Published in final edited form as:
Drug Alcohol Depend. 2021 January 01; 218: 108358. doi:10.1016/j.drugalcdep.2020.108358.

Alcohol type and ideal cardiovascular health among adults of the Multi-Ethnic Study of Atherosclerosis

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Abstract

Background: Light to moderate alcohol consumption is associated with favorable cardiovascular health (CVH). However, the association between alcohol type and ideal CVH has not been well-established. We examined the relationship between alcohol type and ideal CVH as measured by the American Heart Association's seven CVH metrics.

Methods: We analyzed data from 6,389 men and women aged 45–84 years from a multi-ethnic cohort free of cardiovascular disease. Alcohol type (wine, beer and liquor) was categorized as never, former, 0 but drink other alcohol types, >0 but <1 drink/day, 1–2 drinks/day and >2 drinks/day. A CVH score ranging from 0–14 points was created from the seven CVH metrics (Inadequate

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Contributors

OO, OO and EDM designed the study, analyzed the data and drafted the manuscript. OO, OO, EDM, RLM, ML, LM, VO, ETO and GLB interpreted the data and critically revised the manuscript for intellectual content. All authors approved the final version of the manuscript.

Conflict of interest

The authors have no conflict of interest to declare

score, 0–8; average, 9–10; optimal, 11–14). We used multinomial logistic regression to examine the association between alcohol type and CVH, adjusting for age, sex, race/ethnicity, education, income, health insurance, field site and total calorie intake.

Results: The mean (SD) age of participants was 62 (10) years and 53% were women. Participants who consumed 1–2 drinks/day of wine had higher odds of optimal CVH scores compared to those who never drank wine [adjusted prevalence odds ratio (POR) 1.64 (1.12–2.40)]. In comparison to participants who never drank beer, those who consumed >2 drinks/day of beer had lower odds of optimal CVH scores [0.31 (0.14–0.69)]. Additionally, those who consumed >2 drinks/day of liquor had lower odds of optimal scores compared to those who never drank liquor [0.32 (0.16–0.65)].

Conclusion: Moderate consumption of wine was associated with favorable CVH. However, heavy consumption of beer or liquor was associated with poorer CVH.

Keywords

Alcohol type; beverage type; cardiovascular disease; ideal cardiovascular health metrics; Life’s Simple 7; risk factors; prevention

1. Introduction

According to the National Institute of Alcohol Abuse and Alcoholism (NIAA), alcohol misuse is the fifth leading risk factor for premature morbidity and mortality worldwide (NIAA, 2018). Heavy alcohol consumption is associated with an increase in the incidence of cardiovascular diseases (CVD), non-CVD such as cancers and all-cause mortality (Smyth et al., 2015; WHO, 2018; Xi et al., 2017), and it comes with a considerable economic burden (NIAA, 2018; Sacks JJ, 2015; WHO, 2018). For instance, the United States annual expenditure for alcohol misuse was $249.0 billion in 2010 and three-quarters of this was spent on binge drinking related misuse (NIAA 2018; Sacks JJ, 2015).

Several observational studies report that light to moderate alcohol consumption is associated with a lower mortality and morbidity from CVD, in particular coronary heart disease (CHD) (O’Keefe et al., 2018; Ronksley et al., 2011; Wood et al., 2018); however, the literature on the effects of different alcohol types (wine, beer and liquor) on CVD incidence, and CVD related biomarkers is less clear. Although, some of these studies report that light to moderate consumption of wine may be cardioprotective because of the higher concentration of polyphenols (Arranz et al., 2012; Chiva-Blanch et al., 2013; Estruch, 2000), other studies report that this finding may be explained by confounders such as dietary intake, drinking patterns and lifestyle characteristics (Djousse et al., 2009; Gronbaek, 2003; Haseeb et al., 2017; Rimm et al., 1996; Tjonneland et al., 1999).

Furthermore, a few epidemiological studies have shown light to moderate alcohol consumption is associated with favorable cardiovascular health (CVH) (Chevli et al., 2020; Ogunmoroti et al., 2019; Piano et al., 2018), defined by the American Heart Association (AHA) as meeting specific criteria for seven CVH metrics (smoking, physical activity, body mass index (BMI), diet, total cholesterol, blood pressure and blood glucose) (Labarthe, 2012; Lloyd-Jones et al., 2010). The CVH metrics are useful surveillance tools to monitor and evaluate the trends of CVD and CVH in the continued efforts to promote and improve global CVH and wellness (Angell et al., 2020; Roger et al., 2020). However, the effects of alcohol type on CVH are largely unknown. Therefore, this study aims to: 1) examine the association between alcohol type and CVH using data from the Multi-Ethnic Study of Atherosclerosis (MESA), 2) examine whether alcohol type is more strongly associated with one or more CVH metrics and 3) determine whether age, sex or race/ethnicity modifies the association between alcohol type and CVH. We hypothesized that higher quantities of alcohol consumed will be associated with poorer CVH irrespective of alcohol type.

2. Methods

2.1 Study population

MESA is a prospective cohort study of the characteristics of subclinical CVD and the risk factors that predict progression to clinical CVD. A detailed methodology has been previously described (Bild et al., 2002). From 2000 to 2002, the MESA study recruited an ethnically diverse population-based sample of 6,814 men and women without clinical CVD between the ages of 45–84 year old from six field centers across the United States (Baltimore, MD; Chicago, IL; Forsyth County, NC; Los Angeles, CA; New York, NY and St Paul, MN). Approximately 38% of the recruited participants were White, 28% Black, 22% Hispanic, and 12% Chinese American. All participants gave informed consent and the institutional review boards of each recruitment center approved the study protocol. MESA study personnel collected data from participants using standardized questionnaires, physical examination and laboratory tests. In this study, we included 6,389 men and women after the exclusion of participants without complete information on the CVH metrics (n=308) or other key variables (n=117). For this analysis, we only used data collected at the baseline exam.

2.2 Alcohol type

MESA study personnel collected data on the type of alcohol consumed (wine, beer, and liquor) by asking study participants to complete a 120-item food frequency questionnaire (FFQ). Liquor has also been referred to as “hard alcohol” or “spirits”. The MESA FFQ is a modification of a previously validated questionnaire originally designed for the Insulin Resistance and Atherosclerosis Study (Block et al., 1990; Mayer-Davis et al., 1999). As documented in a prior research in MESA (McClelland et al., 2008), participants were asked to review their usual eating patterns in the past year and to record the usual serving size (small, medium and large) in addition to providing information on the average consumption of specific types of alcohol and food. For example, type of alcohol consumed had nine options: “rare or never,” “1–3 per month,” “1 per week,” “2–4 per week,” “5–6 per week,” “1 per day,” “2–3 per day,” “4–5 per day,” and “≥ 6 per day.” (McClelland et al., 2008). Finally, we categorized each alcohol type into “never”, former”, “0 but drink other alcohol types”, “>0 but <1 drink/day” (very light), “1–2 drinks/day” (light to moderate) and “>2 drinks/day” (heavy) (McClelland et al., 2008).

2.3 Cardiovascular health

We measured CVH using the AHA’s seven CVH metrics (smoking, physical activity, BMI, diet, total cholesterol, blood pressure, and blood glucose) (Lloyd-Jones et al., 2010). Data collected from study participants on smoking status were self-reported and classified as current, former (quit within the last 12 months) and nonsmokers (never smoked or quit more than 12 months ago). MESA assessed physical activity using responses from a self-report survey instrument modified from the Cross-Cultural Activity Participation Study (Ainsworth et al., 1999). The survey comprised of 28 questions on time and frequency of activities during a week in the previous month and included questions on conditioning activities, care of children/adults, dancing and sports activities, household chores, lawn/yard/garden/farm activities, leisure activities, occupational activities and volunteer activities. We calculated the total minutes of moderate and vigorous exercise from the minutes spent during activities such as conditioning, leisure, and walking expressed in metabolic equivalents of task (Unger et al., 2014).

We calculated BMI using the measurements of weight and height expressed in kg/m^2. For dietary assessment, we utilized the aforementioned 120-item validated FFQ modified from the Insulin Resistance Atherosclerosis Study instrument (Block et al., 1990; Mayer-Davis et al., 1999). As previously described by the AHA, the 5 components of a healthy diet comprised of fruits and vegetables, fish, whole grains, intake of sodium <1500mg per day and sugar-sweetened beverages ≤450 kcal (36 oz.) per week (Lloyd-Jones et al., 2010). MESA study personnel took three blood pressure readings from study participants in a seated position after 5 minutes of rest and calculated the documented blood pressure from the average value for the last two readings. Total cholesterol and blood glucose levels were measured from laboratory tests of blood samples after a 12-hour fast.

2.4 Covariates

MESA study personnel collected data on sociodemographic variables such as age, sex, race/ethnicity, education, income, health insurance, MESA field site and total calorie intake measured in kilocalories. In our stratified analyses, we considered age as two categories (<65 and ≥65 years); however, in our models, we adjusted for age as a continuous variable. Sex and race/ethnicity were self-reported and had two categories (men and women) and four categories (White, Chinese American, Black, and Hispanic), respectively. Education was classified as ≥bachelor's degree and < bachelor's degree but was adjusted for using the nine categories collected at baseline. Income was divided into participants who made ≥$40 000 and < $40 000 annually but we included the thirteen baseline categories of income in our models. We classified health insurance into "Yes" and "No" and analyzed total calorie intake as a continuous variable.

2.5 Statistical analysis

We reported the characteristics of study participants by CVH score categories. We presented categorical variables as frequencies with percentages, and continuous variables as means with standard deviation (SD). In addition, we reported variables with skewed distributions as median with interquartile range (IQR). To compare the differences between the characteristics of study participants across CVH score categories, we used the ANOVA or chi-square tests as appropriate. As shown in Supplemental Table S1, to create the CVH score, we categorized each of the seven CVH metrics into poor, intermediate and ideal, and assigned 0 points, 1 point and 2 points, respectively, to the categories (Lloyd-Jones, 2012).

After summing up the points, the total points attainable was 0–14. We further categorized the total points into inadequate (0–8 points), average (9–10 points), and optimal (11–14 points) CVH scores, based on prior studies (Osibogun et al., 2020; Osibogun et al. 2019; Unger et al., 2014).

We used multinomial regression models to examine the associations between alcohol type and the CVH score. We fitted two separate regression models. Model 1 was adjusted for sociodemographic factors (age, sex, race/ethnicity, education, income, health insurance status and MESA field site). In model 2, we adjusted for the covariates in model 1 and total calorie intake. We reported prevalence odds ratios (POR) and their corresponding 95% confidence intervals (CI) for average and optimal CVH scores across alcohol types. Consistent with previous research (Ogunmoroti et al., 2019), the reference groups were the “inadequate” category for CVH scores and the “never” category for alcohol type. In addition, we examined the association between alcohol type and each CVH metric adjusted for the covariates in model 2. The reference group for the individual CVH metrics was the “poor” category. We tested for effect modification by age (<65 vs ≥65 years), race/ethnicity and sex by inserting interaction terms in model 2. We performed all analyses using STATA version 15.1 (StataCorp LP, College Station, Texas). A two-sided P-value <0.05 was considered statistically significant for analyses that examined the CVH score. To account for multiple testing, a Bonferroni corrected two-sided P-value of <0.002 was considered statistically significant for analyses that examined the CVH metrics.

3. Results

Table 1 shows the baseline characteristics of study participants. The mean age (SD) of the 6,389 participants was 62 (10) while women accounted for 53% of the study population. We found that participants with optimal CVH scores were younger and there was no difference in the distribution of the CVH scores by sex. The majority of participants with inadequate scores were either Black or participants with <bachelor’s degree or those who earned < $40,000 annually. Across the study population, irrespective of the category of each alcohol type, a larger proportion of participants met the criteria for inadequate CVH while a smaller proportion met the criteria for optimal CVH, with the exception of the participants who drank 1–2 drinks/day of wine (Figure 1).

Table 2 shows the multivariable-adjusted association between alcohol type and the CVH score. In the fully adjusted models, participants who drank 1–2 drinks of wine per day had a higher odds of optimal CVH scores [POR 1.64 (95% CI, 1.12–2.40)] compared to those who never drank wine. Participants whose daily intake of beer or liquor was >2 drinks had a lower odds of optimal CVH scores in comparison to those who never drank [0.31 (0.14–0.69) and 0.32 (0.16–0.65), respectively.

Tables 3 and 4 show the multivariable-adjusted association between alcohol type and the individual CVH metrics. Participants who drank >0 but <1 drink/day of wine had a higher odds of ideal physical activity and blood glucose [1.70 (1.38–2.10), and 1.92 (1.45–2.56)], respectively (Tables 3 & 4). Those who drank 1–2 drinks/day of wine had a higher odds of ideal BMI [2.86 (1.83–4.45)]. Participants who reported zero drinks of wine per day but drank other alcohol types and those who drank >0 but <1 drink/day had a lower odds of ideal smoking [0.29 (0.22–0.39) and 0.46 (0.30–86)], respectively.

Participants who reported zero drinks of beer but drank other alcohol types had a higher odds of ideal blood glucose [1.55 (1.20–2.02)] (Table 4). Former drinkers of beer as well as those who drank beer regardless of quantity had a lower odds of ideal smoking (Table 3). Participants who reported zero drinks of beer but drank other alcohol types had a lower odds of ideal smoking [0.39 (0.29–0.52)].

Participants who reported zero drinks of liquor but drank other alcohol types had a higher odds of ideal BMI and blood glucose [1.44 (1.15–1.79), and 1.50 (1.17–1.93)], respectively (Tables 3 & 4). Former drinkers of liquor as well as those who drank liquor regardless of quantity had a lower odds of ideal smoking (Table 3). Participants who reported zero drinks of liquor but drank other alcohol types had a lower odds of ideal smoking [0.42 (0.31–0.56)].

We found that age and sex modified the association between all 3 alcohol types and CVH with P<0.05. In stratified analysis, women who reported 1–2 drinks/day of wine had a higher odds of optimal CVH scores [2.71 (1.51–4.83)] (Supplemental Table S2). Men who reported >2 drinks/day of beer had a lower odds of optimal CVH scores [0.27 (0.11–0.64)]. In addition, men who reported 1–2 or >2 drinks/day of liquor had a lower odds of optimal CVH scores [0.43 (0.21–0.89) and 0.33 (0.15–0.74), respectively] (Supplemental Table S2). Furthermore, participants <65 years who reported >2 drinks/day of beer or liquor had a lower odds of optimal CVH scores [(0.33 (0.12–0.89) and 0.38 (0.16–0.91, respectively)] (Supplemental Table S3). Participants ≥65 years who reported >2 drinks/day of liquor had a lower odds of optimal CVH scores [0.24 (0.07–0.76)] (Supplemental Table S3).

4. Discussion

In this multi-ethnic community-based study of adults free of CVD at baseline, we found that after adjusting for sociodemographic characteristics and total calorie intake, study participants who consumed 1–2 drinks/day of wine had a higher odds of optimal CVH scores compared to those who never drank wine. Participants who consumed >2 drinks/day of beer or liquor had a lower odds of optimal CVH scores compared to those who never drank beer or liquor. However, we cannot prove either a temporal or a causal relationship between alcohol type consumed and CVH because of the cross-sectional design of this study. Furthermore, for all alcohol types, drinking was associated with lower odds of ideal smoking status, reinforcing the influence of lifestyle behaviors in determining overall CVH.

Previous studies have shown that heavy drinking is associated with poorer CVH (Chevli et al., 2020; Ogunmoroti et al., 2019). However, the literature is sparse on the association between alcohol type and CVH, as measured by the AHA's seven CVH metrics. In a combined analysis of over half a million current drinkers from 83 prospective studies conducted by Wood and colleagues (Wood et al., 2018) to examine the effect of alcohol type on CVD, wine consumption (100g/week or ≈1 drink/day) was associated with a lower risk for myocardial infarction (Wood et al., 2018). Beer consumption (100g/week) was associated with a higher risk for stroke and heart failure (Wood et al., 2018) while spirits consumption (100g/week) was associated with a higher risk for myocardial infarction, stroke, heart failure and CHD (Wood et al., 2018).

The French paradox, first described by Renaud and de Lorgeril, attributes the low mortality from CHD in spite of a diet high in saturated fat to moderate wine consumption (Renaud & de Lorgeril, 1992). Comparably, we found that light to moderate wine consumption was associated with favorable CVH, which may be attributable to the cardioprotective effects of the polyphenols in wine. Polyphenols which are broadly categorized as flavonoids (e.g. quercetin) and non-flavonoids (e.g. resveratrol) prevent the development of atherosclerosis by inhibiting LDL oxidation and platelet aggregation in addition to increasing HDL-C and preventing endothelial dysfunction. Although some prior studies have corroborated this finding (Arranz et al., 2012; Chiva-Blanch et al., 2013; Estruch, 2000), other studies concluded that differences in lifestyle characteristics, dietary habits, drinking patterns, and access to healthcare, between wine and non-wine drinkers may be responsible for the associations seen (Djousse et al., 2009; Gronbaek, 2003; Rimm et al., 1996; Tjonneland et al., 1999). Moreover, in stratified analyses, we found that women who reported light to moderate wine consumption were more likely to have favorable CVH. As previously documented, the explanation for this finding is unclear (Di Castelnuovo, Rotondo, Iacoviello, Donati, & De Gaetano, 2002); however, our data suggest that women may engage in healthier eating habits compared to men.

Our study finding of a lower odds of ideal smoking among former or current drinkers is expected because smoking rate among individuals with alcohol use disorder is estimated at 90% (NIAA, 2018). Concurrent use of alcohol and tobacco is attributable to an interaction of several factors including shared genetic and environmental risk factors, neurobiological mechanisms such as cross-tolerance and cross-sensitivity as well as psychosocial factors such as personality traits and psychiatric comorbidities (NIAA, 2018).

Study participants who reported consuming light to moderate wine were more likely to have ideal BMI. It may be that in these participants, the alcohol consumption is replacing intake of other unhealthy food sources that drive weight gain such as highly processed foods, as we did adjust for total caloric intake. In addition, very light consumption of wine per day was associated with ideal physical activity, which may also contribute to maintaining an ideal BMI. These findings are not novel but the biological mechanisms responsible for the associations are still under investigation (Dodge, Clarke, & Dwan, 2017; Sayon-Orea et al., 2011; Traversy & Chaput, 2015). Moreover, participants who reported consuming very light wine or beer or liquor per day were more likely to have ideal glucose levels which may be due to the hypoglycemic effects of alcohol, mediated through the inhibition of gluconeogenesis and liver glycogen storage (Field et al., 1963).

Furthermore, a causal relationship has been established between heavy drinking and several acute and chronic disease outcomes (Rehm et al., 2010). A recent Mendelian randomization study using the UK Biobank data found that genetic risk for higher alcohol consumption (rs1229984 in ADH1B gene) was associated with increased risk of stroke and peripheral arterial disease (Larsson et al., 2020). Predictably, our results showed that in the overall cohort, participants who reported heavy drinking of beer or liquor were more likely to have poorer CVH scores. In stratified analyses, these findings were more pronounced for poorer CVH scores among men and participants <65 years who reported heavy drinking of beer or liquor and participants ≥65 years who reported heavy drinking of liquor.

While the American Heart Association and the 2015–2020 Dietary Guidelines from the Centers for Disease Control and Prevention (CDC) do not endorse drinking alcohol, they encourage drinking in moderation for people who choose to drink, which means no more than 2 drinks a day for men and 1 drink a day for women (USDHHS 2020). However, there was no further guidance in regards to alcohol type, which is what our study undertook to provide insight. Although, our study is observational and cannot show a causal effect, our findings suggest that even in moderation, the specific type of alcohol may matter for CVH, with wine perhaps being more favorable for consumption than other alcohol types.

Despite the fact that our results support prior epidemiological studies that have shown light to moderate wine consumption is associated with favorable CVH, we do not advocate initiating or increasing wine consumption to gain health benefits because regardless of alcohol type consumed there is a significant potential for addiction and increased risk for CVD, non-CVD, as well as intentional and unintentional injuries (NIAA, 2018; Miller et al., 2020; WHO, 2018). In addition, with the considerable socioeconomic burden associated with heavy drinking (NIAA, 2018; WHO, 2018), preventive intervention programs should be increasingly directed at the entire population, and subgroups of the population at greater risk of developing alcohol related outcomes (Gordon, 1983; Institute of Medicine Committee to Identify Research Opportunities in the & Treatment of Alcohol-Related, 1990). In fact, current guidelines for the quantity of alcohol consumed may need to be revised in light of the aforementioned study by Wood and colleagues that showed the threshold for the lowest risk for all-cause mortality in men and women was (100g/week or ≈1 drink/day) (Wood et al., 2018).

Some of the strengths of this study include the large multi-ethnic community-based population that allowed for stratification of our analysis by sex, age and race/ethnicity. Additionally, MESA study personnel collected data for alcohol type and CVH using standardized methods and procedures. However, our study also has some limitations. First, we used self-report questionnaires for the collection of data on the CVH metrics (such as smoking, physical activity and diet) so recall bias cannot be ruled out. Second, some participants may have underreported the quantity of alcohol consumed, which may have led to a non-differential misclassification causing a bias of the associations examined towards the null. Third, data were not available on the different types of wine so we could not assess the relationship of white or red wine with CVH. Fourth, we did not have additional information on when alcohol consumption was discontinued among former drinkers. Fifth, we cannot exclude residual confounding because our study design was observational and may not have accounted for all the differences between participants in the categories of each alcohol type even though we adjusted for several confounding factors such as sociodemographic characteristics and total calorie intake. Sixth, we assessed CVH once at baseline and this assessment may not capture future CVH status of study participants. Seventh, although MESA is a large multi-ethnic community-based study from 6 different recruitment centers in the US, it was not designed to be nationally representative of the US general population. Lastly, we cannot make causal inferences from the findings of this study nor can we determine temporality because of the cross-sectional study design.

4.1 Conclusion

This study found that light to moderate consumption of wine was associated with favorable CVH while heavy consumption of beer or liquor was associated with poorer CVH. However, we do not recommend that abstainers or current drinkers of alcohol initiate or increase wine consumption to gain health benefits because of the high risk of addiction and untoward health effects (Miller et al., 2020). Future research should be carefully designed using randomized clinical trials with sufficient follow-up time to elucidate if a cause-effect relationship exists between alcohol type, particularly light to moderate wine consumption, and CVH in addition to providing useful information on the causal pathways involved.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

The authors thank the other investigators, the staff, and the MESA participants for their valuable contributions. A full list of participating MESA investigators and institutions can be found at http://www.mesa-nhlbi.org.

Role of funding sources

The Multi-Ethnic Study of Atherosclerosis is supported by contracts, Grant/Award Number: N01-HC-95159, N01-HC-95160, N01-HC-95161, N01-HC-95162, N01-HC-95163, N01-HC-95164, N01-HC-95165, N01-HC-95166, N01-HC-95167, N01-HC-95168, N01-HC-95169, and HHSN268201500003I; from the National Heart, Lung, and Blood Institute (NHLBI) and by grants, Grant/Award Number: UL1-RR-024156 and UL1-RR-025005; from the National Center for Research Resources (NCRR). Dr. Michos was additionally supported by the Blumenthal Scholars Fund for Preventive Cardiology at the Johns Hopkins University.

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Highlights

- We examined the relationship between alcohol type and cardiovascular health
- Data analyzed were from men and women of the Multi-Ethnic Study of Atherosclerosis, 2000–2002
- Light to moderate consumption of wine was associated with favorable cardiovascular health
- Heavy consumption of beer or liquor was associated with poorer cardiovascular health

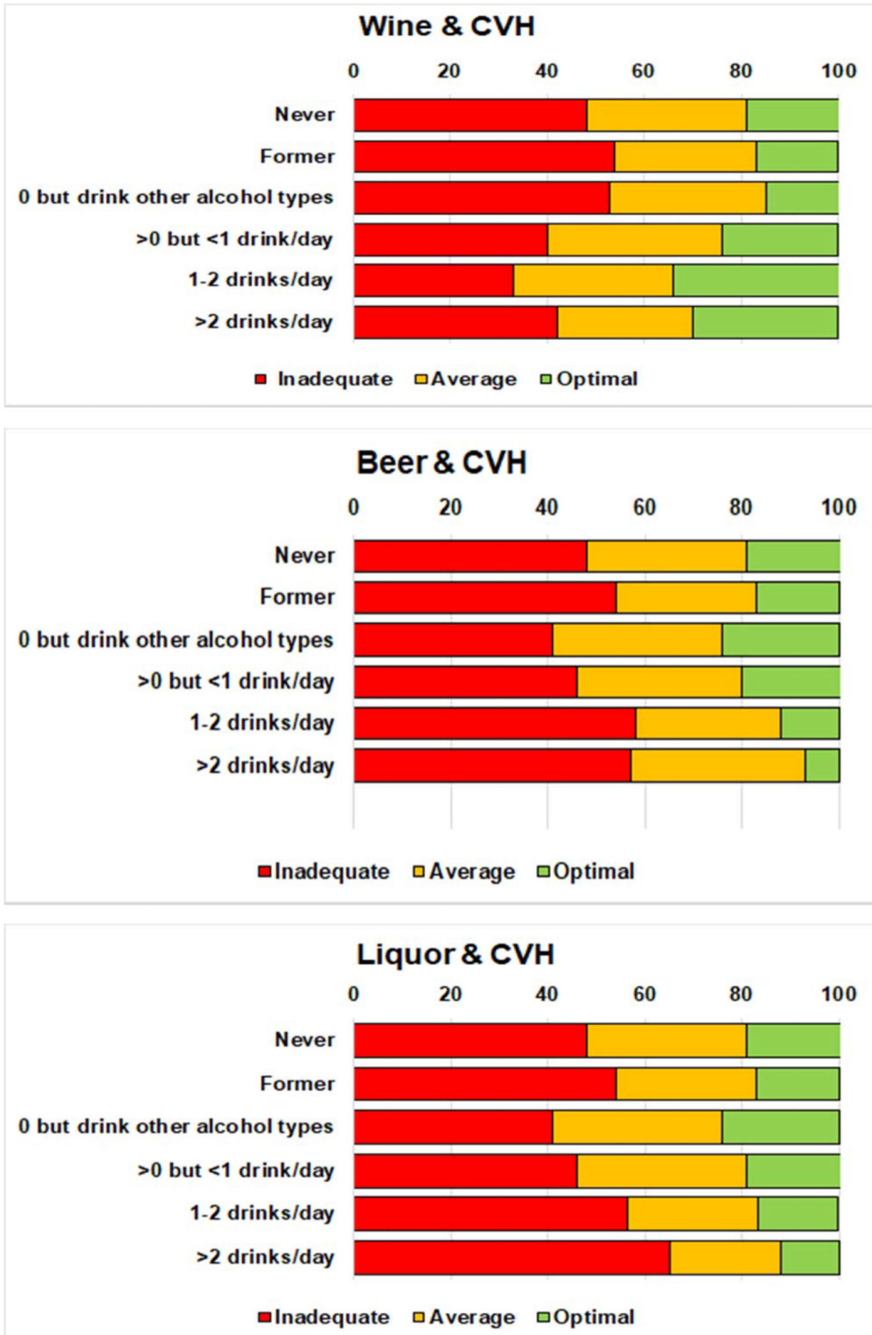

Figure.

Distribution of the cardiovascular health (CVH) score by categories of alcohol type. Red: inadequate (0–8 points), Orange: average (9–10 points) and Green: optimal (11–14 points).

Table 1:

Characteristics of study participants by cardiovascular heath score in MESA, 2000–2002, N= 6,389

	Total	Inadequate	Average	Optimal	P value
	N=6,389	n=3,026	n=2,085	n=1,278	
Age, mean (SD), y	62 (10)	63 (10)	62 (11)	60 (10)	<0.001
< 65 years	3,629 (57%)	1,650 (55%)	1,181 (57%)	798 (62%)	<0.001
≥ 65 years	2,760 (43%)	1,376 (45%)	904 (43%)	480 (38%)	
Sex					
Men, n (%)	3,013 (47%)	1,431 (47%)	991 (48%)	591 (46%)	0.75
Women, n (%)	3,376 (53%)	1,595 (53%)	1,094 (52%)	687 (54%)	
Race/Ethnicity					
White	2,498 (39%)	964 (32%)	893 (43%)	641 (50%)	<0.001
Chinese American	796 (12%)	216 (7%)	319 (15%)	261 (20%)	
Black	1,666 (26%)	1,015 (34%)	462 (22%)	189 (15%)	
Hispanic	1,429 (22%)	831 (27%)	411 (20%)	187 (15%)	
Education					
≥ Bachelor's degree	2,294 (36%)	785 (26%)	820 (39%)	689 (54%)	<0.001
< Bachelor's degree	4,095 (64%)	2,241 (74%)	1,265 (61%)	589 (46%)	
Income					
≥$40,000	3,158 (49%)	1,250 (41%)	1,109 (53%)	799 (63%)	<0.001
<$40,000	3,231 (51%)	1,776 (59%)	976 (47%)	479 (37%)	
Health insurance					
Yes	5,817 (91%)	2,742 (91%)	1,912 (92%)	1,163 (91%)	0.41
No	572 (9%)	284 (9%)	173 (8%)	115 (9%)	
Total calorie intake	1475 (1035–2030)	1546 (1095–2126)	1445 (1025–1987)	1350 (937–1866)	<0.001

Abbreviations: MESA, Multi-Ethnic Study of Atherosclerosis; SD, standard deviation.

Cardiovascular health score ranges from 0–14 points; inadequate score, 0–8; average, 9–10; optimal, 11–14.

We expressed total calorie intake as median (interquartile range).

Row percentages were reported for alcohol type. Percentages are rounded up to 1 decimal place.

Table 2:

Association between alcohol type and cardiovascular health score in MESA, 2000–2002, N=6,389

Alcohol type	Average vs Inadequate	Optimal vs Inadequate	Average vs Inadequate	Optimal vs Inadequate
	Model 1		Model 2	
	OR (95% CI)		OR (95% CI)	
Wine consumption				
Never	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]
Former	0.96 (0.80–1.15)	1.09 (0.87–1.37)	0.95 (0.79–1.15)	1.15 (0.90–1.45)
0 but drink other alcohol types *	0.93 (0.77–1.13)	0.80 (0.63–1.02)	0.92 (0.76–1.11)	0.81 (0.63–1.03)
>0 but <1 drink/day	1.19 (0.98–1.43)	1.16 (0.92–1.46)	1.18 (0.98–1.43)	1.23 (0.98–1.56)
1–2 drinks/day	1.12 (0.79–1.59)	**1.50 (1.02–2.20)**	1.13 (0.79–1.61)	**1.64 (1.12–2.40)**
>2 drinks/day	0.74 (0.43–1.28)	1.00 (0.57–1.78)	0.77 (0.45–1.33)	1.19 (0.67–2.11)
Beer consumption				
Never	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]
Former	0.94 (0.78–1.13)	1.03 (0.82–1.30)	0.94 (0.78–1.13)	1.09 (0.86–1.38)
0 but drink other alcohol types *	1.13 (0.94–1.35)	1.15 (0.92–1.43)	1.11 (0.92–1.33)	1.16 (0.93–1.45)
>0 but <1 drink/day	0.97 (0.80–1.19)	0.86 (0.67–1.10)	0.98 (0.80–1.19)	0.93 (0.72–1.19)
1–2 drinks/day	0.74 (0.49–1.11)	**0.49 (0.27–0.86)**	0.76 (0.51–1.15)	0.57 (0.32–1.02)
>2 drinks/day	0.86 (0.56–1.33)	**0.27 (0.12–0.58)**	0.89 (0.57–1.37)	**0.31 (0.14–0.69)**
Liquor consumption †				
Never	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]
Former	0.93 (0.78–1.12)	1.04 (0.82–1.31)	0.93 (0.77–1.13)	1.09 (0.86–1.38)
0 but drink other alcohol types *	1.13 (0.95–1.35)	1.14 (0.92–1.42)	1.11 (0.93–1.34)	1.17 (0.94–1.46)
>0 but <1 drink/day	1.00 (0.82–1.22)	0.83 (0.65–1.07)	0.99 (0.81–1.22)	0.89 (0.69–1.15)
1–2 drinks/day	**0.59 (0.38–0.91)**	**0.52 (0.30–0.89)**	**0.60 (0.39–0.93)**	0.59 (0.35–1.02)
>2 drinks/day	**0.40 (0.24–0.67)**	**0.28 (0.14–0.55)**	**0.41 (0.24–0.69)**	**0.32 (0.16–0.65)**

Abbreviations: CI, confidence interval; OR, odds ratio; MESA, Multi-Ethnic Study of Atherosclerosis.

Cardiovascular health score ranges from 0–14 points; inadequate score, 0–8; average, 9–10; optimal, 11–14.

* 0 but drinks other alcohol types: participants do not drink wine, beer or liquor as applicable but drink other alcohol types

Statistically significant results at $p < 0.05$ are in bold font

Model 1: Adjusted for age, sex, race/ethnicity, education, income, health insurance and MESA field site

Model 2: Adjusted for model 2 covariates + total calorie intake

† Liquor has also been referred to as “hard alcohol” or “spirits”.

Table 3:

Association between alcohol type and cardiovascular health metrics in MESA, 2000–2002, N=6,389

Alcohol type	Smoking		Body mass index		Physical activity		Diet	
	Intermediate vs poor	Ideal vs poor	Intermediate vs poor	Ideal vs poor	Intermediate vs poor	Ideal vs poor	Intermediate vs poor	Ideal vs poor
	OR (95% CI)		OR (95% CI)		OR (95% CI)		OR (95% CI)	
Wine consumption								
Never	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]
Former	1.55 (0.58, 4.16)	*0.64 (0.47,0.86)*	0.83 (0.68,1.01)	1.03 (0.82,1.29)	1.25 (0.98, 1.61)	1.04 (0.86,1.27)	0.96 (0.81, 1.14)	0.61 (0.27, 1.37)
0 but drink other alcohol types*	0.86 (0.32, 2.29)	**0.29 (0.22,0.39)**	0.97 (0.79,1.19)	1.21 (0.96,1.53)	1.29 (1.00,1.66)	1.03 (0.85, 1.26)	*0.79 (0.67, 0.95)*	0.52 (0.23, 1.17)
>0 but <1 drink/day	0.94 (0.34.2.61)	**0.46 (0.30,0.86)**	*1.25 (1.02,1.54)*	*1.38 (1.09,1.74)*	**1.91 (1.46, 2.49)**	**1.70 (1.38, 2.10)**	0.96 (0.80, 1.14)	0.81 (0.38, 1.70)
1–2 drinks/day	0.79 (0.14,4.44)	*0.51 (0.30,0.86)*	**2.50 (1.65,3.78)**	**2.86 (1.83,4.45)**	1.14 (0.67, 1.94)	1.45 (0.97, 2.17)	1.24 (0.91, 1.70)	2.04 (0.72, 5.82)
>2 drinks/day	-	*0.40 (0.19,0.82)*	1.18 (0.67,2.08)	1.50 (0.81, 2.76)	1.51 (0.68, 3.35)	1.32 (0.70, 2.51)	1.26 (0.79, 2.02)	1.38 (0.16, 11.79)
Beer consumption								
Never	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]
Former	1.52 (0.56,4.11)	**0.60 (0.44, 0.82)**	0.84 (0.69,1.02)	1.04 (0.83,1.31)	1.26 (0.98, 1.62)	1.04 (0.85, 1.26)	0.94 (0.79, 1.12)	0.60 (0.27, 1.34)
0 but drink other alcohol types*	0.88 (0.32,2.36)	**0.39 (0.29,0.52)**	1.08 (0.89,1.31)	*1.27 (1.02,1.59)*	*1.41 (1.10, 1.81)*	*1.30 (1.07, 1.58)*	0.94 (0.79, 1.11)	0.70 (0.35, 1.38)
>0 but <1 drink/day	0.95 (0.34,2.63)	**0.34 (0.25,0.47)**	1.21 (0.97,1.49)	*1.40 (1.10,1.79)*	**1.71 (1.30, 2.25)**	*1.32 (1.06, 1.64)*	0.85 (0.71, 1.02)	0.81 (0.35, 1.87)
1–2 drinks/day	0.19 (0.02,1.78)	**0.19 (0.12,0.30)**	*1.78 (1.15, 2.75)*	*1.88 (1.12,3.18)*	1.39 (0.74, 2.62)	1.54 (0.96, 2.48)	0.75 (0.51, 1.11)	1.24 (0.15, 10.23)
>2 drinks/day	0.89 (0.21,3.78)	**0.21 (0.12,0.36)**	1.31 (0.80,2.15)	*1.99 (1.14,3.47)*	1.31 (0.70, 2.46)	0.92 (0.57, 1.50)	*0.60 (0.38, 0.94)*	-
Liquor consumption†								

Alcohol type	Smoking		Body mass index		Physical activity		Diet	
	Intermediate vs poor	Ideal vs poor	Intermediate vs poor	Ideal vs poor	Intermediate vs poor	Ideal vs poor	Intermediate vs poor	Ideal vs poor
	OR (95% CI)		OR (95% CI)		OR (95% CI)		OR (95% CI)	
Never	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]
Former	1.52 (0.56,4.11)	**0.60 (0.44,0.81)**	0.82 (0.67,1.00)	1.00 (0.80,1.26)	1.25 (0.98, 1.61)	1.04 (0.85, 1.26)	0.94 (0.79, 1.12)	0.59 (0.26, 1.34)
0 but drink other alcohol types*	0.87 (0.32,2.35)	**0.42 (0.31,0.56)**	1.15 (0.95,1.40)	**1.44 (1.15,1.79)**	*1.44 (1.13, 1.84)*	*1.28 (1.06, 1.55)*	0.98 (0.83, 1.16)	0.74 (0.37, 1.46)
>0 but <1 drink/day	0.93 (0.33,2.58)	**0.31 (0.22,0.42)**	1.17 (0.95,1.45)	1.21 (0.95,1.55)	**1.70 (1.28, 2.26)**	*1.39 (1.11, 1.73)*	*0.76 (0.63, 0.92)*	0.71 (0.31, 1.61)
1–2 drinks/day	0.49 (0.09,2.77)	**0.17 (0.10,0.27)**	0.88 (0.57,1.35)	0.97 (0.59,1.62)	1.22 (0.64, 2.30)	1.11 (0.68, 1.79)	1.08 (0.73, 1.59)	1.51 (0.31, 7.49)
>2 drinks/day	0.56 (0.10,3.17)	**0.10 (0.06,0.18)**	0.90 (0.55,1.49)	0.81 (0.45,1.48)	1.18 (0.58, 2.41)	0.93 (0.54, 1.61)	*0.50 (0.32, 0.80)*	-

Abbreviations: CI, confidence interval; OR, odds ratio; MESA, Multi-Ethnic Study of Atherosclerosis.

*0 but drinks other alcohol types: participants do not drink wine, beer or liquor as applicable but drink other alcohol types

Statistically significant results at $p < 0.002$ are in bold font. Statistically significant results at $p < 0.05$ are italicized.

We adjusted the odds ratios for age, sex, race/ethnicity, education, income, health insurance, MESA field site and total calorie intake

†Liquor has also been referred to as “hard alcohol” or “spirits”.

Table 4:

Association between alcohol type and cardiovascular health metrics in MESA, 2000–2002, N=6,389

Alcohol type	Total cholesterol		Blood pressure		Glucose	
	Intermediate vs poor	Ideal vs poor	Intermediate vs poor	Ideal vs poor	Intermediate vs poor	Ideal vs poor
	OR (95% CI)		OR (95% CI)		OR (95% CI)	
Wine consumption						
Never	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]
Former	1.17 (0.90, 1.52)	1.25 (0.97, 1.62)	*1.35 (1.10, 1.66)*	*1.27 (1.03, 1.57)*	1.11 (0.82, 1.50)	1.02 (0.80,1.29)
0 but drink other alcohol types *	0.87 (0.68, 1.13)	0.90 (0.70, 1.16)	1.08 (0.87, 1.33)	1.15 (0.93, 1.42)	*1.43 (1.04, 1.96)*	1.24 (0.95, 1.60)
>0 but <1 drink/day	0.85 (0.66, 1.10)	0.82 (0.64, 1.06)	1.15 (0.93, 1.41)	1.23 (0.99, 1.52)	**1.83 (1.30, 2.57)**	**1.92 (1.45, 2.56)**
1–2 drinks/day	0.74 (0.48, 1.15)	0.70 (0.45, 1.08)	0.94 (0.65, 1.37)	1.07 (0.74, 1.55)	*2.09 (1.02, 4.28)*	*1.96 (1.04, 3.70)*
>2 drinks/day	*0.52 (0.27, 0.99)*	*0.49 (0.26, 0.93)*	1.28 (0.72, 2.28)	1.24 (0.69, 2.25)	*3.65 (1.20, 1.15)*	1.78 (0.62, 5.10)
Beer consumption						
Never	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]
Former	1.16 (0.89, 1.51)	1.23 (0.95, 1.59)	*1.34 (1.09, 1.64)*	*1.24 (1.00,1.53)*	1.09 (0.81, 1.48)	1.01 (0.79, 1.29)
0 but drink other alcohol types *	0.89 (0.70, 1.14)	0.91 (0.72, 1.16)	1.14 (0.93, 1.39)	*1.28 (1.04, 1.56)*	**1.71 (1.25, 2.35)**	**1.55 (1.20, 2.02)**
>0 but <1 drink/day	0.79 (0.60, 1.04)	0.77 (0.59, 1.00)	1.08 (0.87, 1.35)	1.11 (0.89, 1.39)	*1.47 (1.04, 2.07)*	*1.46 (1.10, 1.94)*
1–2 drinks/day	0.90 (0.51, 1.59)	0.72 (0.41, 1.26)	1.00 (0.64, 1.58)	0.80 (0.50, 1.28)	1.60 (0.73, 3.53)	1.82 (0.93, 3.57)
>2 drinks/day	0.62 (0.34, 1.12)	*0.50 (0.28, 0.89)*	0.72 (0.44, 1.17)	*0.53 (0.32, 0.91)*	1.64 (0.72, 3.71)	1.41 (0.69, 2.88)
Liquor consumption †						
Never	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]	1.00 [reference]
Former	1.19 (0.92, 1.55)	1.25 (0.97, 1.62)	*1.35 (1.10, 1.66)*	*1.26 (1.02, 1.55)*	1.12 (0.83, 1.51)	1.01 (0.79, 1.29)
0 but drink other alcohol types *	0.79 (0.62, 1.01)	0.86 (0.68, 1.09)	1.09 (0.89, 1.32)	1.19 (0.98, 1.45)	*1.52 (1.12, 2.07)*	**1.50 (1.17, 1.93)**
>0 but <1 drink/day	0.97 (0.74, 1.27)	0.83 (0.63, 1.08)	1.17 (0.94, 1.46)	1.25 (1.00, 1.56)	**1.79 (1.26, 2.56)**	*1.57 (1.17, 2.11)*
1–2 drinks/day	1.12 (0.60, 2.07)	0.95 (0.51, 1.76)	0.87 (0.55, 1.36)	0.68 (0.42, 1.11)	*2.62 (1.07, 6.43)*	2.17 (0.96, 4.89)
>2 drinks/day	0.89 (0.47, 1.69)	0.57 (0.30, 1.10)	1.00 (0.61, 1.65)	*0.53 (0.30, 0.96)*	1.30 (0.56, 2.99)	0.97 (0.47, 2.00)

Abbreviations: CI, confidence interval; OR, odds ratio; MESA, Multi-Ethnic Study of Atherosclerosis.

[*] 0 but drinks other alcohol types: participants do not drink wine, beer, or liquor as applicable but drink other alcohol types.

Statistically significant results at $p < 0.002$ are in bold font. Statistically significant results at $p < 0.05$ are italicized.

We adjusted the odds ratios for age, sex, race/ethnicity, education, income, health insurance, MESA field site and total calorie intake

[†] Liquor has also been referred to as “hard alcohol” or “spirits”.