancestry from Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka - are one of the fastest-growing ethnic groups in the United States[1] and make up one-quarter of the world's population.[2] South Asians are more likely to develop coronary heart disease (CHD) at a younger age[3] and have higher mortality from ischemic heart disease compared to other populations[4] that is not explained by widely known risk factors. Ethnicity is known to account in part for inter-individual variability in the prevalence and incidence of cardiovascular disease (CVD). [5]

An important question yet to be answered definitively is whether alcohol influences the risk of cardiovascular disease (CVD). Alcohol has both protective and detrimental effects on CVD.[6] Epidemiological studies have consistently found that alcohol intake within recommended limits is associated with a lower risk of CVD.[7-10] One potential mechanism is the effect of alcohol consumption on atherogenesis.[11] The relationship between alcohol and subclinical atherosclerosis could provide clues about the mechanisms underlying the relationship between alcohol and CVD.[12] To understand this relationship; we can examine its association with subclinical atherosclerosis measured by surrogate markers, including coronary artery calcium (CAC) and carotid intima-media thickness (cIMT). However, the studies examining the relationship between alcohol consumption and subclinical atherosclerosis have shown inconsistent results, either no association[13-16], a dose-response relation[17, 18] or a U-shaped relationship.[19] Similarly, the studies examining the association of alcohol consumption and cIMT have yielded conflicting results. [20-22]

Among all the ethnicities and nations that have been studied previously, the cardioprotective effect of light to moderate drinking has not been consistently replicated. [23-25] The INTERHEART study that included 27,000 subjects from 52 different countries showed that moderate (but not high levels of) alcohol use was associated with a reduced risk of MI. Although moderate or low alcohol consumption was protective in most countries, such an effect was not seen in South Asia[26]. Our study may provide insights into the understanding of the association between alcohol intake and subclinical atherosclerosis in South Asians. We examined cross-sectional association between alcohol consumption and subclinical atherosclerosis using data from the Mediators of Atherosclerosis in South Asians Living in America (MASALA) study, a community-based sample of asymptomatic South Asians in the United States. We hypothesized that light to moderate alcohol consumption is

associated with decreased prevalence of CAC and lower CIMT among asymptomatic South Asians aged 40-84 years in the U.S

Methods

Study population

A detailed description of the MASALA study design and methodology have been previously published. [27] MASALA is a prospective community-based cohort study of South Asians to examine the etiology and prognostic significance of subclinical atherosclerosis. This project is similar in measures and methods to a large ongoing Multi-Ethnic Study of Atherosclerosis (MESA).[28] The sampling frames were created by clinical site and included all 9 counties of the San Francisco Bay Area for the UCSF field site, and the 7 census tracts closest to the NWU medical center and secondary suburban locations around Chicago where census data revealed high proportions of South Asian residents. Between October 2010 and March 2013, 906 South Asians with a mean age of 55 ± 9 years were enrolled. All participants signed informed consent forms before undergoing study procedures. The study protocol was approved by the institutional review boards of the University of California, San Francisco, and Northwestern University.

Assessment of alcohol consumption

Based on the personal history questionnaire, alcohol consumption was assessed. The participants were asked, "Have you ever consumed alcoholic beverages?" If yes, they were then asked, "Do you presently drink alcoholic beverages?" Based on the answers given to these 2 questions, the participants were categorized into never, former, and current drinkers. Both current and former drinkers were asked, "For how many years did you drink alcoholic beverages?" They were also asked about the usual number of drinks consumed per week (before stopping drinking in the case of former drinkers). Current drinkers were asked about the number of drinks consumed during the past 24 hours, and the largest number of drinks consumed in 1 day in the past month. If the participant consumed 5 drinks on one occasion in the past month, it was defined as binge drinking. [27]

Measurement of coronary artery calcium

Non-contrast cardiac CT scans were performed using cardiac gated computed tomography scanners (UCSF: Phillips 16D scanner or a Toshiba MSD Aquilion 64; and NWU: Siemens Sensation Cardiac 64 Scanner). A four-sample calibration phantom was placed under the thorax for attenuation correction. All scans were interpreted at the CT reading center at Harbor-UCLA using the 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.

Measurement of carotid artery 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). The vascular technician located the bifurcation of the carotid artery distinguished the internal from an external carotid artery, and identified the maximal wall thickening in the near or far wall, in the

carotid bulb or internal carotid artery. Each of these images was collected in a specified order and recorded. The digitized data were batched and mailed on magneto-optical disks to the Reading Center at Wake Forest University for wall-thickness measurements. 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.

Measurement of covariates

Other covariates include demographic characteristics and potential confounders and mediators of alcohol-subclinical atherosclerosis association. Information on participant's demographic data, income, tobacco use, family history, medical history, and medication use was obtained using standard questionnaires and structured interview conducted by trained bilingual study staff. Education was categorized as having \geq bachelor's degree or $<$ bachelor's degree. Physical activity was assessed using the Typical Week's Physical Activity Questionnaire[29]. Resting blood pressure was measured three times in the seated position, using an automated blood pressure monitor (V100 Vital sign monitor, GE Medical Systems, Fairfield, CT) and the average of the last two readings was used for analysis. Participant height was measured using a stadiometer, and weight was measured using a standard balance beam scale or digital weighing scale. 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. Fasting plasma glucose was measured by the glucose oxidase method; total cholesterol, triglycerides, high-density lipoprotein (HDL) cholesterol and creatinine were measured by enzymatic methods (Quest, San Jose, CA) and low-density lipoprotein (LDL) cholesterol was calculated. Fasting serum samples were batched for insulin measured by the sandwich immunoassay method (Roche Elecsys 2010, Roche Diagnostics, Indianapolis, IN). Diabetes mellitus was defined as fasting glucose ≥ 126 mg/dL, or a post-challenge glucose ≥ 200 mg/dl, or by use of glucose-lowering medication. Hypertension was defined as systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg or medication use for hypertension. Use of an HMG-CoA reductase inhibitor, fibrate, or niacin was categorized as cholesterol medication use.

Statistical Analysis

Baseline characteristics of the total population were compared across alcohol consumption categories (never drinker, former drinker, 1-3 drinks/week, 4-7 drinks/week, and >7 drinks/week). Continuous variables were summarized using the mean (standard deviation) or median (interquartile range) depending on the normality of the data. Categorical variables were summarized using frequency (percentages). Analysis of variance (ANOVA) was used to compare the continuous variables while the chi-squared test was used to compare categorical variables. CAC scores were analyzed as a dichotomous outcome for the presence of any CAC ($CAC > 0$), and as a categorical outcome for the degree of prevalent CAC ($CAC = 0$, $1-300$, and >300). We used multivariable logistic regression models to compute odds ratios and 95% confidence intervals (CI) for the cross-sectional association between each alcohol consumption categories (never drinker (reference), former drinker, 1-3 drinks/week, 4-7 drinks/week, and >7 drinks/week) with the presence of any CAC, while multinomial logistic regression models were used to examine the association between alcohol consumption and degree of prevalent CAC ($CAC = 0$, $1-300$, and >300). Linear regression

models were used to examine the associations between categories of alcohol consumption and common CIMT modeled on a continuous scale. Model 1 was adjusted for age, sex, and education level. Model 2 was adjusted for model 1 plus smoking (never, former, current, and pack-years), BMI, self-reported physical activity and family history of heart attack, systolic and diastolic blood pressures, HDL-C, LDL-C, triglyceride, use of cholesterol medications, diabetes, C-reactive protein and eGFR (estimated glomerular filtration rate).

Additionally, we examined the interaction of alcohol consumption with sex, and age using the likelihood ratio χ^2 test, by including interaction terms in model 2. A two-sided p-value of <0.05 was considered statistically significant. All statistical analyses were performed using with SAS version 9.4 (SAS Institute Inc., Cary, North Carolina).

Results

Baseline Characteristics

Sociodemographic characteristics by alcohol consumption categories are shown in Table 1. The average age of the 906 MASALA participants was 55.3 (± 9.4) years, and 46% of participants were women. Among these, 304 (34.6%) were never drinkers, 303 (33.4%) were former drinkers, and 299 (33%) were current drinkers. Of the current drinkers, 182 (60.9%) reported consuming 1-3 drinks/week, 75 (25.1%) reported consuming 4-7 drinks/week, and 42 (18%) reported consuming >7 drinks/week. Participants consuming >7 drinks/week were more likely to be older, male, and current smokers. Higher categories of drinks per week were associated with higher blood pressure and waist circumference. In univariate analysis, higher alcohol consumption was associated with a higher cIMT score. The prevalence of any CAC was 37%, 43.2%, 44.4%, 43.8% and 63.4% in never drinkers, former drinkers, those who consume alcohol 1-3 drinks/week, 4-7 drinks/week, and >7 drinks/week, respectively.

Alcohol consumption and presence of CAC

Table 2 displays the association between levels of alcohol consumption and any prevalent CAC using multivariable logistic regression. In the model adjusted for sociodemographic factors, alcohol consumption of 4-7 drinks/week was associated with decreased odds of any CAC presence (odds ratio [OR] (95% CI):0.53 (0.28-1.00), $P = 0.05$). Compared with never drinkers, participants consuming 4-7 drinks/week had a 63% lower odds of any CAC after adjusting for potential confounders and mediators (OR (95% CI): 0.37 (0.18-0.75), $P < 0.01$). The interaction between alcohol consumption and sex or age was not statistically significant. After adjustment for all mediators and confounders, there was no association between binge drinking in the past month and any CAC presence.

Figure 1 and 2 shows the association between alcohol consumption and the burden of CAC. For the categorical model, participants consuming 4-7 drinks/week had significantly lower odds of CAC = 1-300 compared with never drinkers (OR (95% CI): 0.34 (0.16-0.72), $P = 0.005$) (Figure 1). A similar inverse association was observed for the odds of CAC>300 (OR (95% CI): 0.28 (0.07-0.97), $P = 0.04$) (Figure 2).

Alcohol consumption and common cIMT

Table 3 shows the multivariable model result for the association between alcohol consumption categories and common cIMT. Alcohol consumption of >7 drinks/week was associated with a 0.096 mm increase in common cIMT compared to no alcohol intake in a fully adjusted model. (β (95% CI): 0.096 (0.024-0.167), $P = 0.009$). Using multiple linear regression analysis, we also calculated the least mean square and standard error (SE) of the association of alcohol consumption categories and cIMT (Table 4). There was an incremental increase in mean cIMT across alcohol consumption categories with the higher score in >7 drinks/week followed by 4-7 drinks/week followed by 1-3 drinks/week followed by former drinker and then never drinker (trend P -value of 0.01 for Model 1 and 0.07 for Model 2).

Discussion

Main Findings

Several important insights were obtained in this study about alcohol consumption and subclinical atherosclerosis among middle-aged US South Asian adults free of CVD at baseline. We found an inverse association of light alcohol consumption of 4-7 drinks/week with presence and amount of CAC. In contrast, moderate to high alcohol consumption of >7 drinks/week was associated with higher cIMT. Moreover, there was a graded association with the number of drinks/week and common cIMT, with higher alcohol consumption associated with the higher cIMT. Our study was designed to further the understanding of the relationship between alcohol consumption and subclinical atherosclerosis. To our knowledge, this is the first study assessing the association of alcohol consumption and measures of subclinical atherosclerosis in South Asians in the U.S.

Comparison with previous studies

The studies examining the relationship between alcohol consumption and CAC have shown inconsistent results. Tofferi et al. [14] used a cohort of 731 consecutive, consenting, active-duty US Army personnel (39 to 45 years of age) without known CVD. This cross-sectional study found no relationship between the CAC score and the alcohol intake. It was one of the first studies focusing on the relation between alcohol consumption and CAC in a group at low risk for cardiovascular disease and with early atherosclerosis. Using CAC and atherosclerotic plaque in the aorta as surrogate markers of subclinical atherosclerosis, Ellison et al. [15] investigated this relationship using data from a prospective cohort study including 3166 white and African American subjects with a mean age around 55 years. They found no evidence of an association between total alcohol intake and CAC, although there was a tendency for the increased prevalence of CAC in the highest category of alcohol intake. Analyses of aortic calcification showed similar nonsignificant associations. Yang et al. [16] tried to determine if alcohol intake was associated with reduced coronary risk in a high-risk asymptomatic population and whether this effect was independent of coronary risk factors and coronary calcium. The study showed no relation between alcohol use and CAC. The definition of moderate alcohol consumption was different at that time. Also, the study lacked detail data on alcohol consumption. The first large study to evaluate the association of alcohol with CAC in 4 racial-ethnic groups and to evaluate the progression of

calcification, was done by McClelland et al. [13] The researchers studied the association between alcohol consumption and CAC prevalence, incidence and progression in The Multi-Ethnic Study of Atherosclerosis (MESA) which is a prospective community-based cohort study including 6814 participants aged 45–84 y who identified themselves as white, African American, Hispanic, or Chinese. They showed that overall alcohol consumption was not associated with the prevalence of any CAC > 0 at baseline regardless of alcohol type.

In contrast to these studies, Vliegthart et al. [19] found a U-shaped association between alcohol consumption and CAC performing a cross-sectional analysis using data from the population-based Rotterdam Coronary Calcification Study. By using prospective study design. Interestingly, Pletcher et al. [17] found a dose-response relation between alcohol and CAC. Our study did have some evidence of J-shaped association of alcohol with the presence and degree of CAC.

Carotid IMT is another non-invasive measure that can be used as a surrogate marker of subclinical atherosclerosis. To address the relationship between alcohol consumption and carotid atherosclerosis in older adults, Mukamal et al. [20] used data from the Cardiovascular Health Study (CHS), including 5888 adults aged 65 years and older. The result of this cross-sectional study found that relative to older adults who abstain from alcohol, consumption of 1 to 6 drinks per week had an inverse association with carotid atherosclerosis whereas consumption of 14 or more drinks had a positive association. The CHS participants represent a relatively healthy group of older adults, so the results can only be generalized to older adults in similar health. Kim et al. [21] tried to find relationships between alcohol consumption and subclinical atherosclerosis in 5539 Korean subjects (2121 men and 3418 women) who were participants in the Multi-Rural Communities cohort (MRcohort) study. The result showed that carotid artery intima-media wall thickness (CCA-IMT) was lower with alcohol consumption in men only. Zyriax et al. [22] conducted a cross-sectional study with the aim of investigating the relationship between alcohol intake and c-IMT in a selectively healthy population of the Stress Atherosclerosis and ECG Study (STRATEGY study). The results revealed a significant positive correlation between daily alcohol consumption and IMT in men, whereas in women the positive correlation was not significant. Our study found a positive association between alcohol consumption and cIMT. In our study, we could not do a stratified analysis by gender given a small sample size of women in 4-7 drinks/week and >7 drinks/week categories.

Potential mechanisms

An explanation for these conflicting results is unclear. Moderate alcohol acts upon the liver and can, therefore, serve to directly increase the hepatic production and secretion of apolipoproteins and lipoprotein particles, increase triglyceride concentrations, and decrease the removal of circulating high-density lipoprotein cholesterol. [8] We did not find any association between alcohol consumption categories and HDL or triglyceride in MASALA participants (Table 1). Systemic inflammation is a known aggravating factor in the pathogenesis of CVD, and studies have shown that moderate alcohol intake is associated with lower levels of inflammatory markers such as IL-6, TNF- α , and CRP. [30-34] Some alcoholic beverages, especially red wine, contains polyphenols.[35] One of the polyphenols,

resveratrol, is postulated to be an important contributor in explaining the cardio-protective effect of red wine through its anti-inflammatory effect. [36, 37] This anti-inflammatory effect may mediate the observed reduction of atherosclerotic burden. Alcohol also reduces hyperglycemia through the inhibition of hepatic gluconeogenesis, with a resulting reduction in plasma glucose levels.[38] Chronic kidney disease (CKD) has shown to be associated with atherosclerosis. [39, 40] Although few studies have suggested a harmful association between alcohol consumption and CKD, our study found no such association.[41, 42]

In contrast, moderate to heavy alcohol intake has been shown to increase blood pressure in a dose-dependent fashion. [43-45] Our study confirmed this finding showing that both SBP and DBP increased with higher levels of alcohol consumption. Alcohol is the second most energy-dense macronutrient consumed and also has an appetite enhancing effect, which could lead to an increased energy-intake, thereby causing weight gain. [6] We found that the level of alcohol consumption was positively associated with waist circumference in MASALA participants. These findings, if causal, could partly explain the dose-response relationship of alcohol consumption and cIMT in MASALA cohort.

Lastly, genetic factors of South Asians may play a role in modifying the relationship between alcohol consumption and atherosclerosis. The study by Hines et al. [46] showed that moderate drinkers who were homozygous for the slow-oxidizing ADH3(alcohol dehydrogenase type 3) allele have higher HDL levels and a substantially decreased risk of myocardial infarction. A meta-analysis of 56 epidemiological studies containing individuals of European descent revealed that individuals with a genetic variant associated with non-drinking and lower alcohol consumption had a more favorable cardiovascular profile. [47] Although, we could not find any studies examining the role of genetic factors in the association of alcohol and heart disease among South Asians.

Implications

Due to the diversity of language, cultural and religious practices, it is difficult to stereotype degree and pattern of alcohol use among a group as diverse as South Asians. Moreover, differences between generations and increased alcohol consumption due to acculturation further complicate the picture.[48] The recommended limit of alcohol consumption varies substantially across different national guidelines. [49] Despite multiple studies revealing the benefits of moderate alcohol consumption to lower CVD risk, a recent study analyzing data from nearly 600,000 people concluded that in current drinkers of alcohol in high-income countries, the threshold for lowest risk of all-cause mortality was about 100 g/week (<7 drinks/week).[50] Even though our study showed the inverse association of consuming 4-7 drinks/week with respect to CAC, we also observed that >7 drinks/week of alcohol consumption was related to greater cIMT. Thus, it would be difficult to make any recommendations regarding a safe threshold in South Asian population.

Strengths and limitations

The major strength of our study is the understudied and unique population of South Asian. Also, we were able to adjust for many potential confounders and mediators, including lifestyle variables and CVD risk factors. There are certain limitations that need to be taken

into consideration in the interpretation of our study. First, alcohol consumption was based on questionnaire responses, and participants may have underreported heavy or any consumption. These would most likely attenuate the association due to misclassification. Second, our study design was cross-sectional, and therefore, a causal relationship between alcohol and subclinical atherosclerosis cannot be established. Third, there were very few participants with heavy alcohol consumption defined as >14 drinks/week, which limited our ability to explore alcohol associations among this subset. Finally, we adjusted for several confounders, but residual confounding remains a possibility.

Conclusion

In conclusion, we found different associations of alcohol consumption with surrogate markers of subclinical atherosclerosis. We observed an inverse association of alcohol consumption and presence and burden of CAC while alcohol seems to have an unfavorable association with cIMT. Future research can examine the association between alcohol consumption and incidence and progression of CAC as well as incident coronary heart disease in MASALA cohort.

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Highlights

- Moderate alcohol consumption has been associated with lower CVD risk in some race/ethnic groups, but the association of alcohol consumption and atherosclerosis in South Asians has not been investigated
- We found an inverse association of light alcohol consumption of 4-7 drinks/week with presence and amount of CAC among South Asians
- In contrast, moderate to high alcohol consumption of >7 drinks/week was associated with higher cIMT

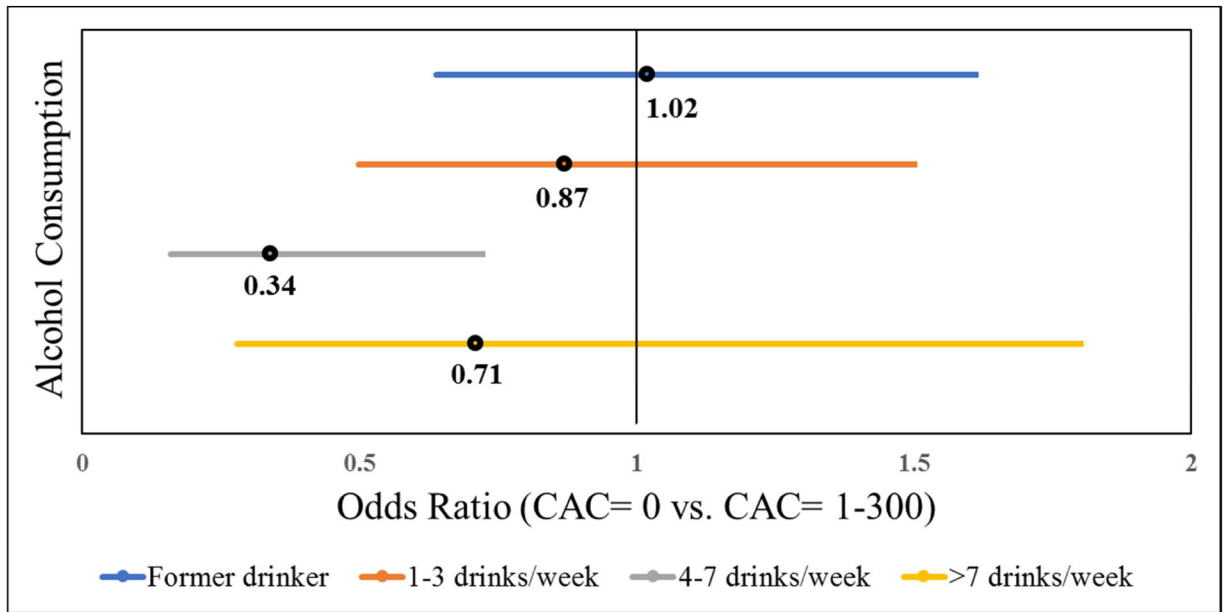


Figure 1.
Multivariable Odds Ratio and 95% CI of association between alcohol consumption and degree of CAC (CAC = 1-300)
Reference group = Never drinker

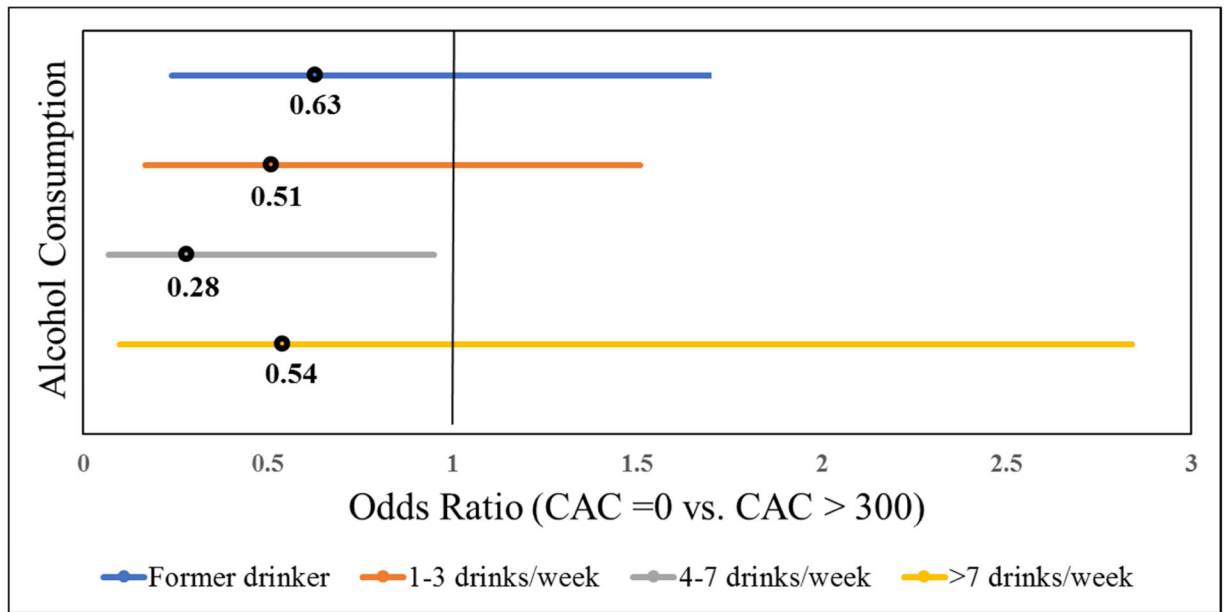


Figure 2.
Multivariable Odds Ratio and 95% CI of association between alcohol consumption and degree of CAC (CAC > 300)
Reference group = Never drinker

Table 1.

Baseline Characteristics of MASALA Participants

Characteristics Mean± SD or N (%)	Alcohol consumption (number of drinks/week)					P value
	Never N=304	Former N=303	1-3 N=182	4-7 N=75	>7 N=42	
Male	93 (31)	173 (57)	116 (64)	63 (84)	41 (98)	<0.001
Age (years)	55.9 ± 9.4	54.6 ± 9.1	54.4 ± 9.6	56.1 ± 8.3	59 ± 11.5	0.021
Systolic Blood Pressure (mm Hg)	124.6 ± 16.5	123.4 ± 14.1	124.2 ± 16	128 ± 17.3	131.1 ± 14.5	0.014
Diastolic Blood Pressure (mm Hg)	71.7 ± 9.6	73.3 ± 9.9	74.4 ± 9.3	76.3 ± 9.4	78.4 ± 10.1	<0.001
LDL Cholesterol (mg/dL)	111.7 ± 32.3	112.7 ± 32.4	108.2 ± 29.8	108.1 ± 33.6	116.5 ± 31.7	0.374
HDL Cholesterol (mg/dL)	50.9 ± 12.9	48.5 ± 12.9	50.5 ± 14	50.8 ± 15.3	51.7 ± 13.6	0.168
Triglyceride (mg/dL)	127.5 ± 55.9	135.3 ± 74.6	132.3 ± 90.8	136.1 ± 69.1	122.7 ± 49.3	0.594
BMI (kg/m ²)	25.9 ± 4	26 ± 4	26.2 ± 4.5	25.8 ± 4	25.6 ± 3.8	0.879
Physical activity (METs per week) *	929 (689-1230)	951 (744-1191)	974 (805-1187)	899 (739-1172)	933 (746-1148)	0.776
Waist Circumference (cm)	91.3 ± 10.4	93 ± 10.2	93.4 ± 10.2	94.4 ± 10.7	96.3 ± 9.6	0.009
Family Income \$75,000 per year	121 (40)	68 (23)	152 (84)	63 (84)	32 (75)	0.001
Education < Bachelor's Degree	37 (12)	36 (12)	21(12)	7 (9)	9 (21)	<0.001
Diabetes Mellitus †	77 (26)	80 (27)	40 (22)	24 (32)	8 (19)	0.47
Smoker Status						<0.001
Never	290 (95)	265 (88)	135 (74)	45 (60)	16 (38)	
Former	11 (4)	28 (9)	42 (23)	25 (33)	18 (43)	
Current	3 (1)	10 (3)	5 (3)	5 (7)	8 (19)	
Lipid-Lowering Medication use	93 (31)	80 (26)	58 (32)	28 (37)	13 (31)	0.39
Family history of heart attack	120 (40)	157 (52)	82 (45)	36 (48)	17 (40)	0.04
C-Reactive Protein (CRP) (ug/mL) *	1.37 (0.7-3.2)	1.3 (0.6-2.9)	1.03 (0.7-2.5)	0.96 (0.5-2.3)	0.96 (0.5-2.6)	0.376
eGFR (ml/min/1.73 m ²) §	95.3 ± 20.5	94.3 ± 20.6	92.9 ± 16.8	89.9 ± 16.1	90.3 ± 14.2	0.156
Common Carotid IMT (mm)	0.84 (0.73-0.95)	0.84 (0.72-0.95)	0.84 (0.72-1.00)	0.89 (0.77-1.06)	0.93 (0.82-1.17)	<0.001
CAC Presence(CAC>0)	112 (37)	130 (43)	80 (44)	32 (44)	26 (63)	0.021

* median (interquartile range) shown for skewed variables

† diabetes defined by fasting plasma glucose ≥ 126 mg/dl, or a post-challenge glucose ≥ 200 mg/dl, or by use of a glucose-lowering medication

§ eGFR calculated from Modification of Diet in Renal Disease formula

LDL, low-density cholesterol; HDL, high-density cholesterol; BMI, body mass index; MET, metabolic equivalent; eGFR, estimated glomerular filtration rate; IMT, intima-media thickness; CAC, coronary artery calcium

Table 2.

Multivariable Odds Ratio and 95% CI of association between alcohol consumption and CAC presence (CAC>0)

Alcohol Consumption	Model 1		Model 2	
	<i>Odds Ratio (95% CI)</i>	<i>p-value</i>	<i>Odds Ratio (95% CI)</i>	<i>p-value</i>
Never Drinker	<i>reference</i>		<i>reference</i>	
Former Drinker	1.03(0.68, 1.56)	0.89	1.02(0.65, 1.59)	0.92
1-3 drinks/week	1.01 (0.62, 1.63)	0.98	0.82(0.48, 1.40)	0.47
4-7 drinks/week	0.53 (0.28, 1.00)	0.05	0.37 (0.18, 0.75)	0.007
>7 drinks/week	0.92 (0.40, 2.16)	0.85	0.61 (0.24, 1.53)	0.29

Model 1 adjusted for age, sex, education, and income

Model 2 adjusted for Model 1 plus smoking (never, former, current, and pack-years), BMI, self-reported physical activity, family history of heart attack, systolic and diastolic blood pressures, HDL-C, LDL-C, triglyceride, use of cholesterol medications, diabetes, C-reactive protein and eGFR.

CAC, coronary artery calcium; BMI, body mass; HDL, high-density cholesterol; LDL, low- density cholesterol

Table 3.

Multivariable Beta-coefficient and 95% CI of association between alcohol consumption Categories and common cIMT

Alcohol Consumption	Model 1		Model 2	
	<i>Beta-Coefficient (95% CI)</i>	<i>p-value</i>	<i>Beta-Coefficient (95% CI)</i>	<i>p-value</i>
Never Drinker	<i>reference</i>		<i>reference</i>	
Former Drinker	0.016 (−0.018, 0.050)	0.37	0.012 (−0.022, 0.047)	0.48
1-3 drinks/week	0.039 (−0.00, 0.079)	0.06	0.033 (−0.007, 0.074)	0.10
4-7 drinks/week	0.049 (−0.006, 0.103)	0.08	0.045 (−0.010, 0.100)	0.11
>7 drinks/week	0.114 (0.045, 0.183)	0.001	0.096 (0.024, 0.167)	0.009

Model 1 adjusted for age, sex, education, and income

Model 2 adjusted for Model 1 plus smoking (never, former, current, and pack-years), BMI, self-reported physical activity, family history of heart attack, systolic and diastolic blood pressures, HDL-C, LDL-C, triglyceride, use of cholesterol medications, diabetes, C-reactive protein and eGFR.

cIMT, carotid intima-media thickness; BMI, body mass; HDL, high-density cholesterol; LDL, low-density cholesterol

Table 4.

Least Mean Square and SE of common cIMT across alcohol categories.

Alcohol categories	Model 1		Model 2	
	<i>Mean ± SE</i>	<i>Trend p-value</i>	<i>Mean ± SE</i>	<i>Trend p-value</i>
Never Drinker	0.86±0.013	0.01	0.86±0.013	0.07
Former Drinker	0.87±0.012		0.87±0.012	
1-3 drinks/week	0.89±0.015		0.89±0.015	
4-7 drinks/week	0.90±0.024		0.90±0.024	
>7 drinks/week	0.97±0.032		0.95±0.033	

Least mean square and standard error calculated from multiple linear regression analysis

Model 1 adjusted for age, sex, race, and education

Model 2 adjusted for Model 1 plus smoking (never, former, current, and pack-years), BMI, self-reported physical activity, family history of heart attack, systolic and diastolic blood pressures, HDL-C, LDL-C, triglyceride, use of cholesterol medications, diabetes, C-reactive protein and eGFR.

SE, standard error; cIMT, carotid intima-media thickness; BMI, body mass; HDL, high-density cholesterol; LDL, low-density cholesterol