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Alcohol consumption and overweight in Brazilian adults – CUME Project

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Abstract *This is a cross-sectional study with 2,909 participants (aged ≥18 years) from the baseline of the Cohort of Universities of Minas Gerais [CUME – Coorte de Universidades Mineiras] which verified the association between alcohol consumption and overweight. Data on sociodemographic factors, lifestyle, eating habits, anthropometric factors and clinical conditions were collected through an online questionnaire. Body mass index ≥ 25 kg/m² was considered an indicator of overweight. The daily consumption of alcohol was evaluated in grams (alcohol) and according to type in milliliters (beer, wine, hard liquor). The prevalence of alcohol consumption and overweight was 73.6% and 40.8%, respectively. There was a significant tendency of an increase in overweight with higher beer consumption (tendency p value of 0.038), which was not observed for the other types of alcohol. After sensitivity analyses, alcohol consumption was associated to overweight, with a tendency of increase in prevalence with higher daily consumption. There is a crucial need to curb the widely accepted idea that a low or moderate alcohol consumption is not harmful to one's health, and to be cautious of such a proposition. The influence of alcohol consumption regarding weight gain must be considered in public health policies and policies of alcohol consumption control.*
Key words *Alcohol drinking, Overweight, Obesity*

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Introduction

The overweight (or excess weight) is currently the major nutritional disorder and is considered one of the main public health problems. In 2016, the global prevalence of this disorder in adults was 39%[1], and in the countries with a high prevalence of excess weight, it accounted for 1 to 3% of total cost of healthcare[2]. In Brazil, 55.7% of adults were considered to have excess weight in 20183, and in 2017, the costs related to the disorder amounted to 2.1 billion dollars[4].

The causes of excess weight include genetic, metabolic, psychosocial and cultural aspects, food intake and sedentary lifestyle. In general, studies attempting to explain such factors have mainly focused on decreased energy expenditure due to sedentary lifestyle and increased intake of energy-dense foods and sugary and alcoholic beverages[5-7].

Regarding the relation between alcohol consumption and excess weight, it is noteworthy that alcoholic beverages have an elevated energy density – one gram of alcohol has 7.1 kilocalories (kcal), whereas one gram of carbohydrates has 4 kcal, one gram of protein has 4 kcal, and one gram of lipids has 9 kcal[6,8]. Due to its energy value, it is assumed that alcohol could potentially provide one's daily energy requirements and lead to excess weight, depending on the frequency and type of consumption, quantity and type of alcohol[9-12].

Alcohol abuse, in addition to causing dependence, increases the risk of excess weight in both sexes[7,8,12-16], regardless of the type of alcohol (wine, beer or hard liquor)[17-20]. On the other hand, moderate alcohol use has been shown to be a protective factor, especially the intake of wine and beer[5,7,12].

Excess weight and alcohol consumption are important public health issues that need to be investigated due to the relation between them and the fact that both represent risk factors for non-communicable diseases and injuries (NCDI)[6,21,22], which are the main causes of morbidity and mortality in Brazil and represent very high costs for the Brazilian Unified Health System[4].

Even though the Brazilian population presents a high mean daily alcohol consumption, there are few studies analyzing its association to excess weight, leading to little consistency in the scientific findings on this topic in Brazil[23-26].

This study is also relevant because it evaluates a cohort of the Brazilian population which is underexplored in epidemiological investigations. These individuals are distributed throughout Brazil, have a high schooling level, hold high positions of employment that are crucial to the country's economy, present a high prevalence of unhealthy habits[27]; therefore, when their contributions are cut short by getting ill or death, these could result in significant social and economic burdens for the country.

Thus, the objective of our study was to verify the association between alcohol consumption and overweight in adults from the baseline of the *Coorte de Universidades Mineiras* (CUME – Cohort of Universities of Minas Gerais), Brazil.

Method

This is a cross-sectional study that analyzes the baseline of Cohort of Universities of Minas Gerais (CUME – *Coorte de Universidades Mineiras*), an open cohort that included a restricted population group, to evaluate the impact of the Brazilian dietary pattern and of the nutritional transition experienced by former students from the *Instituições Federais de Ensino Superior* (IFES) [Federal Institutions of Higher Education] in the State of Minas Gerais, Southeastern region of Brazil. The study design, communication strategies and baseline profile of participants were detailed in a previous article[27].

Data was collected between March and August 2016, in a virtual environment owned by CUME Project, of former students of *Universidade Federal de Viçosa* (UFV) and *Universidade Federal de Minas Gerais* (UFMG) who were invited via e-mail. Those who signed the informed consent form were granted access to the data collection instrument.

The invitation to participate in the study was sent to all 64,202 former students of UFMG and the 16,945 former students of UFV, who graduated between 1994 and 2014 (undergraduates and graduates), whose e-mail address were listed on the database of the alumni associations or the IT directories of IFES. A total of 4,949 participants answered the baseline questionnaire (Q_0), which represented a rate of 6.1%.

The study analysis excluded individuals who did not complete the Food Frequency Questionnaire (FFQ) (n = 1,679); pregnant women and women who had given birth within one year prior to the study (n = 123); those who reported inconsistent values for total calorie intake [< 500 kcal/day (n = 1) or > 6,000 kcal/day (n = 92)];[28]

non-Brazilian former students (n = 11); and Brazilians students residing abroad (n = 134). With that, the final sample was made up of 2,909 participants.

The data was collected through an online self-managed baseline questionnaire divided into two parts due to its length (access at: http://www.projetocume.com.br/questionario). The first part was made up of questions related to sociodemographic and economic characteristics; lifestyle; referred individual and family morbidity; use of medication; personal history of clinical and biochemistry tests from the previous two years; and anthropometric data. The second part was sent one week after completion of the first part and included the FFQ, composed by 144 food items based on the original version previously validated in Brazil about food intake in the last year[29].

The outcome variable chosen was "excess weight", defined according to self-referred data on weight (in kilos) and height (in centimeters), which were used to calculate the body mass index (BMI). The individuals were classified as follows: BMI < 25.0 kg/m² = no excess weight and BMI ≥ 25.0 kg/m² = excess weight.

The self-referred data on weight, height and BMI were previously validated in a study conducted with a subsample from CUME, which generated intraclass correlation coefficients that indicated excellent agreement; i.e., 0.989 (weight); 0.995 (height); and 0.983 (BMI)[30].

To evaluate alcohol consumption, the study used information collected from the FFQ. In the part of the FFQ regarding alcoholic beverages, for each beverage selected (*cachaça*; hard liquor – rum, vodka and whisky; beer; wine), each participant indicated the portion size expressed in measurements commonly used in Brazil (glasses, cans) and the usual consumption frequency (day/week/month/year).

The consumption frequency of each beverage was transformed into daily frequencies which, in turn, were multiplied by the portion size to calculate the daily consumption of each beverage (grams – g, or milliliters – ml). To calculate alcohol intake and the intake of each alcoholic beverage (beer, wine and hard liquor), Brazilian tables of the nutritional composition of the foods[31] and, whenever necessary, the table from the United States Department of Agriculture, were used[32].

At the end, the exposure variables considered were: a) *alcohol consumption* (no, yes); b) *weekly frequency of alcohol consumption* (< 1 day/week; 1-4 days/week; ≥ 5 days/week); c) *daily alcohol consumption* (g) (in quartiles); d) *daily consumption of the types of alcoholic beverages* (ml) (in quartiles) = d1) beer; d2) wine; d3) hard liquor, including *cachaça*, rum, vodka and whisky.

The daily intake of each alcoholic beverage and alcohol in general, in addition to the covariables related to food intake, were adjusted by calorie intake through the residual method[33], before the statistical analyses.

The covariables considered were: a) *sociodemographic characteristics*: sex (male, female); age (years – continuous); skin color (white, brown/black, yellow/indigenous); marital status (single, married/common law marriage, separated or divorced/widow(ed)); professional status (retired/homemaker/unemployed, student, full-time work, part-time work, informal work); and household income (continuous); b) *life habits*: smoking (never smoked, former smoker, current smoker) and physical activity, evaluated through a list of 24 activities and expressed in minutes per week (active = individuals with ≥ 150 minutes/week of moderate activity or ≥ 75 minutes/week of vigorous activity; insufficiently active = individuals with < 150 minutes/week of moderate activity or < 75 minutes/week of vigorous activity; inactive = individuals with no leisure physical activity)[34]; c) *clinical characteristics*: self-reported medical diagnosis for chronic diseases: stroke, myocardial infarction, celiac disease, inflammatory bowel diseases (Crohn's disease, ulcerative colitis), non-alcoholic liver steatosis, alcoholic cirrhosis, gastritis, gastric or duodenal ulcer, acute renal failure, chronic renal failure, lung cancer, skin cancer, colon cancer, breast cancer, cervical cancer, prostate cancer, type 2 diabetes mellitus, hypertension, high triglyceride levels, high cholesterol levels, depression (no, yes); d) *food intake*: these variables were also obtained through the FFQ, with a methodology similar to the one used for alcohol consumption estimates, and were calculated in daily grams of each food. To calculate calorie (kcal) and nutrient intake, Brazilian Tables of the Nutritional Composition of the Foods[31] and the Table from the United States Department of Agriculture were used[32]. Food items were classified according to the NOVA classification as minimally processed, processed and ultra-processed foods[35].

The characterization of the participants was done with the distribution of absolute and relative frequencies, means and standard deviations of the sociodemographic, economic, lifestyle and health conditions variables, according to the presence or absence of excess weight. Statistical differences were evaluated through Pearson's chi-square test or the Student's *t* test.

Prevalence ratios (PR) and their respective 95% confidence intervals (CI) of the associations between each exposure variable and excess weight were estimated through Poisson's regression models with robust variances, initially adjusted for sex and age, and later for skin color, marital status, professional status, smoking, physical activity, medical diagnosis of depression, household income, total alcohol consumption and total energy intake.

Sensitivity analyses were conducted to evaluate the robustness of results, and excluded: (a) individuals with previous medical diagnosis of obesity; (b) individuals who gained 10 kilograms or more before the study; (c) all individuals considered in the analyses (a) and (b), besides those who were on weight control medication.

The data was analyzed through the software Stata, version 13.0, and statistical significance was set at 5%.

The study was approved by the Human Research Ethics Committees of UFV and UFMG.

Results

Of all the participants, 40.8% (n = 1,188) had excess weight; in that, 27.6% (n = 804) were overweight and 13.2% (n = 384) were obese. Moreover, 3.0% (n = 87) were underweight and 56.2% (n = 1,634) were eutrophic.

In comparison to the participants without excess weight, individuals with excess weight were, in their majority, male, married, working full time and with a higher mean age and household income ($p < 0.05$) (Table 1).

Furthermore, individuals with excess weight presented higher frequencies of smoking or previous smoking, no physical activity and medical diagnoses of depression and chronic diseases, in addition to presenting a higher mean of calorie intake (kcal/day) and intake of macronutrients (g/day) [carbohydrates, proteins, lipids (polyunsaturated fatty acid – PUFA; monounsaturated fatty acids – MUFA; saturated fat; trans fat)] and a lower mean of intake of minimally processed food ($p < 0.05$) (Table 2).

Regarding alcohol intake, 73.6% reported having consumed alcohol, and the mean daily alcohol consumption was equal to 5.9 g (standard deviation – SD = 9.1 g). Regarding the type of alcohol, the mean daily consumption of beer was 76.2 ml (SD = 22.6 ml); of wine was 16.1 ml (SD = 5.0 ml); and of hard liquor was 2.9 ml (SD = 1.6 ml).

Participants with excess weight, in comparison to those without, presented higher frequencies of alcohol consumption between 1 to 4 days/week, and a higher mean of daily consumption of alcohol, beer, wine and liquor ($p < 0.05$) (Table 3).

In the multivariate analysis, the participants in the intermediate quartile of daily alcohol consumption (Q2 – PR: 0.87; 95% CI: 0.77-0.99) had a lower prevalence of excess weight in comparison to the lowest quartile. In the analysis by type of alcohol, participants in the intermediate quartiles of beer consumption (Q2 – PR: 0.84; 95% CI: 0.74-0.96); hard liquor consumption (Q3 – PR: 0.84; 95% CI: 0.74-0.94) and wine consumption (Q3 – PR: 0.85; 95% CI: 0.75-0.96) had a lower prevalence of excess weight in comparison to those in the lower quartiles. However, there was a significant tendency of increase in the prevalence of excess weight with the increase in beer consumption (tendency $p = 0.038$), which was not observed with the other types of alcohol ($p \geq 0.05$) (Table 4).

The sensitivity analyses showed that when there was exclusion of: 1) participants with a previous medical diagnosis of obesity (n = 256); 2) those who gained ≥ 10 kilograms before the study (n = 203); or 3) a combination of both criteria plus participants who were on weight loss medication (n = 420), the results were as follows: a) an increase tendency of prevalence of excess weight with a higher intake of alcohol in exclusion criteria 1 and 3, and with a higher intake of beer in all exclusion criteria (tendency $p < 0.05$); b) the elimination of the negative association between intermediate wine consumption (Q2) and excess weight, and the appearance of a negative association between the intermediate consumption of hard liquor (Q3) and excess weight in all exclusion criteria (Table 5).

Discussion

In this study, the high prevalence of alcohol consumption and excess weight among the participants was demonstrated. On the other hand, the means of total daily alcohol intake and of the types of alcohol were low. It is also noteworthy that the consumption of alcohol, beer, wine, and hard liquor in intermediate quartiles was negatively associated to excess weight. However, after the sensitivity analyses, such finding was maintained only for liquor, while the consumption of alcohol and beer showed a positive association to excess weight.

Table 1. Sociodemographic characteristics of participants according to the presence of overweight. Cohort of niversities of Minas Gerais (CUME), 2016.

Variables	Overweight						p-value*
	Total (n = 2.909)		Yes (n = 1.188)		No (n = 1.721)		
	n	%	n	%	n	%	
Gender							< 0,001
Male	909	31,3	525	44,2	384	22,3	
Age (years)**	36,3 (9,5)		39,8 (10,7)		33,9 (7,8)		< 0,001
Skin color							0,202
White	1.896	65,2	753	63,4	1.143	66,4	
Black/brown	984	33,8	421	35,4	563	32,7	
Yellow/indigenous	29	1	14	1,2	15	0,9	
Marital status							< 0,001
Single	1.276	43,9	428	36	848	49,3	
Legally married/stable union	1.465	50,4	669	56,3	796	46,2	
Separated or Divorced/widow/widowe	168	5,7	91	7,7	77	4,5	
Professional status							< 0,001
Retired/work at home/unemployed	235	8,1	110	9,2	125	7,3	
Student	382	13,1	107	9	275	15,9	
Full-time work	1.857	63,8	805	67,8	1.052	61,1	
Part-time work	358	12,3	138	11,6	220	12,8	
Informal work	77	2,7	28	2,4	49	2,9	
Family income (R$) **	8.758 (6.901)		9.344 (7.343)		8.758 (6.901)		< 0,001

Notes: *p-values according to Pearson's chi-square test or t-Student test, when appropriate. **Data are mean and standard deviation.

Source: Authors' elaboration.

The portion of participants who consumed some type of alcoholic beverage (73.6%) was higher than those found for the global population (43%) and the Brazilian population in general (40%)[36]. On the other hand, the mean daily alcohol consumption (5.9 g) of our participants was below that of the world population, which was 33 g (equivalent to 300 ml of wine, 750 ml of beer, or 80 ml of liquor)[36], and it was within the limits of intake recommended by the World Health Organization (10 to 12 g – equal to one 100-ml glass of wine, a 330-ml can of beer or a 30-ml dose of hard liquor)[37]. It is important to highlight that the quantity of daily alcohol consumption that is considered safe, and the recommendations on maximum daily intake of alcohol, vary within and between different countries, and there is no consensus regarding an intake limit[37,38], which ranges from 10 to 14 g. A study recently published by the Global Burden of Disease (GBD)[36] discourages the consumption of any quantity ("zero tolerance").

In the analysis by type of alcohol, there was a higher mean of daily beer intake (76.2 ml), followed by wine (16.1 ml) and hard liquor (2.9 ml). Globally, hard liquor is the most frequently consumed type (44.8%), followed by beer (34.3%) and wine (11.7%). In the Americas, beer is the most consumed type of alcohol (53.8%), followed by hard liquor (31.7%) and wine (13.5%). In Brazil, the results are similar (beer: 62%; hard liquor: 34%; wine: 3%), which means Brazil ranks third in Latin American and fifth in the Americas regarding alcohol consumption[36].

The fact that the participants of our study reported a high consumption of alcohol, but at a low daily quantity, can be considered a positive aspect in the participants' behavior since a high daily alcohol intake can be harmful to one's health[36]. Such results are likely to be explained by the high schooling level of participants because, in general, individuals with higher levels of education tend to have healthier habits[39].

The intermediate consumption of alcohol (Q2; 1.18 to 3.3 g/day), beer (Q2; 8.1 to 31 ml/day), wine (Q3; 6.4 to 17.6 ml/day) and hard liquor (Q3; 1.1 to 2.5 ml/day) is negatively associated to excess weight, which suggests an in-

Table 2. Characteristics of participants' lifestyle, food consumption, and medical diagnosis of disease according to the presence of overweight. Cohort of Universities of Minas Gerais (CUME), 2016.

Variables	Total (n = 2.909)		Overweight				p-value*
			Yes (n = 1.188)		No (n = 1.721)		
	n	%	n	%	n	%	
Smoking habit							< 0,001
Never smoker	2.303	79,2	870	73,2	1.433	83,3	
former smoker	353	12,1	197	16,6	156	9,1	
Current smoker	253	8,7	121	10,2	132	7,6	
Physical activity							0,016
Inactive	706	24,3	321	27	385	22,4	
Insufficiently active	595	20,4	236	19,9	359	20,8	
Active	1.608	55,3	631	53,1	977	56,8	
Energy consumption (Kcal/day)**	2.412 (939)		2.568 (991)		2.304 (887)		< 0,001
Macronutrient consumption (g/day)**							
Carbohydrates	283,4 (116,3)		296,3 (121,7)		274,5 (111,7)		< 0,001
Proteins	107,8 (54,9)		116,4 (56,1)		101,9 (52,3)		< 0,001
Lipid	89,5 (45,8)		96,5 (48,7)		84,7 (43,1)		< 0,001
Polyunsaturated fat	16,1 (9,1)		17,3 (9,7)		15,2 (8,5)		< 0,001
Monounsaturated Fats	37,9 (21,1)		40,9 (22,4)		35,9 (20,1)		< 0,001
Saturated fat	31,4 (16,3)		34,2 (17,7)		29,4 (15)		< 0,001
Trans-fat	1,1 (0,8)		1,2 (0,9)		0,9 (0,7)		< 0,001
Minimally processed foods (g/day)**	1.292,9 (399,5)		1.268,6 (409,1)		1.309,6 (391,9)		0,006
Processed Foods (g/day)**	77 (56,7)		79,2 (56)		75,4 (57,2)		0,076
Ultra-processed Foods (g/day)**	227,8 (117,6)		226 (121,4)		229 (115)		0,494
Presence of chronic disease(s)***							
Yes	664	22,8	303	25,5	361	21	0,004
Medical diagnosis of depression							
Yes	353	12,1	181	15,2	172	10	< 0,001

Notes: g – grams; Kcal – calories. *p-values according to Pearson's chi-square test or t-Student test, when appropriate. **Data are mean and standard deviation. ***Clinical variables were obtained from questions if the participant had already received the medical diagnosis, that is, confirmation by a medical professional, for each of the following diseases: stroke, infarction, celiac disease, inflammatory bowel disease (Crohn, rectocolitis ulcerative disease), nonalcoholic liver steatosis, alcoholic cirrhosis, gastritis, gastric or duodenal ulcer, acute renal failure, chronic renal failure, lung cancer, skin cancer, colon cancer, breast cancer, cervical cancer, cancer prostate cancer, diabetes mellitus type 2, systemic arterial hypertension, high triglycerides, high cholesterol.

Source: Authors' elaboration.

verse association, even though the tendency p is significant only in the analysis of daily beer consumption – therefore, one can infer a higher consumption of beer increases the prevalence of excess weight. Other studies present similar findings[10,14,38,40].

Among the moderate and heavy consumers of alcohol, a larger fraction of the energy of alcohol may not be an available source of energy due to the induction of the microsomal ethanol oxidizing system (MEOS)[40], which means that the calories contained in alcohol are less related to weight gain and more related to alcohol toxicity, such as hepatotoxicity or carcinogenesis[38,40]. Moreover, individuals with normal weight who consume a low or moderate quantity of alcohol can maintain their habits of consuming alcohol without gaining weight, which may have conferred this protective effect to the intermediate quartiles in our study[38].

It is important to highlight that many cross-sectional, longitudinal and experimental studies evaluated by systematic reviews and meta-analyses demonstrated findings that differ from ours, which indicated a positive association between alcohol consumption and excess weight[5,10,12,14]. Alcohol has a high potential to interact with different aspects of body weight reg-

Table 3. Characteristics of the participants' alcohol consumption according to the presence of overweight. Cohort of Universities of Minas Gerais (CUME), 2016.

Variables	Total (n = 2.909)		Yes (n = 1.188)		No (n = 1.721)		p-value*
	n	%	n	%	n	%	
Alcohol consumption							0,010
No	767	26,4	283	23,8	484	28,1	
Yes	2.142	73,6	905	76,2	1.237	71,9	
Frequency of consumption							0,002
< 1 time/week	1.824	62,7	702	59,1	1.122	65,2	
1-4 days/week	1.047	36,0	466	39,2	581	33,8	
≥ 5 days/week	38	1,3	20	1,7	18	1,0	
Daily alcohol consumption (g)**	5,9 (9,1)		6,6 (9,9)		5,4 (8,4)		< 0,001
Daily alcohol consumption							< 0,001
Q1 (up to 1,17g)	728	25,0	308	25,9	420	24,4	
Q2 (up to 3,3g)	727	25,0	250	21,0	477	27,7	
Q3 (up to 8g)	727	25,0	274	23,1	453	26,3	
Q4 (up to 117,3g)	727	25,0	356	30,0	371	21,6	
Daily consumption of beer (ml)**	76,2 (22,6)		80,0 (23,9)		73,6 (21,4)		< 0,001
Daily consumption of beer							< 0,001
Q1 (up to 8ml)	728	25,0	316	26,7	412	23,9	
Q2 (up to 31ml)	727	25,0	242	20,3	485	28,2	
Q3 (up to 105,3ml)	727	25,0	274	23,0	453	26,3	
Q4 (up to 2087,5ml)	727	25,0	356	30,0	371	21,6	
Daily consumption of wines (ml)**	16,1 (5,0)		16,9 (5,3)		15,5 (4,7)		< 0,001
Daily consumption of wines							< 0,001
Q1 (up to 1,4ml)	728	25,0	335	28,2	393	22,8	
Q2 (up to 6,3ml)	727	25,0	283	23,8	444	25,8	
Q3 (up to 17,6ml)	727	25,0	261	22,0	466	27,1	
Q4 (up to 543,5ml)	727	25,0	309	26,0	418	24,3	
Daily consumption of spirits (ml)**	2,9 (1,6)		3,2 (1,7)		2,7 (1,5)		< 0,001
Daily consumption of Spirits							< 0,001
Q1 (up to 0,1ml)	728	25,0	349	29,4	379	22,0	
Q2 (up to 1ml)	727	25,0	288	24,2	439	25,5	
Q3 (up to 2,5ml)	727	25,0	249	21,0	478	27,8	
Q4 (up to 99,5ml)	727	25,0	302	25,4	425	24,7	

Notes: Q1 – first quartile; Q2 – second quartile; Q3 – third quartile; Q4 – fourth quartile; g – grams; ml – milliliters. *p-values according to Pearson's chi-square test or t-Student test, when appropriate. **Data are mean and standard deviation.

Source: Authors' elaboration.

ulation. Therefore, other causes for controversial results might be the different confounding factors included in the data analysis[38,40]. Then, it is important to try to control these biases in epidemiological studies and consider, in addition to the known and widely used aspects (sex, age, physical activity, smoking, psychosocial factors, income and professional status), those aspects related to the pattern of consumption and intake of alcohol; previous body weight; and factors that may have previously influenced weight gain or loss, such as past illnesses, medications, caffeine consumption and individual genetic factors[38,40].

Some of the potential biases mentioned are difficult to control in cross-sectional studies; hence, our study opted for sensitivity analyses in an attempt to mitigate such biases. In this way, participants with a previous medical diagnosis of obesity, those who gained 10 or more kilograms before the study, and those who were on weight control medications were excluded. After these procedures, only the intermediate consumption

Table 4. Prevalence ratio and 95% confidence intervals for the association between overweight and alcohol consumption patterns. Cohort of Universities of Minas Gerais (CUME), 2016.

Variables	Gross analysis		Adjusted analysis	
	PR (95% CI)	p-value	PR (95% CI)	p-value
Alcohol consumption*				
No (n = 283)	1,00	-	1,00	-
Yes (n = 905)	1,14 (1,03-1,27)	0,011	1,07 (0,97-1,19)	0,151
Frequency of consumption*				
< 1 time/week (n = 702)	1,00	-	1,00	-
1-4 days/week (n = 466)	1,15 (1,05-1,26)	0,001	1,07 (0,97-1,17)	0,132
≥ 5 days/week (n = 20)	1,36 (1,00-1,85)	0,046	0,83 (0,61-1,13)	0,254
p linear trend		< 0,001		0,598
Daily alcohol consumption (g)**				
Q1 (n = 728)	1,00	-	1,00	-
Q2 (n = 727)	0,81 (0,71-9,92)	0,002	0,87 (0,77-0,99)	0,037
Q3 (n = 727)	0,89 (0,78-1,01)	0,073	0,95 (0,84-1,07)	0,449
Q4 (n = 727)	1,15 (1,03-1,29)	0,011	1,02 (0,91-1,14)	0,684
p linear trend		< 0,001		0,221
Daily consumption of beer (ml)**				
Q1 (n = 728)	1,00	-	1,00	-
Q2 (n = 727)	0,76 (0,67-0,87)	< 0,001	0,84 (0,74-0,96)	0,011
Q3 (n = 727)	0,86 (0,76-0,98)	0,027	0,92 (0,82-1,04)	0,203
Q4 (n = 727)	1,12 (1,00-1,26)	0,034	1,04 (0,93-1,16)	0,416
p linear trend		< 0,001		0,038
Daily consumption of wines (ml)**				
Q1 (n = 728)	1,00	-	1,00	-
Q2 (n = 727)	0,84 (0,75-0,95)	0,006	0,92 (0,82-1,03)	0,175
Q3 (n = 727)	0,78 (0,68-0,88)	< 0,001	0,85 (0,75-0,96)	0,010
Q4 (n = 727)	0,92 (0,82-1,03)	0,178	0,91 (0,81-1,01)	0,097
p linear trend		0,936		0,280
Daily consumption of spirits (ml)**				
Q1 (n = 728)	1,00	-	1,00	-
Q2 (n = 727)	0,82 (0,73-0,92)	0,001	0,91 (0,81-1,02)	0,134
Q3 (n = 727)	0,71 (0,62-0,81)	< 0,001	0,84 (0,74-0,94)	0,005
Q4 (n = 727)	0,86 (0,77-0,97)	0,014	0,93 (0,84-1,04)	0,237
p linear trend		0,067		0,325

Notes: Q1 – first quartile; Q2– second quartile; Q3 – third quartile; Q4 – fourth quartile; PR ¬– prevalence ratio; CI – 95% confidence interval; g – grams; ml – milliliters. *Analysis adjusted by gender; age; color; marital status; professional status; smoking habit; physical activity; medical diagnosis of depression; family income; total energy consumption. **Analysis adjusted by gender; age; color; marital status; professional status; smoking habit; physical activity; medical diagnosis of depression; family income.

Source: Authors' elaboration.

of hard liquor (Q3; 1.1 to 2.5 ml/day) kept its negative relation to excess weight.

Regarding wine and beer, after the sensitivity analysis, our findings (beer: 8.1 to 31 ml/day; wine: 6.4 to 17.6 ml/day) were different from the findings of other studies, which showed that a moderate consumption of beer (11 to 22 ml/day)[41] and wine (5 to 13 ml/day)[5,12] provided protection against weight gain. Among the possible explanations for this effect is the presence of polyphenols in wine and beer, which provide antioxidant and anti-inflammatory action, with the reduction of leukocyte adhesion molecules and inflammatory biomarkers, which improves lipid profile[42], and establishes another favorable characteristic of these beverages.

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Table 5. Sensitivity analysis of prevalence ratio and 95% confidence intervals for the association between overweight and alcohol consumption patterns. Cohort of Universities of Minas Gerais (CUME), 2016.

Variables	Sensitivity analysis		
	Analysis 1 PR (95% CI)	Analysis 2 PR (95% CI)	Analysis 3 PR (95% CI)
Daily alcohol consumption (g)*			
Q1 (n = 728)	1.00	1.00	1.00
Q2 (n = 727)	0.90 (0.77-1.04)	0.90 (0.78-1.04)	0.90 (0.76-1.06)
Q3 (n = 727)	0.97 (0.85-1.12)	1.02 (0.89-1.17)	1.02 (0.87-1.19)
Q4 (n = 727)	1.09 (0.95-1.24)	1.06 (0.93-1.20)	1.13 (0.97-1.30)
p linear trend	0.042	0.129	0.018
Daily consumption of beer (ml)*			
Q1 (n = 728)	1.00	1.00	1.00
Q2 (n = 727)	0.88 (0.76-1.02)	0.89 (0.77-1.03)	0.92 (0.78-1.08)
Q3 (n = 727)	0.97 (0.84-1.12)	0.96 (0.84-1.10)	1.00 (0.85-1.17)
Q4 (n = 727)	1.11 (0.98-1.27)	1.07 (0.95-1.22)	1.16 (1.00-1.34)
p linear trend	0.007	0.037	0.005
Daily consumption of wines (ml)*			
Q1 (n = 728)	1.00	1.00	1.00
Q2 (n = 727)	0.97 (0.85-1.11)	0.96 (0.84-1.10)	1.01 (0.87-1.17)
Q3 (n = 727)	0.89 (0.77-1.02)	0.90 (0.78-1.03)	0.92 (0.78-1.08)
Q4 (n = 727)	0.97 (0.85-1.11)	0.95 (0.84-1.08)	1.02 (0.88-1.18)
p linear trend	0.946	0.702	0.640
Daily consumption of spirits (ml)*			
Q1 (n = 728)	1.00	1.00	1.00
Q2 (n = 727)	0.92 (0.81-1.05)	0.94 (0.82-1.07)	0.96 (0.83-1.11)
Q3 (n = 727)	0.84 (0.73-0.96)	0.85 (0.74-0.98)	0.83 (0.71-0.98)
Q4 (n = 727)	0.95 (0.84-1.08)	0.97 (0.86-1.09)	0.99 (0.86-1.14)
p linear trend	0.621	0.771	0.948

Notes: Q1 – first quartile; Q2 – second quartile; Q3 – third quartile; Q4 – fourth quartile; PR – prevalence ratio; CI – 95% confidence interval; g – grams; ml – milliliters. Analysis 1: exclusion of people with previous medical diagnosis of obesity (n = 256). Analysis 2: exclusion of people who gained ten or more kg prior to the study (n = 203). Analysis 3: exclusion of all persons considered in analyzes 1 and 2 (n = 408), in addition to those who used weight control medication (n = 12) (total = 420). *Analysis adjusted by gender; age; color; marital status; professional status; smoking habit; physical activity; medical diagnosis of depression; family income.

Source: Authors' elaboration.

It is important to highlight that this difference between our results and those from other investigations can be explained by the fact that in our analysis we did not differentiate between red and white wine - the former presents better protective effects due to the presence of more than ten times the amount of phenolic compounds[17,42]. Regarding beer, our questionnaire did not consider different types of beer separately. A study conducted in Brazil analyzed the phenolic compounds in the different types of Brazilian beers and found that the physical-chemical attributes (density, refractive index, bitterness and ethanol content) influence the quantity of phenolics[43]. Moreover, this same study identified that the phenolic profile of Brazilian beers was different from that of European beers, with a low content of ferulic acid[43], which could be a hypothesis to explain the lower protection offered by the moderate consumption of Brazilian beer in comparison to European beer[5,10,12,14]. However, it is worth mentioning that in our tendency analyses it was found that the more the beer consumption increased, the higher the prevalence of excess weight, which corroborates other studies[12,14,15].

Hard liquor presents higher concentrations of alcohol and lower concentrations of polyphenols, which could mean a higher risk of excess weight[43]. However, in this study, a protective effect was observed in the intermediate quartile

(Q3; 1.1 to 2.5 ml/day), which also is corroborated by other studies[10,12]. Such finding may be explained by the fact that alcohol is positively related to HDL-c[42]. In a meta-analysis of prospective studies, only a very low alcohol intake (between 0.1 and 5 g/day) was proven a protective factor for metabolic syndrome[44]. The consumers in the intermediate quartile (Q3) of hard liquor in this study had a median alcohol consumption of 3.2 g/day.

The *Seguimiento Universidad de Navarra* (SUN), in Spain, found that individuals who consume at least seven drinks per week of beer and hard liquor present a higher risk of overweight and obesity (OR: 1.32 – 95% CI; 1.00-1.74) in comparison to non-drinkers after multivariate data adjustment[45]. It is worth mentioning that the aforementioned study was a longitudinal analysis, which guarantees the causality of associations and thus strengthens our findings.

In this study, we found an increase tendency of the prevalence of excess weight with a higher daily alcohol consumption, which was also found by other studies[1,9,10,14,16,18,46], even though there are studies who found a null or inverse association[10,38,40].

Some of the studies showed a J-shaped curve in the analyses of alcohol consumption and its effects on health[1,9,10,14,16,18,46]. For some authors, the J-shaped pattern must be carefully evaluated, considering that, at times, this relation may occur due to an erroneous classification of consumption patterns. The lower risk among those with zero and moderate alcohol consumption may be due to the inclusion of individuals who already presented alterations and were advised to lower or eliminate alcohol use[46]. It is worth mentioning that our analyses were adjusted for diagnosis of chronic diseases that could potentially affect the consumption of alcohol. Recently, despite finding the J-shaped curve in the relation between alcohol consumption and ischemic diseases, in particular, the GBD[36] argues that when mortality in general is evaluated, the curve loses is J shape, since the risk of death from other causes surpasses the protection offered by lower or intermediate alcohol use. As a recommendation, the GBD emphasizes that, regardless of the amount, alcohol consumption is harmful to human health among populations[36].

Of all the participants, 40.8% presented excess weight. Although this is a high prevalence, it is lower than the one found in the general Brazilian population (55.7%)[3] and in other national and international studies[28,47-50], and it is similar to the prevalence found in the SUN cohort (38%)[45], which shows samples with similar characteristics to our cohort.

These differences can be explained by the characteristics of the population from this study, which was mostly composed by young adults with high levels of income and education, which are protective factors against excess weight[9]. Individuals in a more favorable socioeconomic position are more likely to adopt healthy behaviors and have more access to healthcare[39], even if they do present a higher consumption of alcohol[15,25,27,51].

Although this study presents a privileged sample profile with individuals in a good socioeconomic position, such characteristic allowed detailing and depth in the questions of the questionnaire. A study with a similar sample has shown reliable and valid results in addition to a high retention rate[45,52].

Regarding limitations in this study, we highlight the fact that the participants' level of alcohol consumption was self-reported. There are, however, some authors who claim that in samples of communities where alcohol is legal, socially accepted, and seen as part of the traditional diet standard, the issue of incorrect self-reporting is minimized[53]. In the Spanish cohort SUN, it was shown that individuals with a higher level of education are less likely to inaccurately report alcohol consumption[52,54]. However, we acknowledge that these issues do not eliminate possible measurement errors inherent to the instrument used and to the specific characteristics of our population.

Some studies with adults and using the FFQ showed good reproducibility and validity in the measurement of alcohol consumption[52,55,56], and the Spanish cohort SUN[52] indicated that, even if there might be some inaccuracy in the information, such inaccuracy would not constitute a differential due to the higher level of education of the participants. Nevertheless, it is worth mentioning the estimation of alcohol intake in our study might also be a limitation, since the FFQ has not been specifically validated for alcohol consumption.

Another study limitation was the number of participants who were excluded for not completing the FFQ (n = 1,679), which reduced our sample. This may have increased the probability of type II statistical error; however, even after the multivariate analysis, significant associations were found between alcohol consumption and excess weight. Moreover, when comparing the

participants and the excluded individuals in relation to sex, age, frequency of alcohol consumption, and excess weight, only one statistically significant difference was found. Among the excluded individuals, there were more males (39% *vs.* 31.3%; $p < 0.001$ as per Pearson's chi-square test), which means that this finding must be considered in the interpretation of our results, considering that men consume more alcohol and present a higher prevalence of excess weight than women in Brazil[3].

As strengths of this study, we highlight the fact that there is still little data that effectively characterizes the dietary pattern of the Brazilian population, so the CUME Project can contribute in that sense. This study also has the advantage of better accuracy, obtained by describing the portions of alcohol beverages, which could minimize the memory bias and the expected underestimation of consumption[55]. Finally, with the sensitivity analyses, there was an attempt to mitigate the possibility of reverse causality biases, which cross-sectional studies are highly susceptible to, as previously mentioned, based on other studies recommending sensitivity analyses[38,40].

It was concluded there was a high prevalence of alcohol consumption among the participants of CUME, and an inverse association of the intermediate quartiles of the intake of alcohol, beer, wine, and hard liquor with excess weight was observed. On the other hand, after sensitivity analyses, the high consumption of alcohol and beer was positively associated to excess weight, even if the intermediate hard liquor intake was negatively associated to excess weight. However, regarding this last finding, it is worth highlighting the need to reduce the widely accepted view that a low or moderate alcohol consumption is not harmful to one's health[5,7,12] and approach this proposition cautiously. Thus, those individuals with a low use or no use at all of alcohol cannot be encouraged to expect a substantial benefit from alcohol intake. On the other hand, for those who already consume alcohol, moderation is recommended to avoid binge drinking.

Additional longitudinal analyses (which consider the temporal sequence) are required to support these associations, especially in populations with a high variability of alcohol consumption, and evaluate the specific role of different types of alcoholic beverages.

Collaborations

Souza e Souza LP and Miranda AES participated in the data collection, analysis and interpretation. Hermsdorff HHM, Bressan J and Pimenta AM participated in the design and planning of the study.

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