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Cardiovascular Risk Profile and Type of Alcohol Beverage Consumption: A Population-Based Study

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Key Words
Alcohol · Alcoholic beverages · Cardiovascular risk factors · Cholesterol

Abstract
Aims: To determine the association between several cardiovascular risk factors with total alcohol and types of alcoholic beverage consumption. ***Methods:*** The subjects were Spanish men (n = 2,383) and women (n = 2,535) aged 25–74 years who were examined in 1994–1995 and 1999–2000, in two population-based cross-sectional surveys in the north-east of Spain (Gerona). Information of total amount and type of alcohol consumption, educational level, smoking, leisure-time physical, antihypertensive and hyperlipidemic drug treatment was obtained through structured questionnaires. The cardiovascular risk factors total cholesterol, HDL cholesterol, triglycerides, fasting glucose, fibrinogen, lipoprotein (a), heart rate and systolic and diastolic blood pressures were determined. ***Results:*** Men consumed significantly more alcohol than women (19.5 vs. 4.5 g/day, respectively) and the prevalence of elevated alcohol consumption (>2 glasses of wine/day) also was higher in men (35.3%) than women (3.5%). Total alcohol intake was significantly related with HDL cholesterol and fibrinogen improvements in both genders. In contrast, total cholesterol, triglycerides, heart rate, and systolic and diastolic blood pressures were directly and significantly ($p < 0.05$) associated with total alcohol consumption in men but not in women. Wine drinking, particularly in women, was associated with a healthy cardiovascular risk profile. Most of the observed significant associations between type of alcohol beverage and CHD risk factors disappeared after controlling for total alcohol consumption and other confounders. ***Conclusions:*** Alcohol consumption was favorably related to the cardiovascular risk profile in women but not in men. The relationship of alcohol beverages seems to be mediated by the total alcohol content rather than by the type of beverage itself.

Introduction

Alcohol consumption is a prevalent lifestyle in industrialized western societies. Spaniards actually consume on average 10.5 g of pure alcohol per inhabitant per year. Wine is the predominant alcoholic beverage in Spain and Spaniards are in the upper top of total alcohol consumption among European countries [1]. Beside the known adverse effects of alcohol intake [2], there is evidence that moderate alcohol consumption reduces coronary heart disease (CHD) mortality [3–7]. Renaud and de Lorgeril

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[8] suspected that, in spite of the high consumption of dietary cholesterol and saturated fat, low CHD mortality in France could be attributed to the consumption of wine, the predominant alcoholic beverage in this country.

The beneficial properties of alcohol, particularly moderate alcohol consumption on CHD, are based on its effects on hemostatic factors, endothelial function and lipoprotein metabolism [9].

CHD is the major cause for mortality in Spain. Conversely, the prevalence of cardiovascular risk factors is higher than would be expected on the basis of the low incidence and mortality of this disease, compared to other industrialized countries [10]. Hence, it is possible that there are protective factors that explain these findings. Moderate alcohol consumption reduces the risk of cardiovascular mortality [4–6]. However, there is no conclusive evidence as to whether this effect is mediated by the ethanol content or non-alcoholic constituents of alcoholic beverages, or both [11].

There are few large population-based studies on the relationship of cardiovascular risk factors with total alcohol and types of alcoholic beverage consumption [12–14]. The search for reasons related to the potentially lower morbimortality of CHD should include the analysis of the relationship between alcohol consumption and cardiovascular risk factors as a potentially important factor.

The aim of the present study was first to describe the association of total alcohol and type of alcohol consumption with several cardiovascular risk factors, and second to determine whether these associations are dependent on the alcohol content of these beverages.

Methods

Subjects

Data of two representative population-based surveys conducted in 1995 and 2000 in Gerona (Spain) were used for this analysis. The recruitment procedure has been described in detail elsewhere [10]. From 6,952 randomly selected subjects between 25 and 74 years of the general population of Gerona, 4,908, (2,383 men and 2,535 women) agreed to participate (70.9%). All participants were duly informed and consented to be entered in a computer database and cede their biological samples for the necessary analyses. The protocol was approved by an Ethics Committee and the results sent to participants.

Alcohol Consumption

Participants were asked to report their alcohol consumption on the last week by a structured open-end questionnaire, that contained questions on the consumption of several typical alcoholic beverages of the region. The assumption for average alcohol gradation (%) of wine, beer and spirits was 12.5, 5 and 40% respectively. The alcohol intake (g/day) was calculated by multiplying the amount of the beverage (ml) with the respective gradation (%) and the constant 0.80 to transform alcohol volumes into weight (g).

Measurement of Cardiovascular Risk Factors

Two blood pressure determinations were taken by trained personnel using a periodically calibrated mercury sphygmomanometer with strict standard procedures. Blood samples were obtained after a 14-hour fast. Serum was immediately frozen at –120°C in liquid nitrogen for transportation, and stored at –80°C for final conservation. Total cholesterol and high-density lipoprotein (HDL) cholesterol were analyzed by standardized enzymatic methods (Roche Diagnostics, Basel, Switzerland) adapted to a Cobas Mira Plus autoanalyzer (Hoffmann-La Roche, Basel, Switzerland). Serum concentration was determined by an immunoturbidimetric method (Immunoturb Lp(a), Immuno Diagnostica, Vienna, Austria). Analyses were performed in a Cobas Mira Plus (Roche Diagnostics). Plasma fibrinogen concentration was determined by a coagulometric method in a coagulometric autoanalyzer (Toa Medical Electronics Co., Ltd, Kobe, Japan).

Information on smoking habits of the participants was obtained by a structured standard interview. Participants were categorized as people who had never smoked, former smokers (<1 year), and current smokers (at least 1 cigarette/day on average during the last year). The latter were asked for the average daily amount of cigarettes smoked.

Educational Status

Maximum level of education attained was elicited and for analysis purposes was recorded as basic education, secondary school and university.

Leisure-Time Physical Activity

Leisure-time physical activity was measured by the Minnesota Leisure-Time Physical Activity Questionnaire that was previously validated for Spanish men and women [15, 16]. In summary, the questionnaire was administrated by a trained interviewer. The interviewee was provided with detailed instructions and a list of physical activities. Participants were asked to mark those activities that they had undertaken during the last year. The number of times this activity had been performed and the average duration of its practice on each occasion were then recorded. Each physical activity has an intensity code obtained in standardized experimental situations, based on the ratio between the metabolic rate during work and the basal metabolic rate (Ainsworth). An estimation of energy expenditure in the leisure-time physical activity in MET · min/day is obtained. One MET, the energy expended by sitting quietly, is equivalent to 3.5 ml of oxygen uptake per kilogram of body weight per minute. A sedentary lifestyle was defined as an energy expenditure during leisure time <1,000 METs min/week.

Statistical Analysis

Analyses were conducted for men and women separately. Analysis of variance (PROC.GLM Version 8.0; SAS Institute, Inc., Cary, N.C., USA) was used to estimate age, leisure-time physical activity, smoking status, educational level and type of beverage consumption according to total daily alcohol intake (0, 1–20, 21–30, >30 g).

Linear regression analysis was performed (PROREG Version 8.0; SAS Institute, Inc.) to analyze the association of cardiovascular

Table 1. Characteristics of the study population according to amount of alcohol consumption

	Alcohol consumption, g/day				
	0	1–20	21–30	>30	p for linear trend
Men (n = 2,201)					
Amount, %	19.9	45.8	12.0	22.3	–
Age, years	53.4	50.4	50.6	49.6	<0.001
Leisure- time physical activity METs · min · day^{-1}	381.7	378.5	344.5	358.0	0.192
Body mass index, kg/m^2	27.0	27.3	27.7	27.3	0.106
Smokers, %	20.1	22.9	30.3	40.3	<0.001
Educational level, %[a]	7.0	12.3	9.9	5.6	0.280
Wine consumption, g alcohol/day	–	8.0	15.1	32.3	<0.001
Beer consumption, g alcohol/day	–	1.8	6.5	10.6	<0.001
Spirits consumption, g alcohol/day	–	1.2	3.2	8.3	<0.001
Women (n = 2,301)					
Amount, %	59.6	36.8	2.2	1.3	–
Age, years	51.5	48.9	46.8	45.2	0.007
Leisure-time physical activity METs · min · day^{-1}	281.5	280.3	255.7	207.9	0.165
Body mass index, kg/m^2	27.4	26.2	25.1	24.8	<0.001
Smokers, %	13.8	16.3	29.4	55.2	<0.001
Educational level, %[a]	8.4	13.0	14.3	16.1	0.152
Wine consumption, g alcohol/day	–	7.5	17.7	31.2	<0.001
Beer consumption, g alcohol/day	–	0.9	4.3	6.3	<0.001
Spirits consumption, g alcohol/day	–	0.4	1.3	2.8	<0.001

[a] University degree.

risk factors (*dependent* variables: total cholesterol, HDL cholesterol, triglycerides, fasting glucose, heart rate, lipoprotein (a), systolic blood pressure (SBP), diastolic blood pressure (DBP), and fibrinogen) with total alcohol consumption adjusted for age, leisure-time physical activity, smoking status, educational level, body mass index and dyslipemic and hypertension drug treatment. Categorical variables smoking status and educational level were included as dummy variables in the models.

To determine the association of different alcoholic beverages with the above-mentioned cardiovascular risk factors, three linear regression models were fitted. The first showed the relationship of the consumption of the type of alcoholic beverage and cardiovascular risk factors. These associations were further adjusted for total alcohol in a second model and for other confounders in a third model to determine whether the relationship between beverage type and cardiovascular risk factor was independent. Analyses of the data were conducted using SAS. In all statistical tests, p values of <0.05 were considered significant.

Results

General characteristics of the study population by level of alcohol consumption are shown in table 1. Alcohol consumption decreased with age and higher amount of alcohol intake was more prevalent in smokers than in non-smokers in both genders. The consumption of wine, beer, and spirits increased with higher amounts of total alcohol consumption in men and women. A higher body mass index was found in female participants consuming less alcohol.

Table 2 shows the regression coefficients of cardiovascular risk factors and total alcohol consumption adjusted for confounders. Generally, the association of alcohol consumption and cardiovascular risk factors was more pronounced in men than women.

In men total cholesterol, HDL cholesterol, triglycerides, heart rate, and SBP and DBP increased with alcohol consumption whereas fibrinogen was inversely associated with alcohol intake. In women, alcohol consumption was directly and inversely associated with HDL cholesterol and fibrinogen, respectively.

Adjusted linear regression coefficients of the association of cardiovascular risk factors and type of alcohol beverage consumption are shown in table 3. Age-adjusted consumption of wine, beer, and spirits was directly associated with several cardiovascular risk factors. Again this

Table 2. Relationship between alcohol consumption and CHD risk variables in men and women[a]

	Alcohol consumption, g/day		
	R^2	B[b]	p
Men (n = 2,201)			
Total cholesterol, mg/dl	0.062	0.328	<0.001
HDL cholesterol, mg/dl	0.083	0.108	<0.001
Triglycerides, mg/dl[c]	0.094	0.001	0.009
Fasting glucose, mg/dl[c]	0.099	<0.001	0.913
Lipoprotein (a), mg/dl[c]	0.017	–0.001	0.336
Fibrinogen, mg/dl	0.188	–0.499	<0.001
Heart rate, beats/min	0.045	0.029	0.026
Systolic blood pressure, mm Hg	0.314	0.047	0.018
Diastolic blood pressure, mm Hg	0.155	0.034	0.001
Women (n = 2,301)			
Total cholesterol, mg/dl	0.158	0.082	0.522
HDL cholesterol, mg/dl	0.080	0.199	<0.001
Triglycerides, mg/dl[c]	0.207	–0.001	0.170
Fasting glucose, mg/dl[c]	0.120	<0.001	0.583
Lipoprotein (a), mg/dl[c]	0.027	–0.001	0.280
Fibrinogen, mg/dl	0.129	–0.793	0.003
Heart rate, beats/min	0.017	–0.008	0.791
Systolic blood pressure, mm Hg	0.492	0.022	0.638
Diastolic blood pressure, mm Hg	0.317	–0.014	0.615

[a] Adjusted for age, leisure-time physical activity, smoking, educational level, body mass index and antihypertensive and hyperlipidemic drug treatment.
[b] Regression coefficient.
[c] log transformed.

relationship was more pronounced in men than in women. Particularly wine consumption was overall favorably associated with cardiovascular risk factors in women. Most of these statistically significant associations were attenuated and statistical significance disappeared after controlling for total alcohol consumption and confounders. However, few associations with type of alcoholic beverage remained significant after controlling for total alcohol consumption and other confounders (table 3).

Discussion

In the present study the adjusted relationship between alcohol consumption and cardiovascular risk factors was found to be stronger among men than women, but varied among the type of alcoholic beverages. The low prevalence of elevated alcohol consumption in women may partially explain the absence of deleterious effects of alcohol consumption on some cardiovascular risk variables. Among alcoholic beverages, wine showed the most favorable association with the cardiovascular risk profile, mainly in women. These associations principally were mediated through the alcohol component of the beverages.

Alcohol consumption in Spain is among the highest of Europe in men and among the lowest in women. Nevertheless, a high regional variation is observed together with a north-to-south decreasing alcohol consumption in this country. Also, wine consumption prevails over other types of alcoholic beverages. Our observations confirm the sex variation whilst the observed consumption is among the lowest in Spain [17].

Beside the adverse effects of alcohol there are a number of studies showing an inverse association between moderate alcohol intake and CHD [9, 18, 19]. Alcoholic consumption has been related to a number of effects on hemostatic factors, endothelial function and lipoprotein metabolism [9]. The most important protective effect of alcohol is thought to be mediated by an increase of HDL lipoprotein [20, 21]. In the present study, we observed a direct association of alcohol consumption and HDL cholesterol in both genders. Alcohol intake has been inversely associated with plasma fibrinogen and so exerting favorable effects on the thrombolytic profile [22]. Lower fibrinogen levels were associated with increasing alcohol consumption in men and women in the present study. Interestingly, increasing alcohol consumption was not significantly related to other cardiovascular risk factors such as total cholesterol, fasting glucose, triglycerides, lipoprotein (a), heart rate, and SBP and DBP in women. Only 3.5% of female participants reported a daily alcohol consumption >20 g which is equivalent to >2 glasses of wine. Additionally, men consumed four times as much alcohol as women (19.5 vs. 4.5 g/day, respectively). The low alcohol intake may partially explain the lack of further significant associations with other cardiovascular risk factors in women. In contrast, alcohol consumption was directly associated with total cholesterol, heart rate, triglycerides and SBP and DBP in men. This indicates a strong deleterious effect of increasing alcohol consumption on the overall cardiovascular risk profile, in spite of favorable associations with HDL and fibrinogen. The magnitude and the direction of the effect of alcohol consumed on HDL cholesterol and fibrinogen, and the deleterious effects of alcohol on total cholesterol observed in men and women, were similar to those found in other studies [12, 23].

Table 3. Adjusted correlation coefficients (B) of cardiovascular risk factors and type of beverage consumption[a] in men and women

	Men (n = 2,201)						Women (n = 2,301)					
	wine		beer		spirits		wine		beer		spirits	
	B	p	B	p	B	p	B	p	B	p	B	p
Total cholesterol, mg/dl												
Age adjusted	0.412	<0.001	0.247	0.026	0.549	<0.001	0.067	0.627	0.447	0.239	0.152	0.839
Age and alcohol adjusted	0.177	0.097	–0.235	0.068	–0.046	0.791	–0.313	0.395	0.376	0.364	–0.018	0.981
Multivariate adjusted[b]	0.152	0.194	–0.187	0.169	–0.035	0.213	–0.312	0.422	0.436	0.320	–0.249	0.753
HDL cholesterol, mg/dl												
Age adjusted	0.123	<0.001	0.142	<0.001	0.122	0.007	0.247	<0.001	0.277	0.040	0.407	0.150
Age and alcohol adjusted	0.035	0.307	0.011	0.801	–0.088	0.106	0.075	0.566	–0.004	0.980	0.032	0.911
Multivariate adjusted[b]	0.023	0.530	–0.019	0.666	–0.011	0.856	–0.060	0.656	0.156	0.299	0.097	0.730
Triglycerides, mg/dl[c]												
Age adjusted	0.001	0.009	0.003	<0.001	0.006	<0.001	–0.001	0.158	0.001	0.369	0.006	0.043
Age and alcohol adjusted	–0.002	<0.001	0.001	0.230	0.004	<0.001	–0.003	0.048	0.002	0.268	0.006	0.005
Multivariate adjusted[b]	–0.001	0.001	0.001	0.031	0.004	<0.001	–0.002	0.172	<0.001	0.881	0.006	0.058
Fasting glucose, mg/dl[c]												
Age adjusted	<0.001	0.819	<0.001	0.918	<0.001	0.445	–0.001	0.034	0.002	0.005	–0.001	0.402
Age and alcohol adjusted	<0.001	0.604	<0.001	0.859	<0.001	0.394	–0.022	0.010	0.003	<0.001	–0.001	0.605
Multivariate adjusted[b]	<0.001	0.230	<0.001	0.444	<0.001	0.573	–0.002	0.010	0.003	0.001	<0.001	0.944
Systolic blood pressure, mm Hg												
Age adjusted	0.044	0.057	0.032	0.483	–0.013	0.822	–0.041	0.440	–0.101	0.491	–0.039	0.890
Age and alcohol adjusted	0.041	0.330	–0.006	0.909	–0.095	0.168	0.066	0.643	–0.050	0.752	0.041	0.888
Multivariate adjusted[b]	0.023	0.591	0.028	0.571	–0.124	0.094	0.022	0.876	–0.003	0.986	0.101	0.722
Diastolic blood pressure, mm Hg												
Age adjusted	0.032	0.028	0.040	0.117	–0.002	0.950	–0.077	0.020	–0.090	0.317	–0.225	0.185
Age and alcohol adjusted	0.009	0.721	0.016	0.589	–0.061	0.131	0.006	0.947	0.032	0.739	–0.138	0.433
Multivariate adjusted[b]	<0.001	0.949	0.001	0.486	–0.002	0.298	–0.001	0.737	–0.001	0.859	0.007	0.367
Fibrinogen, mg/dl												
Age adjusted	–0.499	<0.001	0.220	0.454	–0.725	0.049	–0.900	0.001	–0.824	0.355	–1.776	0.305
Age and alcohol adjusted	–0.286	0.262	0.161	0.129	0.107	0.806	–0.382	0.661	0.419	0.204	–0.126	0.944
Multivariate adjusted[b]	–0.150	0.588	0.309	0.385	–0.106	0.821	–0.261	0.721	0.512	0.652	–0.470	0.739
Heart rate, beats/min												
Age adjusted	0.020	0.223	0.137	<0.001	0.023	0.561	–0.016	0.646	–0.220	0.454	–0.154	0.412
Age and alcohol adjusted	–0.068	0.018	0.124	<0.001	–0.064	0.176	–0.062	0.509	0.003	<0.001	–0.153	0.431
Multivariate adjusted[b]	–0.059	0.058	0.120	0.001	–0.099	0.064	–0.093	0.341	0.184	0.095	–0.079	0.689
Lipoprotein (a), mg/dl[c]												
Age adjusted	–0.001	0.329	<0.001	0.981	–0.001	0.582	–0.001	0.469	–0.003	0.358	0.006	0.414
Age and alcohol adjusted	<0.001	0.700	0.001	0.596	<0.001	0.960	<0.001	0.966	–0.003	0.513	0.008	0.287
Multivariate adjusted[b]	<0.001	0.949	0.001	0.486	–0.002	0.298	–0.001	0.770	–0.001	0.847	0.007	0.404

[a] Expressed as alcohol content in grams of beverages per day.
[b] Adjusted for age, total alcohol consumption, leisure-time physical activity, smoking, educational level, body mass index hypertensive and antihypertensive and hyperlipidemic drug treatment.
[c] log transformed.

Specific alcoholic beverages like wine or beer have been proposed to exert a particular protection against CHD [18]. Several studies found an inverse relationship between different types of alcoholic beverage intake and CHD [3, 4, 24–27]. However, there is no conclusive evidence as to whether alcohol or other constituents of alcoholic beverages are responsible for this protective effect. In the present study, 65.4% of the men and 78.1% of the women were wine drinkers. The predominant consumption of wine has been found to be associated with healthier lifestyles and higher socioeconomic status [28, 29]. Furthermore, lifestyle and socioeconomic status have in

turn been associated with various cardiovascular risk variables [30]. In the present study we adjusted the relationship of alcohol consumption and cardiovascular risk factors for physical activity, smoking, and body mass index as major markers of lifestyle and for socioeconomic status to disclose the independency of the studied associations. However, data of dietary intake were recorded with different dietary assessment methods in the two study surveys. Hence, controlling the association of alcohol intake and cardiovascular risk factors for diet was not possible. This can be considered a limitation of the present study.

We tested alcohol-dependent and -independent associations between type of beverage and cardiovascular risk factors in linear regression models according to the three types of alcoholic beverages. In the models adjusted for age alone we observed significant associations of all types of alcoholic beverage consumption with various cardiovascular risk factors in men and women. It has been suggested that a moderate consumption of wine better contributes to cardiovascular disease reduction than abstinence or heavier intake [11]. Interestingly, wine consumption was related with a favorable cardiovascular risk profile, particularly in women in the present study. Among alcohol drinkers the higher prevalence of moderate wine consumption in women (96.3%) compared with men (81.1%) may partially explain the more favorable cardiovascular risk profile of female wine consumers. Mainly HDL cholesterol was strongly associated with alcoholic beverage consumption in both genders. This is of particular interest because at least 50% of the decrease in coronary disease risk in alcohol consumers has been attributed to an increase in HDL cholesterol levels [31]. However, the magnitude for most age-adjusted associations was attenuated, and statistical significance disappeared after controlling for total alcohol consumption. Hence, it could be suggested that these associations were influenced more by the amount of alcohol in the different types of alcohol beverages than by the types of beverages themselves. However, the association of triglycerides with wine and spirit consumption in men was not attenuated after controlling for total alcohol consumption. The same was observed for fasting glucose and wine and beer drinking in women. Even further controlling for several lifestyle factors did not influence the above-mentioned associations. Although significant however, the magnitude of the observed associations was modest. The influence of dietary data not taken into account in the present study was partially responsible for these findings.

The strength of the present study is the relative large amount of participants, the representative character of the study design, the adjustment for several important confounders and the inclusion of most of the classical cardiovascular risk factors. However, the lack of controlling for dietary data can be considered a limitation. Furthermore, the cross-sectional nature of the study design precludes drawing causal relationships.

In conclusion, the results of the present study suggest that alcohol intake is related with a better HDL cholesterol and fibrinogen profile in both genders and with negative effects on total cholesterol, triglycerides, heart rate, and SBP and DBP in men. Generally, total alcohol and wine consumption was related to a more favorable global cardiovascular risk profile in women as compared with men. The relationship of alcohol beverages seems to be mediated by the total alcohol content rather than by the type of beverage itself.

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