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ASSOCIATION BETWEEN ALCOHOL INTAKE AND CARDIAC REMODELING

ASSOCIAÇÃO ENTRE CONSUMO DE ÁLCOOL E REMODELAGEM CARDÍACA

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Association Between Alcohol Intake and Cardiac Remodeling



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INTRODUCTION

ALCOHOL AND HEART DISEASES

- Alcohol intake is frequent world-wide.
- Alcohol abuse: 7% in USA population. Can lead to the development of alcoholic cardiomyopathy.

presumptive diagnosis: “at risk” drinkers + LV systolic dysfunction and increased volumes + no other known cause

2013 National Survey on Drug Use and Health (NSDUH)

Guzzo-Merello G et al. *Alcoholic cardiomyopathy*. World J Cardiol, 2014. 6(8): p. 771–81

INTRODUCTION

ALCOHOL AND HEART DISEASES

- Dilated cardiomyopathy: 1/3 had excessive alcohol intake.
- Alcohol has also been associated with arrhythmias and hypertension.
- Abstinence can improve LV function.
- However, mild to moderate alcohol may be beneficial for CAD and incident HF.

Fauchier L et al. Eur Heart J, 2000. 21(4): p. 306-14.

Pavan D et al. Eur Heart J, 1987. 8(5): p. 535-40.

Rimm EB et al. BMJ, 1999. 319(7224): p. 1523-8.

Walsh CR et al. Ann Intern Med, 2002. 136(3): p. 181-91.

INTRODUCTION

ALCOHOL AND HEART DISEASES

NIAAA (National Institute of Alcohol Abuse and Alcoholism) - AT RISK DRINKING:



>3 drinks on a single day or
>7 per week



>4 drinks on a single day or
>14 per week

INTRODUCTION

ALCOHOL AND HEART DISEASES

- Previous studies

→ Showed association between alcohol and subtle echocardiographic changes

However: most were cross-sectional, or had a short follow-up or were in middle-aged/
older adults

Park SK et al. Eur Heart J Cardiovasc Imaging, 2018. 19(3): p. 271-8

Gonçalves A et al. Circ Cardiovasc Imaging, 2015. 8(6): p. pii: e002846.

INTRODUCTION

CONTROVERSIES

- What is the threshold for alcohol cardiotoxicity?
- Are there subject's characteristics that modulate this response?
- Are the effects on the heart reversible and how?
- Does the pattern of alcohol intake play a role?
- Does the type of beverage make a difference?

INTRODUCTION

AIMS

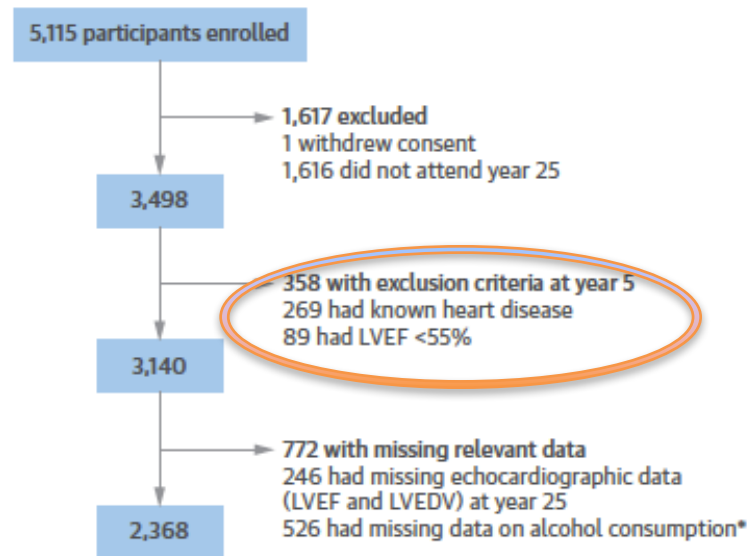
- To evaluate the effect of alcohol intake in cardiac structure and function, assessed by echocardiography
 - Using a large longitudinal cohort study
 - In young healthy adults
- To explore if that association was modified by participants' characteristics, types of beverages and binge-drinking

METHODS

STUDY SAMPLE

- CARDIA (Coronary Artery Risk Development in Young Adults) cohort: apparently healthy black and white individuals aged between 18 and 30 years old, stratified by age, race, sex and educational level, recruited in 4 american cities.
- Year 5-25.

FIGURE 1 Flowchart With Exclusion Criteria and Definition of the Study Sample



*Participants who did not respond to the alcohol questionnaires at least at years 5, 15, and 25 of the CARDIA study. LVEDV = left ventricular end-diastolic volume; LVEF = left ventricular ejection fraction.

METHODS

ALCOHOL INTAKE

- Alcohol consumption: estimated using questionnaires (at year 5, 15 and 25).
- Types of beverages: **beer**, **wine** and **liquor**.
- Calculation of **standardized drinks - SD** (17.24 mL or 14 g of alcohol).



- Average consumption of **SD per week** – 5 categories: abstainers (no alcohol consumption); >0 and <4 (very low risk); ≥ 4 and <7 (low risk); ≥ 7 and <14 (at risk) and ≥ 14 (high risk).
- Estimated **cumulative** alcohol intake during the 20 years of follow-up (L of alcohol).
- Binge-drinking:** ≥ 5 SD on the same occasion, at least once within the last 30 days.

METHODS

ECHOCARDIOGRAPHIC PARAMETERS

- iLVEDV
- LVEF
- iLV mass
- LA diameter

→ TTE performed at year 5 and 25

RESULTS

- 2368 participants were included
- Median age at the end of the study: 51 (IQR 47-53)
- 44.4% (n=1051) male
- 57.3% (n=1356) Caucasian
- Average daily ethanol intake was 10 mL
- Only 8.1% (n=192) of the participants were “at risk” drinkers, with a weekly alcoholic intake above 14 drinks per week

RESULTS

Distribution of
covariates among
groups of alcohol
intake

Also used for
adjustment:
age, "other cardiac
diseases" at year 25,
as well as the
echocardiographic
values at baseline

	Standard-Drinks per Week						
	Total (N = 2,368)	None (n = 619)	>0 and <4 (n = 934)	≥4 and <7 (n = 303)	≥7 and <14 (n = 320)	≥14 (n = 192)	p Value
Age, yrs	51 (47-53)	50 (47-53)	51 (47-53)	51 (48-53)	51 (48-53)	51 (47-53)	0.171
Sex							
Men	1,051 (44.4)	192 (31.0)	373 (40.0)	146 (48.2)	185 (57.8)	155 (80.7)	<0.001
Race							
White	1,356 (57.3)	258 (42.7)	560 (60.0)	202 (66.7)	218 (68.1)	118 (61.5)	<0.001
Black	1,006 (42.5)	359 (58.0)	371 (39.7)	101 (33.3)	101 (31.6)	74 (38.5)	
Other	6 (0.2)	2 (0.32)	3 (0.32)	0 (0.0)	1 (0.31)	0 (0.0)	
Educational level*							
High school or above	1,593 (67.3)	384 (62.0)	659 (70.6)	221 (72.9)	223 (69.7)	106 (55.2)	<0.001
Below high school	775 (32.7)	235 (38.0)	275 (29.4)	82 (27.1)	97 (30.3)	86 (44.8)	
Physical activity*							
Low	492 (20.9)	149 (24.2)	212 (22.8)	47 (15.6)	53 (16.6)	31 (16.3)	<0.001
Moderate	1,059 (44.9)	302 (49.0)	399 (43.0)	143 (47.4)	144 (45.1)	71 (37.4)	
High	806 (34.2)	166 (26.9)	318 (34.2)	112 (37.1)	122 (38.2)	88 (46.3)	
Body mass index, kg/m ²							
<18.5	17 (0.7)	5 (0.8)	7 (0.8)	1 (0.33)	3 (0.94)	1 (0.52)	<0.001
18.5-25.0	632 (26.7)	122 (19.7)	258 (27.7)	103 (34.0)	94 (29.5)	55 (28.7)	
25.0-30.0	779 (32.9)	164 (26.5)	304 (32.6)	106 (35.0)	127 (39.8)	78 (40.6)	
>30.0	938 (39.6)	328 (53.0)	364 (39.0)	93 (30.7)	95 (29.8)	58 (30.2)	
Relevant medical history							
Smoking†	386 (43.4)	46 (32.2)	116 (36.9)	58 (42.7)	76 (49.0)	90 (64.8)	<0.001
Illicit drug use‡	959 (40.6)	139 (22.5)	349 (37.5)	146 (48.2)	182 (57.1)	143 (75.3)	<0.001
Cerebrovascular disease	41 (1.7)	14 (2.27)	17 (1.82)	3 (0.99)	4 (1.26)	3 (1.56)	0.711
Peripheral arterial disease	28 (1.2)	10 (1.6)	11 (1.2)	2 (0.7)	2 (0.6)	3 (1.6)	0.636
Hypertension	737 (31.2)	229 (37.1)	258 (27.7)	94 (31.1)	94 (29.6)	62 (32.5)	0.003
Diabetes mellitus	220 (9.3)	85 (13.8)	83 (8.9)	17 (5.6)	23 (7.2)	12 (6.3)	<0.001
Dyslipidemia	685 (29.0)	185 (29.9)	262 (28.1)	98 (32.5)	75 (23.6)	65 (34.0)	0.056
Renal disease	144 (6.1)	43 (7.0)	57 (6.1)	18 (6.0)	19 (6.0)	7 (3.7)	0.586
Liver disease	63 (2.7)	15 (2.4)	22 (2.4)	11 (3.6)	7 (2.2)	8 (4.2)	0.478
Thyroid disease	206 (8.7)	72 (11.7)	87 (9.3)	20 (6.6)	19 (6.0)	8 (4.2)	0.002
Obstructive sleep apnea	222 (9.4)	70 (11.3)	85 (9.1)	31 (10.3)	20 (6.3)	16 (8.3)	0.140
Chronic pulmonary disease§	24 (1.0)	5 (0.8)	8 (0.9)	3 (1.0)	5 (1.6)	3 (1.6)	0.653
Other cardiac diseases	151 (6.4)	39 (6.3)	61 (6.6)	23 (7.6)	19 (6.0)	9 (4.7)	0.774
Familiar cardiovascular disease	20 (0.9)	9 (1.5)	5 (0.5)	4 (1.3)	2 (0.6)	0 (0.0)	0.180

Categorical variables: Chi-square test or Fisher's exact test.

Continuous variables: analysis of variance (followed by pairwise comparison with Bonferroni adjustment for multiple comparisons whenever necessary), or Kruskal-Wallis test (for variables without a normal distribution).

RESULTS

Echocardiographic outcomes

Multiple linear regression analysis, using alcohol consumption as a categorical (model 1) or continuous (model 2) variable

TABLE 2 Echocardiographic Outcomes at Year 25 According to Alcohol Consumption

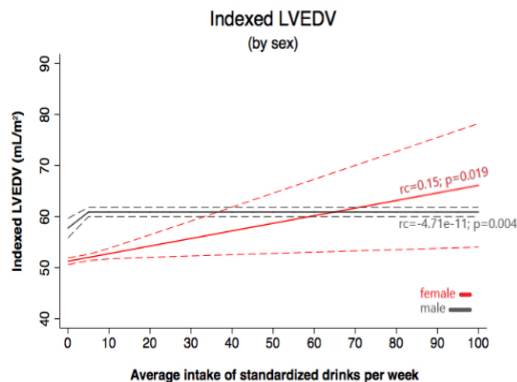
	Total	Model 1: Standard Drinks per Week Regression Coefficient (95% CI); p Value					Model 2: Cumulative Alcohol Intake p Value
		None (n = 619)	>0 and <4 (n = 934)	≥4 and <7 (n = 303)	≥7 and <14 (n = 320)	≥14 (n = 192)	
LVEF, %	61.6 ± 7.2	61.2 ± 7.4	62.0 ± 6.7	61.4 ± 7.8	61.4 ± 7.2	61.4 ± 7.5	
Unadjusted		Reference	0.81 (0.08 to 1.55); 0.029	0.21 (−0.78 to 1.21); 0.672	0.19 (−0.78 to 1.17); 0.695	0.26 (−0.91 to 1.43); 0.666	0.842
Adjusted		Reference	1.84 (0.08 to 3.60); 0.040	−0.32 (−2.38 to 1.73); 0.758	1.30 (−0.65 to 3.26); 0.192	0.37 (−1.91 to 2.65); 0.752	0.907
BSA-indexed LVEDV, ml/m ²	55.5 ± 12.4	53.1 ± 10.7	55.3 ± 12.2	56.8 ± 13.1	57.0 ± 12.4	58.8 ± 14.8	
Unadjusted		Reference	2.21 (0.96 to 3.45); 0.001	3.68 (2 to 5.37); 0.001	3.92 (2.26 to 5.57); 0.001	5.68 (3.7 to 7.67); 0.001	0.001
Adjusted		Reference	2.94 (0.21 to 5.68); 0.035	4.25 (1.07 to 7.43); 0.009	3.80 (0.76 to 6.84); 0.014	5.69 (2.14 to 9.23); 0.002	0.037
BSA-indexed LV mass, g/m ²	83.6 ± 21.5	81.2 ± 20.9	81.6 ± 20.5	85.8 ± 24.7	87.1 ± 21.5	92.4 ± 19.6	
Unadjusted		Reference	0.43 (−1.83 to 2.71); 0.708	4.59 (1.52 to 7.66); 0.003	5.91 (2.87 to 8.93); 0.001	11.25 (7.55 to 14.94); 0.001	0.001
Adjusted		Reference	0.33 (−4.86 to 5.51); 0.901	4.01 (−2.04 to 10.06); 0.194	6.37 (0.57 to 12.17); 0.031	6.96 (0.19 to 13.73); 0.044	0.014
LA diameter, cm	3.70 ± 0.49	3.67 ± 0.49	3.69 ± 0.49	3.71 ± 0.48	3.70 ± 0.48	3.76 ± 0.47	
Unadjusted		Reference	0.02 (−0.04 to 0.07); 0.562	0.04 (−0.03 to 0.10); 0.311	0.03 (−0.03 to 0.10); 0.335	0.09 (0.01 to 0.17); 0.033	0.062
Adjusted		Reference	0.03 (−0.04 to 0.10); 0.411	0.04 (−0.05 to 0.12); 0.400	−0.01 (−0.09 to 0.08); 0.871	−0.01 (−0.10 to 0.08); 0.877	0.392

Values are mean ± SD unless otherwise indicated. The means for the drinking categories are unadjusted. Adjustment was made for sex, race, age, educational level, smoking, illicit drug use, hypertension, diabetes, body mass index, dyslipidemia, "other cardiac diseases," and for the values of each echocardiographic parameter at baseline (year 5).
BSA = body surface area; CI = confidence interval; LA = left atrial; LV = left ventricular; LVEDV = left ventricular end-diastolic volume; LVEF = left ventricular ejection fraction.

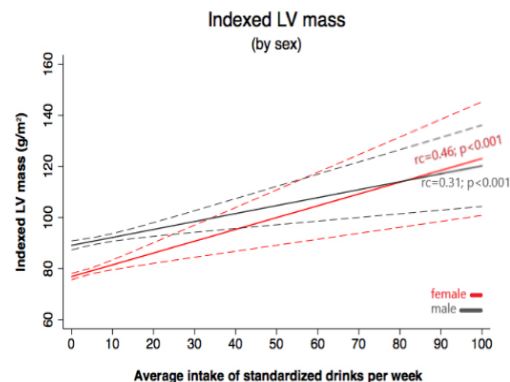
RESULTS

Subgroup analysis

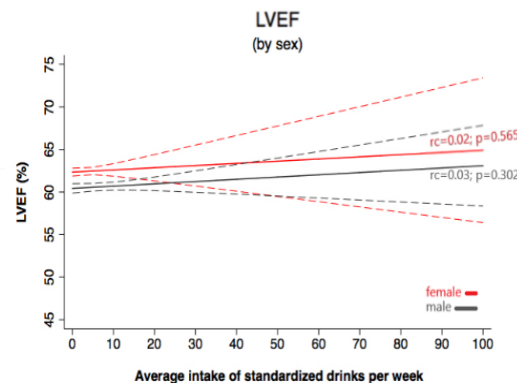
By sex



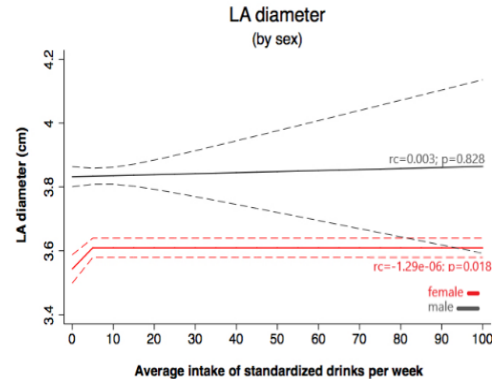
A.1



A.2



A.3



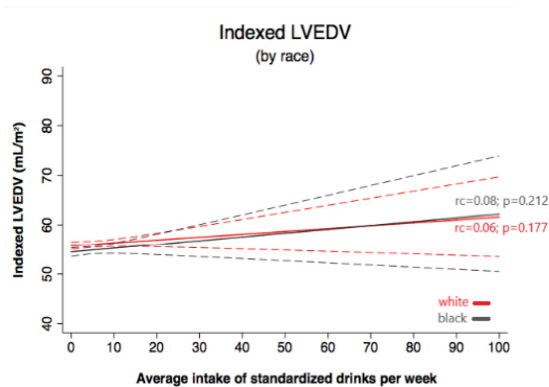
A.4

Multivariable regression using fractional polynomials (to study a possible nonlinear relationship)

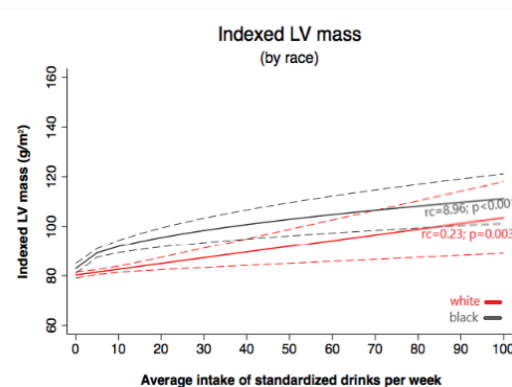
RESULTS

Subgroup analysis

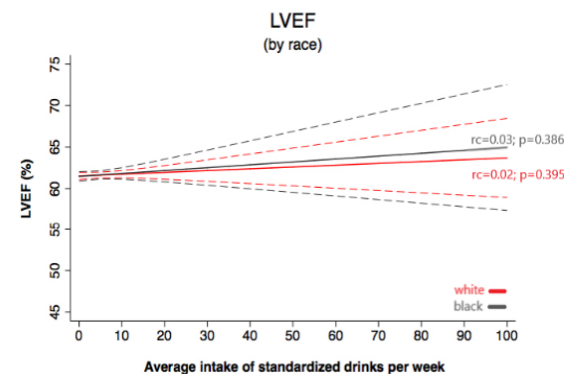
By race



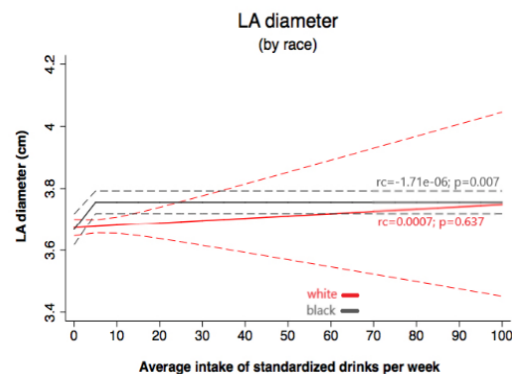
B.1



B.2



B.3



B.4

Multivariable regression
using fractional
polynomials

RESULTS

Type of beverage

TABLE 4 Impact of the Type of Beverage Preference on Ventricular Remodeling

	Beer (n = 713)	Wine (n = 295)	Liquor (n = 166)
LVEF, %	61.15 ± 7.33	62.61 ± 6.90	62.19 ± 7.19
Unadjusted	Reference	1.45 (0.47 to 2.43); 0.004	1.04 (−0.18 to 2.26); 0.095
Adjusted*	Reference	1.38 (0.38 to 2.39); 0.007	1.08 (−0.15 to 2.31); 0.085
BSA-indexed LVEDV, ml/m ²	58.57 ± 13.32	53.66 ± 11.50	54.70 ± 12.04
Unadjusted	Reference	−4.91 (−6.64 to −3.18); 0.001	−3.87 (−6.03 to −1.72); 0.001
Adjusted*	Reference	−4.90 (−6.64 to −3.16); 0.001	−3.65 (−5.78 to −1.51); 0.001
BSA-indexed LV mass, g/m ²	87.94 ± 23.44	79.86 ± 18.15	85.85 ± 23.25
Unadjusted	Reference	−8.08 (−11.21 to −4.95); 0.001	−2.09 (−6.02 to 1.84); 0.297
Adjusted*	Reference	−5.78 (−8.84 to −2.71); 0.001	−3.75 (−7.56 to 0.05); 0.053
LA diameter, cm	3.751 ± 0.491	3.616 ± 0.434	3.813 ± 0.495
Unadjusted	Reference	−0.135 (−0.201 to −0.069); 0.001	0.062 (−0.020 to 0.069); 0.140
Adjusted*	Reference	−0.071 (−0.131 to −0.011); 0.019	0.005 (−0.068 to 0.079); 0.888

Values are mean ± SD or regression coefficient (95% CI); p value. The predominant drink at baseline was chosen (the beverage with the intake corresponding to more milliliters of alcohol). *Adjusted for cumulative alcohol intake and the covariates that were associated with a predominant type of drink in univariate analysis (hypertension, race, body mass index, educational level, sleep apnea, and thyroid disease).

Abbreviations as in Table 2.

RESULTS

Binge-drinking

TABLE 5 Effect of Binge-Drinking on Ventricular Remodeling

	Non-Binge Drinkers (n = 1,449)	Binge Drinkers (n = 300)
LVEF, %	61.83 ± 7.08	61.32 ± 7.32
Unadjusted	Reference	−0.51 (−1.39 to 0.38); 0.263
Adjusted*	Reference	−1.37 (−2.79 to 0.06); 0.060
BSA-indexed LVEDV, ml/m ²	55.81 ± 12.25	58.83 ± 14.89
Unadjusted	Reference	3.01 (1.43 to 4.60); 0.001
Adjusted*	Reference	1.93 (−0.47 to 4.34); 0.114
BSA-indexed LV mass, g/m ²	83.22 ± 21.64	91.32 ± 20.73
Unadjusted	Reference	8.10 (5.20 to 10.99); 0.001
Adjusted*	Reference	1.92 (−2.40 to 6.24); 0.383
LA diameter, cm	3.684 ± 0.491	3.808 ± 0.483
Unadjusted	Reference	0.124 (0.062 to 0.186); 0.001
Adjusted*	Reference	0.085 (0.001 to 0.170); 0.050

Values are mean ± SD or regression coefficient (95% CI); p value. *Adjusted for cumulative alcohol intake and the covariates that were associated with binge drinking in univariable analysis (illicit drug use, smoking, body mass index, educational level and thyroid disease).
Abbreviations as in Table 2.

Multiple linear regression analysis, using alcohol consumption as a continuous variable

CONCLUSIONS

- Greater alcohol intake had an independent adverse association with ventricular structure (greater indexed **LV mass** and **LVEDV**) after 20 years of follow-up.
- This relationship was not significantly modified by sex or race.
- There was an association between alcohol and **LA diameter** in women and in African Americans.
- The absolute changes in echocardiographic parameters were small and overall the values remained within normal limits. Therefore, our results reinforce the concept that mild alcohol consumption (<7 drinks per week) poses little cardiovascular risk.
- In our cohort, only 16 patients developed heart failure and 4 patients had cardiovascular death.

CONCLUSIONS/ DISCUSSION

- Participants were relatively young and few individuals had very high alcohol intake, which may have contributed to the modest association between alcohol and echocardiographic changes.
- Our results support the idea that the pathogenic role of alcohol in the development of dilated cardiomyopathy may be influenced by other individual factors (i.e. genetic predisposition).
- Drinking predominantly **wine** was associated with less LV and LA dilation and higher LVEF.
- **Binge-drinking** was associated with adverse cardiac remodeling only in the crude analysis → could be due to confounding, but also due to the limited number of binge-drinkers.

Thank you for the opportunity to present our work



DISCUSSION

FOR THE FUTURE:

- Prospective trials of alcohol abstinence in DCM.
- Long-term follow-up studies with heavy drinkers (case-control).
- Evaluation using more sensitive methods: echo-LGS, CMR...

Supplementary Material



RESULTS

Intra-individual change in echocardiographic outcomes

Multiple linear regression
analysis, using alcohol
consumption as a categorical
(model 1) or continuous
(model 2) variable

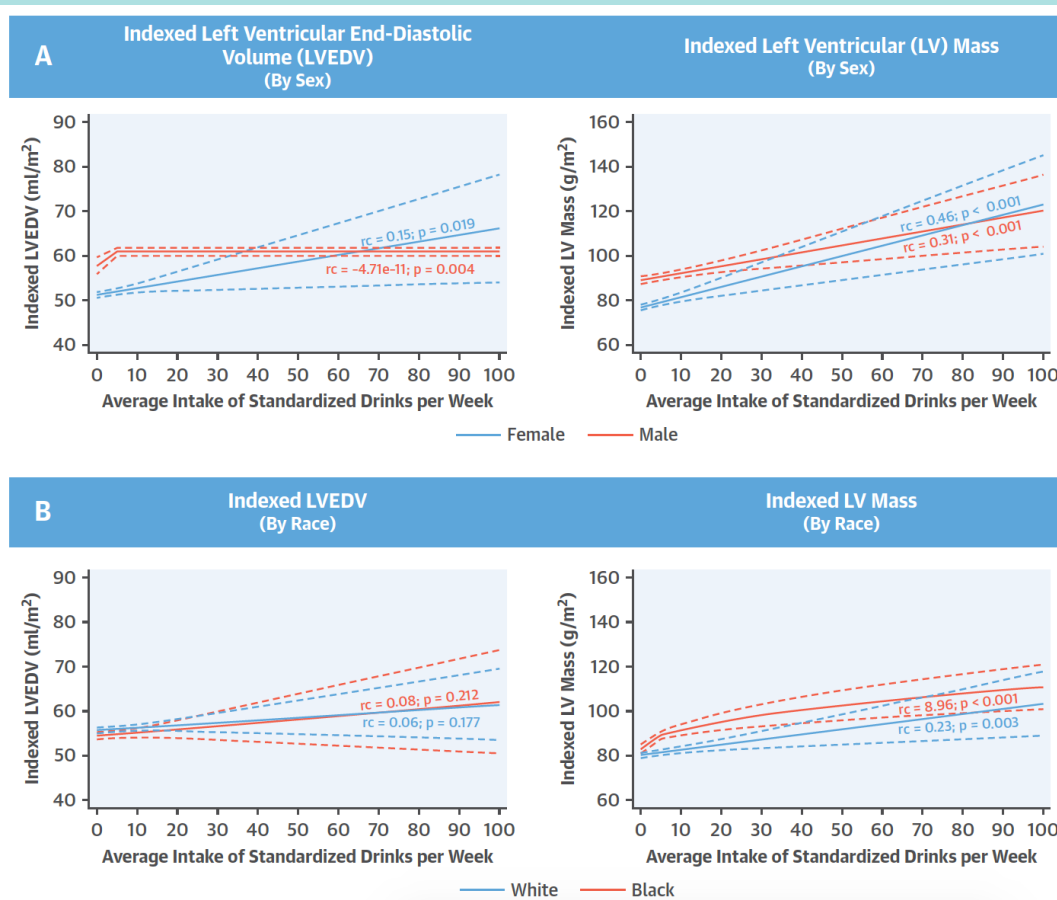
TABLE 3 Change in Echocardiographic Parameters (Between Year 25 and Year 5) According to Alcohol Consumption

	Total	Model 1: Standard Drinks per Week Regression Coefficient (95% CI); p Value					Model 2: Cumulative Alcohol Intake p Value
		None	>0 and <4	≥4 and <7	≥7 and <14	≥14	
ΔLVEF, % (n = 1,067)	-2.88 ± 15.15	-3.96 ± 26.27	-2.68 ± 8.79	-3.15 ± 7.81	-1.86 ± 8.30	-2.13 ± 7.92	
Unadjusted		Reference	1.28 (-1.10 to 3.65); 0.292	0.81 (-2.46 to 4.08); 0.628	2.10 (-1.08 to 5.27); 0.196	1.82 (-2.0 to 5.66); 0.350	0.309
Adjusted		Reference	0.95 (-1.75 to 3.66); 0.489	-0.72 (-4.01 to 2.57); 0.668	1.64 (-1.52 to 4.78); 0.307	-0.10 (-3.79 to 3.60); 0.959	0.597
ΔLVEDV, mL, (n = 1,073)	-10.27 ± 29.54	-8.03 ± 26.90	-11.46 ± 29.34	-11.06 ± 28.68	-11.13 ± 31.09	-13.33 ± 28.42	
Unadjusted		Reference	-3.43 (-7.85 to 0.99); 0.128	-3.03 (-9.11 to 3.04); 0.328	-3.11 (-9.01 to 2.80); 0.303	-5.30 (-12.45 to 1.84); 0.145	0.134
Adjusted		Reference	-2.21 (-11.39 to 6.98); 0.637	0.13 (-11.94 to 6.98); 0.982	1.78 (-8.89 to 12.44); 0.743	0.12 (-12.42 to 12.66); 0.985	0.251
ΔLV mass, g, (n = 2,047)	22.18 ± 46.14	24.54 ± 46.27	20.50 ± 44.96	22.15 ± 49.59	21.67 ± 46.73	23.79 ± 45.03	
Unadjusted		Reference	-4.04 (-9.07 to 0.99); 0.116	-2.39 (-9.23 to 4.45); 0.493	-2.87 (-9.55 to 3.81); 0.399	-0.74 (-8.94 to 7.45); 0.858	0.659
Adjusted		Reference	-0.49 (-12.27 to 11.29); 0.935	2.27 (-11.52 to 16.06); 0.746	5.51 (-7.75 to 18.76); 0.415	-0.14 (-15.51 to 15.21); 0.985	0.600
ΔLA diameter, cm, (n = 2,238)	0.18 ± 0.50	0.21 ± 0.50	0.18 ± 0.50	0.17 ± 0.50	0.14 ± 0.45	0.13 ± 0.52	
Unadjusted		Reference	-0.026 (-0.078 to 0.025); 0.318	-0.033 (-0.104 to 0.036); 0.347	-0.069 (-0.138 to -0.001); 0.048	-0.077 (-0.159 to 0.005); 0.066	0.043
Adjusted		Reference	0.029 (-0.040 to 0.099); 0.409	0.036 (-0.047 to 0.119); 0.395	-0.007 (-0.089 to 0.076); 0.873	-0.007 (-0.099 to 0.085); 0.879	0.392

Values are mean ± SD unless otherwise indicated. The means presented for the drinking categories are unadjusted. Adjustment was made for sex, race, age, educational level, smoking, illicit drug use, hypertension, diabetes, body mass index, dyslipidemia, "other cardiac diseases," and for the values of each parameter at baseline (year 5).
 Abbreviations as in Table 2.

RESULTS

Relationship
between alcohol
intake and iLVEDV
or iLV mass,
according to sex
and race



Multivariable regression
using fractional
polynomials

RESULTS

Echocardiographic outcomes

Inverse probability weighted regression adjustment

		Standard-drinks per week [regression coefficient (95% CI), p-value]				
		None	>0 and <4	≥4 and <7	≥7 and <14	≥14
LVEF, %	Reference		1.58 (0.47; 2.65), p=0.005	1.07 (-0.27; 2.41), p=0.116	1.08 (-0.26; 2.42), p=0.115	1.77 (0.11; 3.43), p=0.036
BSA-indexed LVEDV, mL/m ²	Reference		0.71 (-1.09; 2.51), p=0.440	1.21 (-0.82; 3.25), p=0.242	1.06 (-1.08; 3.21), p=0.331	2.47 (-0.79; 5.72), p=0.137
BSA-indexed LV Mass, g/m ²	Reference		2.12 (1.19; 5.42); p=0.209	4.05 (-0.30; 8.13), p=0.052	5.07 (1.02; 9.11), p=0.014	4.51 (-0.15; 9.18), p=0.058
LA diameter, cm	Reference		0.003 (-0.068;0.075), p=0.926	0.010 (-0.071; 0.092), p=0.804	-0.010 (-0.095;0.076), p=0.825	-0.037 (-0.158;0.084), p=0.547

Adjustment was made for age, sex race, educational level, smoking, illicit drug use, hypertension, diabetes, BMI, dyslipidemia and “other cardiac diseases”.

RESULTS

Echocardiographic outcomes

Multivariable fractional polynomials

Echocardiographic outcomes	BEST-FIT (FP POWERS)	ADJUSTED REGRESSION COEFFICIENT (95% CI)	P-VALUE
LVEF, %	Linear	0.026 (-0.017;0.069)	0.240
BSA-indexed LVEDV, mL/m ²	FP1 (0)*	0.185 (0.071;0.299)	0.001
BSA-indexed LV mass, g/m ²	Linear	0.329 (0.198;0.461)	<0.001
LA diameter, cm	Linear	-0.0002 (-0.0029;0.0024)	0.872

Adjustment was made for age, sex race, educational level, smoking, illicit drug use, hypertension, diabetes, BMI, dyslipidemia and “other cardiac diseases”.

RESULTS

Intra-individual
 change in
 echocardiographic
 outcomes

Echocardiographic outcomes	BEST-FIT (FP POWERS)	ADJUSTED REGRESSION COEFFICIENT (95% CI)	P-VALUE
△ LVEF (%)	Linear	0.083 (-0.059;0.226)	0.253
△ LVEDV (mL)	Linear	-0.260 (-0.525;0.006)	0.055
△ LV Mass (g)	Linear	0.225 (-0.086;0.537)	0.156
△ LA diameter (cm)	Linear	-0.0028 (-0.0059;0.0003)	0.077

Multivariable fractional
 polynomials

Adjustment was made for age, sex race, educational level, smoking, illicit drug use, hypertension, diabetes, BMI, dyslipidemia and “other cardiac diseases”.

RESULTS

Intra-individual
 change in
 echocardiographic
 outcomes

Inverse probability
 weighted regression
 adjustment

		Standard-drinks per week [regression coefficient (95% CI), p-value]				
		None	>0 and <4	≥4 and <7	≥7 and <14	≥14
Δ LVEF (%)	Reference		4.93 (-2.25; 12.13), p=0.178	3.51 (-3.74; 10.76), p=0.343	5.05 (-2.23; 12.32), p=0.174	5.50 (-2.11; 13.12), p=0.157
Δ LVEDV (mL)	Reference		-0.37 (-7.15; 6.41), p=0.915	-2.00 (-10.39; 6.38), p=0.639	0.57 (-7.09; 8.23), p=0.884	6.55 (-3.42; 16.53), p=0.198
Δ LV Mass (g)	Reference		-1.45 (-9.64; 6.74), p=0.728	-0.55 (-10.24; 9.14), p=0.911	0.11 (-9.72; 9.93), p=0.983	-7.35 (-20.40; 5.69), p=0.269
Δ LA diameter (cm)	Reference		-0.050 (-0.138; 0.037), p=0.258	-0.043 (-0.139; 0.054), p=0.387	-0.098 (-0.192; -0.004), p=0.041	-0.128 (-0.254; -0.003), p=0.044

Adjustment was made for age, sex race, educational level, smoking, illicit drug use, hypertension, diabetes, BMI, dyslipidemia and “other cardiac diseases”.