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ORIGINAL

Relationship between alcohol consumption and obesity determinated with different scales

Relación entre el consumo de alcohol y la obesidad determinada con diferentes escalas

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Abstract

Introduction: Alcohol consumption is linked to the development of various diseases, including obesity.
Methods: A descriptive, cross-sectional study was carried out on 60798 workers in which the relationship between high alcohol consumption and the appearance of overweight and obesity determined with different scales (BMI, waist to height ratio, body roundness index, body shape index, visceral adiposity index, conicity index and scales predicting body fat) was assessed.
Results: The mean values and the prevalence of obesity as determined by the different scales are higher among people who consume high amounts of alcohol. The multivariate analysis shows that alcohol consumption is one of the factors that most increase the risk of obesity.
Conclusion: Excessive alcohol consumption increases all the parameters related to overweight and obesity in Spanish workers.

Keywords: Alcohol consumption, obesity, overweight, visceral adiposity index, body fat.

Resumen

Introducción: El consumo de alcohol guarda relación con la aparición de diferentes enfermedades, entre ellas la obesidad.
Material y métodos: Se realiza un estudio descriptivo y transversal en 60798 trabajadores en los que se valora la relación entre el elevado consumo de alcohol y la aparición de sobrepeso y obesidad determinada con diferentes escalas (IMC, cintura/altura, body roundness index, body shape index visceral adiposity index, conicity index y escalas predictoras de grasa corporal).
Resultados: Los valores medios y la prevalencia de obesidad determinada con las diferentes escalas es más elevada entre las personas que consumen altas cantidades de alcohol. En el análisis multivariante se observa que el consumo de alcohol es uno de los factores que más aumentan el riesgo de padecer obesidad.
Conclusiones: El consumo excesivo de alcohol aumenta todos los parámetros relacionados con sobrepeso y obesidad en trabajadores españoles.

Palabras clave: Consumo de alcohol, obesidad, sobrepeso, índice de adiposidad visceral, grasa corporal.

Introduction

Alcohol use has been associated with significant health problems, both physical and mental, as well as social and personal problems. Many clinical decisions, both in terms of treatment of the associated pathology and management of alcohol use itself, will depend on the type of assessment made of alcohol consumption. For all these reasons, it is essential to make an adequate assessment of alcohol consumption and drinking patterns[1].

Overweight and obesity have been defined as the abnormal or excessive accumulation of fat that can be detrimental to health. The traditional way of measuring them is through the body mass index, although there are other indicators such as excess body fat.

Overweight and obesity are considered as a systemic, chronic, multi-causal disease, not exclusive to economically developed, involving all age groups, ethnicities and social classes[2].

According to WHO[2], the main cause of overweight and obesity is an imbalance between calories consumed and calories expended. However, obesity is known to have a multifactorial origin, involving genetic susceptibility, lifestyles (including alcohol consumption) and the environment (globalization, culture, economy, education and the political and social environment).

There are different mechanisms linking alcohol consumption to the development of overweight and obesity. It seems clear that light and moderate alcohol consumption is a protective factor and heavy drinking a risk factor for overweight and obesity. This may be due not only to the energy provided by alcohol but also to the fact that alcohol may stimulate the intake of other foods simultaneously[3-5]. Alcohol consumption has been shown to influence some hormones linked to satiety, especially by inhibiting the effects of leptin (the hormone responsible for satiety), or glucagon-like peptide-1 (GLP-1)[6-7]. Alcohol may also influence appetite through several central mechanisms. The effects of alcohol on opioid, serotonergic, and GABAergic pathways throughout the brain suggest the potential to increase appetite and energy intake[8-9]. Alcohol also acts on energy storage by inhibiting fat oxidation, i.e., it prevents fat from being used as energy, which means that long-term frequent alcohol consumption could lead to the formation of more fat rather than using existing fat for energy, which resulting in an increased likelihood of becoming overweight or obese[8].

For the above reasons, in this study we are interested in finding out the relationship between alcohol consumption and the prevalence of obesity determined with different scales in a group of workers.

Methods

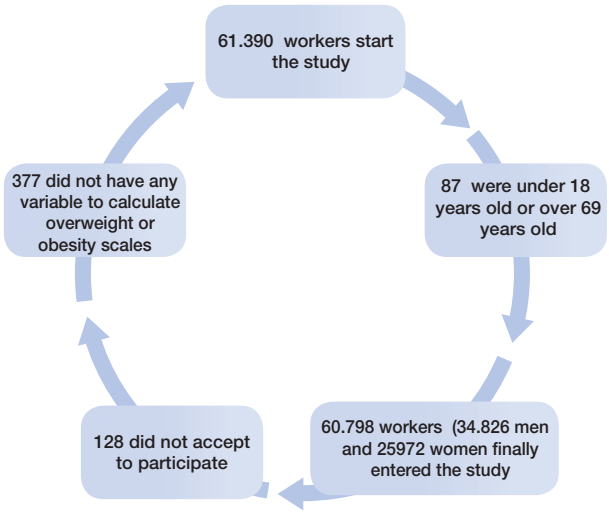
A retrospective, cross-sectional study is conducted on 60,798 Spanish workers during the period from May 2018 to January 2020. Workers were selected among those who attended occupational health follow up appointments periodically.

Inclusion criteria

- Age between 18 and 69 years.
- Agree to participate in the study.

The flow chart of the people involved in the study is shown in **Figure 1**.

Figure I: Mean of indicators (dimensions) after exploratory factor analysis.



Anthropometric (height, weight, waist circumference), clinical and analytical measurements were performed by the occupational health professionals of the companies after having homogenized the measurement techniques.

Weight and height were determined with a scale-measuring device: model SECA 700. Abdominal waist circumference was measured with a tape measure: SECA 200. Blood pressure was assessed with a calibrated OMRON M3 automatic sphygmomanometer and after 10 minutes of rest. Three determinations were made at one-minute intervals and the mean value of the three was obtained. Blood tests were obtained after fasting for at least 12 hours. The samples were sent to reference laboratories where they were processed.

BMI was calculated by dividing weight by height in squared meters. Obesity was considered over 30. The waist-to-height ratio was considered risky over 0.50[10].

Five formulas were used to estimate body fat percentage:

- CUN BAE[11] (Clínica Universitaria de Navarra Body Adiposity Estimator):
  -44.988 + (0.503 x age) + (10.689 x gender) + (3.172 x BMI) - (0.026 x BMI^2) + (0.181 x BMI x gender) - (0.02 x BMI x age) - (0.005 x BMI2x gender) + (0.00021 x BMI^2 x age)

- ECORE BF[12] (Cordoba Equation for body fat estimation):
  -97.102 + 0.123 (age) + 11.9 (sex) + 35.959 (LnIMC)

Where male equals 0 and female equals 1. The CUN BAE and ECORE-BF cut-off points for obesity were from 25% in men and 35% in women.

- Formula Palafolls[13].
  Men = ([BMI/PA]*10) + BMI. Women = ([BMI/PA]*10) + BMI + 10. The authors propose the same cut-off points as CUN BAE.

- Deuremberg formula[14].
- Fat mass %= 1.2 x (BMI) + 0.23 x (Age in years) - 10.8 x (gender) - 5.4

Where female equals 0 and male equals 1.

Obesity was considered to be 25% or more in men and 32% or more in women.

Relative fat mass[15]
Women: 76- (20 x (height/waist))
Men: 64- (20 x (height/w waist))

Height and waist circumference are expressed in meters. The cut-off points for obesity are from 32% in women and 25% in men.

Other indicators of overweight and obesity calculated are:

- Visceral adiposity index16 (VAI).

Male:

$$VAI = \left(\frac{WC}{39{,}68 + (1{,}88 \times BMI)}\right) \times \left(\frac{TG}{1{,}03}\right) \times \left(\frac{1{,}31}{HDL}\right)$$

Female:

$$VAI = \left(\frac{WC}{36{,}58 + (1{,}89 \times BMI)}\right) \times \left(\frac{TG}{0{,}81}\right) \times \left(\frac{1{,}52}{HDL}\right)$$

- Conicity index[17]

$$\frac{\text{waist circumference (in metres)}}{0{,}109} \times 1/\sqrt{\frac{\text{weight (in kilogram)}}{\text{height (in metres)}}}$$

- Body Roundness Index[18] (BRI) is calculated using the following formula, where WC represents the waist circumference.

$$BRI = 364{,}2 - 365{,}5 \times \sqrt{1 - \left(\frac{(WC/(2\pi))^2}{(0{,}5\ \text{height})^2}\right)}$$

- Body shape index (ABSI)[19].

$$ABSI = \frac{WC}{BMI^{2/3} \times \text{height}^{1/2}}$$

Smoking, diet, and physical activity were assessed by a clinical interview. Tobacco was considered a dichotomous variable (yes/no), and an individual was considered a smoker if they had regularly consumed at least 1 cigarette/day (or the equivalent in other types of consumption) in the last month or had stopped smoking less than a year ago. Healthy eating was considered as a diet that includes daily consumption of vegetables and fruits, and adequate physical activity was defined as performing at least 30 minutes a day or 150 minutes a week of moderate intensity aerobic physical activity or 75 minutes a week of vigorous activity. Quantification of consumption in standard drinking units is currently the reference method at all levels of care. The assessment of consumption in standard drinking units allows a rapid quantification of consumption and its easy conversion into grams of pure alcohol[1]. The value of standard drinking units in Spain is set at 10 g of alcohol and is equivalent to one consumption of wine (100 ml), champagne (100 ml) or beer (200 ml) and half a consumption of spirits or mixed drinks (25 ml). If a man goes over 35 standard drinking units in a week and a woman over 20 in a week, there is a significant risk to their long-term health[20].

Social class is determined on the basis of the 2011 National Classification of Occupations (CNO-11) and based on the proposal made by the social determinants group of the Spanish Society of Epidemiology[21]. We opted for classification into 3 categories: Class I. Directors/managers, university professionals, sportsme, women and artists. Class II. Intermediate occupations and self-employed workers without employees. Class III. Unskilled workers.

Statistical analysis

A descriptive analysis of the categorical variables was carried out, calculating the frequency and distribution of responses for each of them. For quantitative variables, the mean and standard deviation were calculated, and for qualitative variables, the percentage was calculated. The bivariate analysis of association was performed using the 2's test (with correction for Fisher's exact statistic when conditions required it) and Student's t-test for independent samples. For the multivariate analysis, binary

logistic regression was used with the Wald method, with the calculation of Odds ratios and the Hosmer-Lemeshow goodness-of-fit test was performed. Statistical analysis was performed with the SPSS 27.0 programme, the accepted level of statistical significance being 0.05.

Ethical considerations and issues

The study received approval from the Clinical Research Ethics Committee. All procedures were performed in accordance with the ethical standards of the institutional research committee and the 2013 Declaration of Helsinki. All patients signed written informed consent documents before participating in the study.

Results

The average age of our workers is not too old (40 years), almost 35% of them smoke and almost 15% consume alcohol to a high degree. Most of them belong to social class III. The clinical and analytical parameters are more unfavorable in men with statistically significant differences. All data are presented in **table I**.

The mean values of all scales related to overweight, and obesity are higher in the group of people who consume high amounts of alcohol, and this was observed in both sexes. The full data can be found in **table II**.

The prevalence of obesity as determined by the different scales is higher in the group of people who consume alcohol compared to those who do not, both in women and men. The full data can be found in **table III**.

Table I: Anthropometric, clinical, analytical, sociodemographic and healthy habits characteristics of the sample.

	Women n=25972	Men n=34826	Total n=60798	p-value
Age	39.5 ± 10.2	40.4 ± 10.5	40.0 ± 10.4	<0.0001
Height	161.3 ± 6.5	173.9 ± 7.1	168.5 ± 9.2	<0.0001
Weight	65.1 ± 13.1	81.3 ± 13.9	74.4 ± 15.8	<0.0001
Systolic Blood Presure	114.6 ± 15.1	125.4 ± 15.7	120.8 ± 16.3	<0.0001
Dyastolic Blood Presure	70.4 ± 10.4	76.0 ± 10.8	73.6 ± 11.0	<0.0001
Cholesterol	193.1 ± 36.4	197.6 ± 38.5	195.7 ± 37.7	<0.0001
HDL-c	55.0 ± 9.2	50.5 ± 7.6	52.4 ± 8.6	<0.0001
LDL-c	120.5 ± 36.9	121.8 ± 37.3	121.2 ± 37.1	<0.0001
Triglycerides	87.9 ± 45.9	126.2 ± 88.5	109.9 ± 75.8	<0.0001
Glucose	85.2 ± 15.1	90.6 ± 21.2	88.3 ± 19.0	<0.0001
	%	%	%	p-value
Alcohol consumption	8.5	19.6	14.8	<0.0001
Tobacco consumption	32.5	36.6	34.8	<0.0001
Healthy food consumption	50.6	40.1	44.6	<0.0001
Physical activity	52.2	44.1	47.5	<0.0001
Social class I	14.1	7.4	10.3	<0.0001
Social class II	32.7	23.5	27.4	
Social class III	53.2	69.1	62.3	
Elementary	47.1	68.8	59.1	<0.0001
Secondary	40.5	25.5	31.9	
University student	12.4	6.5	9.0	

Table II: Mean values of different obesity scales according to alcohol consumption by gender.

	Women			Men		
	n=23768 No alcohol mean ± SD	n=2204 Yes alcohol mean ± SD	p	n=28011 No alcohol mean ± SD	n=6815 Yes alcohol mean ± SD	p
Body mass index	24.4 ± 4.4	31.5 ± 5.6	<0.0001	25.9 ± 3.6	30.9 ± 4.2	<0.0001
Waist to height ratio	0.46 ± 0.1	0.54 ± 0.1	<0.0001	0.50 ± 0.0	0.57 ± 0.1	<0.0001
Relative fat mass	32.0 ± 5.0	38.5 ± 5.0	<0.0001	23.3 ± 3.7	28.5 ± 3.4	<0.0001
Palafolls formula	37.7 ± 4.7	45.2 ± 6.	<0.0001	28.9 ± 3.9	34.0 ± 4.5	<0.0001
Deuremberg formula	32.8 ± 6.1	43.5 ± 7.1	<0.0001	23.8 ± 5.3	31.6 ± 5.4	<0.0001
ECORE-BF	33.9 ± 6.4	44.2 ± 6.4	<0.0001	24.4 ± 5.3	31.7 ± 4.9	<0.0001
CUN BAE	34.0 ± 6.4	43.8 ± 5.9	<0.0001	24.3 ± 5.6	31.9 ± 5.0	<0.0001
Conicity index	1.09 ± 0.1	1.13 ± 0.1	<0.0001	1.18 ± 0.1	1.24 ± 0.1	<0.0001
Body roundness index	2.7 ± 1.0	4.3 ± 1.7	<0.0001	3.3 ± 0.9	4.8 ± 1.2	<0.0001
Visceral adiposity index	2.7 ± 1.6	4.4 ± 3.5	<0.0001	6.7 ± 6.0	12.4 ± 11.0	<0.0001
Body shape index	0.070 ± 0.01	0.070 ± 0.01	<0.0001	0.075 ± 0.01	0.077 ± 0.01	<0.0001

Table III: Prevalence of obesity determined with different scales according to alcohol consumption by gender.

	Women			Men		
	n=23768 No alcohol %	n=2204 Yes alcohol %	p	n=28011 No alcohol %	n=6815 Yes alcohol %	p
BMI obesity	10.2	60.4		11.1	56.7	
WtHR >0.5	19.5	69.7	<0.0001	44.5	91.8	<0.0001
RFM obesity	35.1	83.7	<0.0001	56.7	94.4	<0.0001
Palafolls obesity	53.0	94.1		56.4	93.7	
Deuremberg obesity	64.3	97.9	<0.0001	39.5	90.7	<0.0001
ECORE-BF obesity	39.8	92.3		44.5	93.0	
CUN BAE obesity	40.8	92.6		44.6	93.1	
Conicity index obesity	7.4	19.6	<0.0001	18.9	47.0	<0.0001

Table IV: Binary logistic regression.

Obesity	Male OR (95% CI)	≥ 50 years OR (95% CI)	Social class III OR (95% CI)	Smokers OR (95% CI)	Non-Physical exercise OR (95% CI)	Non healthy food OR (95% CI)	Alcohol OR (95% CI)
Body mass index	0.88 (0.83-0.93)	0.74 (0.70-0.78)	ns	ns	6.41 (6.11-6.72)	1.71 (1.61-1.81)	5.17 (4.88-5.48)
Relative fat mass	2.67 (2.57-2.77)	1.20 (1.14-1.26)	1.25 (1.07-1.46)	0.86 (0.82-0.89)	3.27 (3.06-3.48)	1.67 (1.56-1.78)	4.97 (4.58-5.39)
Deuremberg formula	0.17 (0.16-0.18)	13.10 (12.21-14.16)	1.48 (1.24-1.76)	0.78 (0.75-0.82)	6.79 (6.30-7.32)	1.98 (1.84-2.13)	4.51 (4.12-4.94)
ECORE-BF	1.18 (1.13-1.23)	3.32 (3.13-3.52)	1.34 (1.12-1.60)	0.71 (0.68-0.74)	8.09 (7.55-8.68)	1.87 (1.75-2.01)	4.67 (4.27-5.11)
CUN BAE	1.11 (1.06-1.16)	3.79 (3.57-4.02)	1.35 (1.12-1.61)	0.71 (0.67-0.75)	8.18 (7.63-8.77)	1.83 (1.70-1.96)	4.66 (4.25-5.10)
Conicity index	2.97 (2.82-3.13)	ns	0.77 (0.61-0.96)	1.36 (1.30-1.43)	1.25 (1.14-1.37)	1.24 (1.13-1.36)	3.26 (3.08-3.46)
Waist to height ratio	3.83 (3.68-4.00)	1.11 (1.06-1.17)	1.38 (1.15-1.65)	0.91 (0.88-0.95)	3.38 (3.15-3.63)	1.80 (1.68-1.93)	5.50 (5.14-5.90)

In the multivariate analysis using binary logistic regression, male, age 50 years and older, social class III, tobacco use, non-heart-healthy eating and not performing regular physical activity were established as covariates.

It was observed that sex, alcohol, physical exercise and healthy food were the variables that affected all the parameters related to cardiovascular risk, whereby the effect of social class and tobacco was less powerful in general. The complete data set is presented in **table IV**.

Discussion

The most important finding of this study is the effect of alcohol consumption on the values of the different scales of overweight and obesity. The multivariate study shows that alcohol is one of the variables studied that most increases the risk of obesity.

This relationship between alcohol consumption and the development of obesity is observed in most of the studies reviewed. A European study of nearly 100,000 men and 159,000 women found a positive association between long-term alcohol consumption and abdominal and general adiposity in men, while in women the association was only found with abdominal adiposity[22]. Other studies assess the influence of different levels of alcohol consumption and obesity, for example a study in 250,000 Chinese adults[23] showed that light drinking decreased the proportion of obese people while heavy drinking increased the number of obese people. An American study[24] indicated that men who consumed two or more drinks per day increased the risk of being overweight, whereas if they consumed four or more drinks per day, the risk of obesity increased. In the same study, women who consumed alcohol had a lower prevalence of obesity. An Australian study[25] of 534 men also showed an increase in obesity in heavy drinkers (5 or more drinks per day).

Other studies showed similar results, one in 7855 French men[26], another in 141 Korean workers[27], a Spanish study in almost 3000 people[28], another in Canadians[29], in Koreans[30] and in English[31] showed similar results. A study of Ugandan adults[32] found no association between alcohol consumption and obesity. The strengths of this study are the large sample size, almost 61,000 workers, and the large number of scales assessing overweight and obesity, namely eleven, including five scales predicting body fat.

The main limitation is that alcohol consumption was self-reported and could not be objectified. Moreover, it is only taken into account if the person consumes alcohol in a significant way, there is no graduation of consumption.

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