Eur J Nutr (2004) 43 : 69–76
DOI 10.1007/s00394-004-0442-x

ORIGINAL CONTRIBUTION

Philippe Rouillier
Marie-Christine Boutron-Ruault
Sandrine Bertrais
Nathalie Arnault
Jean-Jacques Daudin
Jean-Noël Bacro
Serge Hercberg

Drinking patterns in French adult men

A cluster analysis of alcoholic beverages and relationship with lifestyle

Summary *Background* Establishing patterns of alcohol consumption may be useful for investigating the relationship between alcohol and diseases. *Methods* We used a hierarchical agglomerative clustering method to describe the intake of eight types of alcoholic beverages and to determine drinking patterns in a cohort of 1797 men enrolled in a French 8-year intervention study involving nutritional doses of vitamins and minerals, the SU.VI.MAX study. *Results* Cluster 1, referred to as 'abstainers', was defined a priori and included 329 men who drank less than 5 g of alcohol per day. Six drinking patterns were defined in alcohol drinkers, with increasing mean alcohol intake: cluster 2, 'low drinkers', included 670 subjects, who drank little of any type of alcoholic beverage; cluster 3, 'high quality wines', included 584 men with a high intake of champagne, high quality wines, and high-alcohol aperitifs; cluster 4, 'beer and cider', included 190 subjects with a high intake of beer and cider; cluster 5, 'digestives', included 54 men with a specifically high consumption of digestive beverages; cluster 6, 'local wines', included 238 subjects with a high intake of local wines and low-alcohol aperitifs; cluster 7, 'table wines', included 61 men with a high intake of table wines and high-alcohol aperitifs. These clusters were significantly associated with socioeconomic and lifestyle variables such as place of residence, occupation, mean caloric intake and distribution of energy intake throughout the day, body mass index, and smoking habits. *Conclusions* They will be useful in future studies of the relationship between alcohol intake and medical conditions or risk factors.

Key words alcohol drinking – epidemiologic methods – cluster analysis – life style – diet

Received: 3 April 2003
Accepted: 10 July 2003
Published online: 6 January 2004

P. Rouillier · M.-C. Boutron-Ruault (✉) · S. Bertrais · N. Arnault · S. Hercberg
ISTNA
CNAM
5 rue Vertbois
75003 Paris, France
Tel.: +33-1/5301-8041
Fax: +33-1/5301-8070
E-Mail: boutron@cnam.fr.

J.-J. Daudin
Institut National Agronomique Paris-Grignon
UMR INAPG-INRA Biométrie
Paris, France

J.-N. Bacro
Université de Montpellier 2
Dépt. Sciences Mathématiques
Montpellier, France

Introduction

Although the relationship between alcohol intake and several diseases, and especially cardiovascular risk, has been extensively studied [1, 2], the influence of specific types of alcohol has been less thoroughly investigated [3]. Statistical techniques are increasingly being used to summarise the relationship between various conditions and diet by establishing dietary patterns [4]. However, these techniques have rarely been used to establish patterns of alcohol drinking in the general population [5], whereas patterns of drinking have often been studied in alcoholics [6, 7]. We attempted to determine drinking patterns among men included in a cohort study, the SU.VI.MAX dietary intervention study [8], taking advantage of the wide range of alcohol drinking and the large variety of alcoholic beverages consumed in France; we then related these patterns to socio-economic and lifestyle characteristics. These patterns will later be used in association with various medical conditions, and especially cardio-vascular disease.

EJN 442

European Journal of Nutrition (2004) Vol. 43, Number 2

Materials and methods

Subjects

Subjects were participants in the SU.VI.MAX Study, the design of which has been described elsewhere [8]. Briefly, it is a randomised, double-blind, placebo-controlled, primary-prevention trial designed to test the efficacy of daily supplementation with antioxidant vitamins (vitamin C, 120 mg; vitamin E, 30 mg; and beta-carotene, 6 mg) and minerals (selenium, 100 µg; and zinc, 20 mg) at nutrition-level doses (one to three times the daily recommended dietary allowances) in reducing several major health problems in industrialised countries, especially the main causes of premature death, cancers and cardiovascular diseases. A total of 12,735 eligible subjects (7,679 women aged 35–60 years and 5,056 men aged 45–60 years) were enrolled in all regions of France in 1994, and are being followed up for eight years. Participants underwent a yearly visit consisting, every other year, of either biological sampling or clinical examination. They also regularly provided information on health events and dietary intake by filling out computerised questionnaires using the Minitel Telematic Network. Data on baseline characteristics of the participants suggested that the present sample was close to the national population in terms of geographic density, socioeconomic status, and the distribution of various major risk factors for the diseases under study. The SU.VI.MAX study has been approved by the Ethical Committee for Studies with Human Subjects of Paris-Cochin (CCPPRB number 706), and by the "Commission Nationale Informatique et Liberté", CNIL number 334641.

All subjects were encouraged to provide dietary data in the form of 24-hour dietary recalls every two months. For the present study, we included only the 2150 men who had completed at least twelve 24-hour dietary recalls over the first two years of the study and had had no major health event during the first twelve dietary recalls (cancer or cardiovascular disease). We further excluded 8 subjects with reported dietary intakes of less than 800 kcal/day, and 16 men with a very high alcoholic intake of over 100 grams per day, because they represented too small a sample to be studied as a specific pattern. A total of 2126 men were included in the assessment of alcohol consumption.

Dietary assessment

The 24-hour dietary recalls were provided in a random assessment of four weekdays and two weekend days per year [9]. Subjects transmitted the corresponding data via the Minitel Telematic Network or Internet, which connected them to the main SU.VI.MAX computer server. They were helped by conversational facilities of the software and by an instruction manual for the codification of foods, which included photographs for estimating portion sizes. Data on alcohol intake included 37 different alcoholic beverages. We used the first 12 recalls in order to include potential seasonal and weekly variations.

Classification of drinking habits

For each type of alcoholic beverage, consumption was expressed as grams of alcohol per day. In order to have enough consumers in the studied categories of beverages, some alcoholic beverages were aggregated according to their type and degree of alcohol. For wine, we tested both the quality of wine and the wine colour, red, rosé or white, but the latter grouping provided less interpretable results with too few subjects in some groups of drinkers. Therefore, the following eight categories were retained: beer and cider, table wines (red, rosé or white), local wines (red, rosé or white), high quality wines (red, rosé or white), champagne, low-alcohol aperitifs (fruit punch, sweet wine, sangria, kir/royal kir, amer picon/Americano, picon-beer, cocktails), high-alcohol aperitifs (aniseed aperitifs, Whisky – Bourbon, vodka, gin, tequila, rum, Marie-Brisard), and digestives (brandy, liquor).

Anthropometric data

Anthropometric data were obtained at the beginning of the second study year, when about half of the dietary recalls were obtained. Height and weight were measured using standardised procedures and with subjects in their underwear. Body mass index (BMI) was calculated by dividing weight by the square of the height (kg/m^2).

Demographic, socioeconomic and lifestyle variables

These were assessed by means of a questionnaire completed at the beginning of the study. The following variables were studied: age at the twelfth dietary recall (45–49 years, 50–54 years, 55–59 years, 60–64 years), education level (primary school, secondary school or higher education), occupation (white collar workers, farmers/workers, handworkers/shop keepers/self-employed workers, employees, inactive/unemployed, retired), marital status (married/widowed/cohabitation, single, divorced-remarried, divorced-non-remarried), region of residence (Northwest, Southwest, Ile-de-France, Northeast, Southeast), urban/rural living (city, suburbs, rural area). Physical activity was obtained from two questionnaires. A qualitative questionnaire at base-

line inquired about overall physical activity. Subjects were classified as active if they had more than the equivalent of one hour of fast walking per day, mildly active if less than one hour of walking per day, or inactive. A specific and detailed questionnaire inquired about leisure-time physical activity, which was transformed into Met-hour/week. Smoking habits were determined from a detailed questionnaire on present and past habits. They were summarised in the following variables: 1) smoking habits (subjects who had never smoked, ex-smokers and current smokers), 2) life-time smoking in pack-years (p-y) in smokers, in three groups, less than 10 p-y, 10–20 p-y, 20 p-y or more, and 3) intensity in current and in ex-smokers (more than 20 cigarettes per day or not).

Statistical analysis

Statistical analyses were carried out using the SAS (version 8, 1999, SAS Institute Inc., Cary, NC) statistical software package.

Factor analysis

A principal components analysis was performed to describe the structure of the data on the eight types of alcoholic beverages, considered in grams of alcohol per day. We used the correlation matrix in order to standardise the consumed amounts. We decided to place the 329 subjects who consumed 5 grams or less of alcohol per day in a separate group as abstainers, as they could not be studied on the basis of the type of alcohol consumed and represented a large group of subjects. Factor analysis was performed on the remaining 1797 men. To determine the number of factors to be retained, we focused on factors with eigenvalues greater than 1.0, as usually recommended. In this analysis, three factors had eigenvalues greater than 1.0. We then performed a plot of the total variance associated with each component (scree-plot) in order to ensure that this three-factor model was sufficient for our data. Labelling of the factors was primarily descriptive and based on our interpretation of the structure of the data.

Cluster analysis

Cluster analysis was used to divide the study population into a limited number of clusters with maximally differing alcoholic patterns. The hierarchical agglomerative clustering method was used, with Ward's minimum variance method and squared Euclidean distance. Cluster analysis was performed on the eight synthetic variables of alcoholic beverages which were standardised (mean zero and standard deviation one) to adjust for unequal variances of the variables. The hierarchical agglomerative clustering method consists of merging the two closest individuals or clusters to form a new cluster that replaces them and iterating the process with the new group until complete regrouping [10]; it provides a dendrogram (classification tree). The Ward's minimum variance method minimised the within-cluster sum of squares at each step of the algorithm. We determined the number of clusters by using the dendrogram. We then calculated the squared multiple correlation R^2, which is the proportion of variance accounted for by the clusters. The number of clusters was then decided based on two criteria, i. e. a sufficient proportion of variance accounted for by the clusters and large enough groups to be further studied.

Analysis of sociodemographic characteristics

Lifestyle variables were compared between drinking patterns resulting from the cluster analysis using chi-square tests for categorical variables and analysis of variance for continuous variables. All analyses were adjusted for age. For adjusted chi-square tests, age was coded as a categorical variable and the Cochran-Mantel-Haenszel statistics was used [11]. Two-sided tests and p-value < 0.05 were used for statistical significance.

Results

Factor analysis

Factor analysis was used to select the best way of grouping alcoholic beverages. For example, we tested quality of wines versus wine colour, the former providing a better proportion of explained variability with three factors than the latter. We retained the three factors with eigenvalues greater than 1.0. They explained 47.6 % of the total variability. The proportions of variance explained by each factor were respectively 18.6 %, 16.2 %, and 12.8 %. The first factor was negatively associated with most alcoholic beverages, and especially high quality wines, digestive beverages and champagne, whereas it was not correlated with table wines and local wines. The second factor was positively associated with high quality wines and champagne, and inversely with table wines, local wines, beer and cider and high-alcohol aperitifs. The third factor was positively associated with beer and cider and less so with high-alcohol aperitifs, and was inversely associated with low-alcohol aperitifs and less so with local wines.

Cluster analysis

Cluster analysis identified 6 patterns among the men who drank at least 5 g/day of alcohol. Subjects who drank less than 5 g/day constituted a 7th cluster (termed

'abstainers'). These 6 groups accounted for 31.7 % of the total variability. We classified them according to the mean alcohol intake in each cluster. Mean alcohol intakes by type of alcoholic beverage are described for each cluster in Table 1. Cluster 1, referred to as 'abstainers', included 329 men whose mean ± SD alcohol intake was 1.9 ± 1.6 g/day. Cluster 2, or 'low drinkers', included 670 subjects whose mean alcohol intake was 15.7 ± 8.9 g/day. Their intake of any type of alcoholic beverage was lower than in the entire studied population. Clusters 3 to 6 had mean daily alcohol intakes ranging from 31.6 to 36.2 g. Cluster 3, that of 'high quality wines', included 584 men, and was characterised by a high intake of champagne, high quality wines, and high-alcohol aperitifs. Cluster 4, 'beer and cider', included 190 subjects and was characterised by a high intake of beer and cider. Cluster 5, 'digestives', included 54 men whose behaviour was close to that of cluster 3, except that they had a specific high consumption of digestive beverages. Cluster 6, referred to as 'local wines', included 238 subjects, and was characterised by a high intake of local wines and of low-alcohol aperitifs. Cluster 7, that of 'table wines', included 61 men, and was characterised by a high intake of table wines as well as high-alcohol aperitifs. This group also had the highest mean total intake of alcohol, 46.2 ± 14.7 g/day.

Lifestyle characteristics of the clusters

Characteristics of each cluster are described as mean ± SD in Table 2 for quantitative lifestyle variables and as proportions in Table 3 for qualitative variables.

Drinking patterns were significantly associated with age, with the mean age ranging from 53.6 to 55.2, and abstainers were the youngest while table wine drinkers were the oldest.

The proportion of energy at each meal also significantly differed according to drinking patterns. The proportion of energy consumed at breakfast was lowest in table wine drinkers, while the proportion of energy at snacking was highest in beer and cider drinkers and in abstainers. Body mass index was lowest in low drinkers and abstainers, and highest in drinkers of table wines.

Table 1 Mean intake of alcohol, energy, and types of alcohol beverages in grams of alcohol per day (SD) by drinking pattern

	General population n = 2126	Abstainers n = 329	Low drinkers n = 670	High quality wines n = 584	Beer and cider n = 190	Digestives n = 54	Local wines n = 238	Table wines n = 61	ANOVA p-value
Mean alcohol intake	23.1 (18.4)	1.9 (1.6)	15.7 (8.9)	31.6 (17.1)	33.2 (17.0)	33.5 (20.6)	36.2 (18.6)	46.2 (14.7)	< 0.0001
Mean energy intake free of alcohol	2161 (465)	2092 (487)	2142 (472)	2187 (434)	2212 (473)	2082 (400)	2193 (450)	2255 (560)	0.006
Champagne	0.6 (1.1)	0.1 (0.4)	0.2 (0.3)	1.4 (1.7)	0.5 (0.9)	1.2 (1.5)	0.3 (0.6)	0.2 (0.5)	< 0.0001
High quality wines	10.2 (11.1)	0.8 (1.1)	7.6 (5.6)	18.7 (14.0)	12.0 (11.1)	15.4 (12.8)	8.2 (6.6)	6.1 (5.9)	< 0.0001
Local wines	4.8 (8.2)	0.2 (0.6)	2.8 (3.7)	4.7 (6.5)	4.0 (5.3)	7.4 (10.6)	17.5 (14.3)	3.9 (4.4)	< 0.0001
Table wines	3.4 (7.0)	0.1 (0.5)	2.9 (4.7)	2.2 (4.0)	4.0 (6.4)	3.0 (4.4)	4.2 (6.3)	31.5 (12.7)	< 0.0001
Beer and cider	2.3 (4.1)	0.3 (0.7)	1.2 (1.6)	2.0 (2.8)	11.4 (6.1)	2.5 (3.2)	2.1 (3.3)	2.3 (3.0)	< 0.0001
Digestives	0.1 (0.3)	0.01 (0.05)	0.03 (0.2)	0.1 (0.2)	0.07 (0.2)	1.6 (1.0)	0.1 (0.2)	0.1 (0.3)	< 0.0001
High-alcohol aperitifs	0.6 (1.1)	0.1 (0.3)	0.3 (0.4)	1.2 (1.8)	0.5 (0.8)	0.8 (0.9)	0.5 (0.6)	1.0 (1.2)	< 0.0001
Low-alcohol aperitifs	0.9 (1.6)	0.2 (0.5)	0.5 (0.6)	1.0 (1.3)	0.7 (0.9)	1.2 (1.9)	2.9 (3.2)	0.7 (1.2)	< 0.0001

Table 2 Association between drinking patterns and lifestyle (quantitative variables, mean (sd), analysis of variance adjusted on age)

	Abstainers n = 329	Low drinkers n = 670	High quality wines n = 584	Beer and cider n = 190	Digestives n = 54	Local wines n = 238	Table wines n = 61	ANOVA p-value
Age (years)	53.6 (4.8)	53.8 (4.7)	54.2 (4.8)	53.9 (4.5)	53.7 (4.4)	54.9 (4.8)	55.2 (4.9)	0.01
% Energy intake at breakfast	21.7 (8.2)	20.2 (6.8)	17.7 (6.7)	18.6 (7.4)	17.4 (6.9)	17.5 (6.9)	16.0 (9.9)	< 0.0001
% Energy intake at lunch	38.0 (7.1)	40.2 (7.2)	39.6 (7.6)	38.8 (7.3)	40.6 (7.6)	40.7 (7.7)	42.9 (7.8)	< 0.0001
% Energy intake at dinner	33.0 (7.6)	33.6 (7.0)	36.9 (8.0)	35.1 (7.5)	36.3 (8.5)	36.1 (7.6)	36.0 (7.8)	< 0.0001
% Energy intake at snacking	7.3 (6.3)	6.0 (5.0)	5.8 (5.2)	7.5 (5.4)	5.7 (4.3)	5.7 (4.6)	5.1 (5.7)	< 0.0001
BMI (kg/m^2)	24.9 (3.2)	24.9 (3.0)	25.5 (3.0)	25.2 (3.1)	25.7 (3.1)	25.2 (2.8)	25.9 (2.8)	0.03
Leisure time physical activity (MET-h/week)	29.3 (39.4)	23.1 (23.7)	22.4 (23.4)	23.9 (23.6)	22.1 (21.0)	24.3 (25.6)	20.9 (25.0)	0.006
TV time (mn)	123.8 (75.3)	117.7 (61.7)	118.6 (59.0)	126.0 (68.1)	113.9 (55.4)	121.0 (64.2)	141.8 (77.7)	0.14

Table 3 Association between drinking patterns and lifestyle (qualitative variables, chi-square adjusted on age)

%	Abstainers n = 329	Low drinkers n = 670	High quality wines n = 584	Beer and cider n = 190	Digestives n = 54	Local wines n = 238	Table wines n = 61	Chi^2 p-value
Education level								0.01
Primary school	23.8	25.3	22.1	21.0	17.3	30.3	39.3	
Secondary school	38.3	33.5	38.3	37.6	42.3	35.0	44.3	
Higher education	38.0	41.2	39.5	41.4	40.4	34.6	16.4	
Occupation								< 0.001
White collar	33.1	40.4	44.4	46.2	45.1	35.1	21.3	
Employee	38.4	32.4	29.6	24.2	27.4	33.3	37.7	
Handworkers/shop keepers/self-employed	6.5	3.8	5.6	4.8	9.8	2.6	1.6	
Farmers/workers	4.6	4.6	3.5	4.3	3.9	4.8	11.5	
Inactive/unemployed	6.5	4.1	5.1	5.9	9.8	3.7	11.5	
Retired	10.8	14.7	11.8	14.5	3.9	20.8	16.4	
Marital status								0.02
Married/widowed/cohabitation	83.9	88.7	85.6	85.4	84.0	88.4	86.4	
Single	5.7	2.6	2.0	6.2	4.0	3.4	1.7	
Divorced-remarried	3.8	4.3	7.0	4.5	10.0	5.2	1.7	
Divorced-non-remarried	6.6	4.3	5.4	3.9	2.0	3.0	10.2	
Region of residence								< 0.001
Ile-de-France	27.8	23.6	32.2	30.2	29.4	24.7	13.3	
Northwest	17.8	17.1	17.3	25.1	13.7	14.0	11.7	
Southwest	20.0	24.8	22.5	15.6	23.5	33.2	40.0	
Northeast	10.3	11.6	10.8	16.2	9.8	7.2	5.0	
Southeast	24.1	22.9	17.2	12.8	23.5	20.9	30.0	
Urban/rural living								0.09
City	67.8	68.0	65.0	68.2	66.7	62.6	50.0	
Suburbs	17.5	16.1	19.3	19.6	13.7	17.0	21.7	
Rural area	14.7	15.8	15.8	12.3	19.6	20.4	28.3	
Smoking habits								< 0.001
Never smokers	50.3	40.9	28.3	31.7	37.3	30.8	25.4	
Ex-smokers	40.3	49.0	58.4	53.8	51.0	55.7	50.8	
Current smokers	9.4	10.0	13.3	14.5	11.8	13.5	23.7	
Life-time smoking in smokers								0.13
< 10 pack-years	45.6	54.9	44.2	43.3	46.9	46.9	43.2	
(10–20) pack-years	25.3	57.6	31.0	33.1	28.1	30.5	31.8	
≥ 20 pack-years	29.1	17.5	24.8	23.6	25.0	22.6	25.0	
Intensity of smoking in ex- or current smokers								0.02
≤ 20 cigarettes/day	77.7	86.9	77.5	81.5	81.3	85.4	77.3	
> 20 cigarettes/day	22.3	13.1	22.5	18.5	18.7	14.6	22.7	
Body mass index								0.05
< 25 kg/m^2	55.9	54.5	46.4	48.8	41.3	52.0	42.9	
≥ 25 kg/m^2	44.1	45.5	53.6	51.2	58.7	48.0	57.1	
Overall physical activity								0.49
High	53.5	53.5	51.3	54.8	47.2	57.6	63.9	
Moderate	23.2	23.6	24.8	25.5	17.0	23.5	18.0	
Low	23.2	22.9	23.9	19.7	35.8	18.9	18.0	

Leisure time physical activity was highest in abstainers, and lowest in drinkers of table wines.

Regarding qualitative variables (Table 3), education and occupation were significantly associated with drinking patterns. The proportion of subjects with only primary education was highest in drinkers of table wines and of local wines (39.3 and 30.3 respectively). The proportion of farmers or workers was highest in table wine drinkers. Area of residence was strongly associated with drinking patterns. The highest proportions of abstainers, and of drinkers of high quality wine, of beer and cider and of digestives were observed in the Ile-de-France. The highest proportions of low drinkers, and of drinkers of local wines or of table wine were ob-

European Journal of Nutrition (2004) Vol. 43, Number 2

served in the Southwest area. Smoking habits differed significantly according to drinking patterns. The proportion of non-smokers was highest among abstainers while high-quality wine drinkers had the highest proportion of ex-smokers, and table wine drinkers the highest proportion of current smokers. The proportion of subjects with overall high physical activity was highest in table wine drinkers and lowest in drinkers of digestives.

In summary, low drinkers and abstainers had rather similar characteristics. However, compared to low drinkers, abstainers were more often employees or handworkers, less often married, and spent more time at leisure physical activity. They ate more snacks and were more often non-smokers, but when smoking, tended to smoke more heavily than low drinkers. Drinkers of high quality wine were characterised by a high proportion of energy at dinner and a low leisure time physical activity; they included a high proportion of white collar workers and often lived in the Ile-de-France area around Paris. Drinkers of beer and cider had a rather high level of education, included a high proportion of white collar workers, and often lived in the Northeast or Northwest regions; they were often single, often ate snacks, and often watched TV. Drinkers of digestives spent little time watching TV, or having leisure physical activity; they had a high level of education. They were mostly either white collar workers, inactive or unemployed, and they had the highest proportion of overweight subjects. Drinkers of local wines included a high proportion of retired men and a low proportion of inactive or unemployed men and handworkers. They had often stopped smoking, and had rarely been heavy smokers. They often lived in the Southwest, had a rather high level of physical activity and a rather low proportion of overweight. Table wine drinkers were the highest alcohol consumers, had the lowest level of education, spent the most time watching TV, and had the lowest level of leisure physical activity, but the highest level of overall physical activity. Only one fourth of them had never smoked, and they tended to smoke heavily. They also often tended to be overweight. They included the lowest proportion of white collar workers and the highest proportion of farmers/workers and inactive/unemployed subjects. They also included the highest proportion of non-remarried divorced subjects. They lived more often in the southern regions and less often in the northern regions and the Ile-de-France.

Discussion

This study enabled us to determine seven well-defined drinking patterns in a cohort of 2126 adult men. These patterns were established on the basis of mean alcohol intake and of preferential intake of specific beverages. To our knowledge, this is the first study based on cluster analysis of drinking habits and not on an a priori definition of the groups according to their preferential intake of wine, beer or spirits, as is usually performed [12, 13]. In France, all drinkers of alcoholic beverages drink wine, so that a group of wine drinkers, as opposed to non-wine drinkers, cannot be identified as is the case in countries with different habits. Our study also enabled us to determine the importance of quality of wines in France. Foods or alcoholic drinks tend to be highly correlated, so that it may be difficult to attribute an effect to a specific drink or food. Therefore, the major advantage of establishing clusters of drinking or eating habits is that they summarise preferences in foods or drinks within a group of subjects of similar behaviour. This thus proves to be very useful for focusing on preventive or curative measures.

One strength of our study is that we considered the whole range of alcohol intake, whereas most studies of drinking patterns are performed solely on alcoholics, i. e. very high alcohol consumers [14, 15]. Such studies have their own purpose: they are aimed at identifying sub-groups of alcoholics who need specific medical and social care [16–18]. Some studies also include lifestyle variables together with drinking habits when establishing clusters [19–22]. In our study, only alcoholic intake was considered to establish clusters, and lifestyle variables were used only in a second step in order to characterise our clusters.

Our a priori definition of abstainers as drinkers of less than 5 grams of alcohol per day may be questioned. Their mean alcohol intake was negligible, below 2 grams of alcohol per day, and might have been the result of alcohol from some food preparations. Therefore, we considered them as abstainers. They shared several characteristics with low-drinkers, but also had specific characteristics such as occupation, physical activity, and eating and smoking habits which justified a posteriori the fact that we had placed them in a separate group. Some of them may be teetotalers who had previously been alcoholics, and it may prove important to study them separately in relation to diseases [23].

Cluster analysis was performed with the hierarchical agglomerative clustering method. In epidemiological studies, dietary or drinking patterns are usually derived from scores obtained after factor analysis or from an iterative k-means clustering method [24–26]. The latter method is usually preferred in case of a very large data set and limited statistical facilities. However, it provides no dendrogram, and therefore is based on an a priori choice of a number of clusters. Comparison between different methods has already been realised [27]. The factor scores method involves subjective decision-making in the course of the analysis, especially regarding the variables retained for establishing the scores. In addition, this method does not enable defining of clusters,

but rather attributes a score for each of the defined factors. Therefore, small groups may not be identified. In clustering methods, each subject belongs to a cluster, which makes interpretation simpler. A limitation of these methods is that there is no gold standard for determining the number of clusters. With the k-means method, this number has to be chosen a priori, whereas with the hierarchical agglomerative clustering method that we used, the dendrogram or classification tree helps to determine the number of clusters, and to choose a more or less refined description of the data [10]. The limits of our study are the limits inherent in a cohort of volunteers. Although it has been determined by previous analyses of the data that our cohort is quite representative of the French population in terms of geographical and age distribution [28], some population groups are always under-represented in studies using volunteers, especially the very low social classes. This would have an impact on the definition of drinking patterns. For example, we had to exclude very high alcohol drinkers, above 100 g per day, because they represented a subgroup of 16 people who could not be studied as such. However, such subjects are of great interest when studying the general population. This may also explain our two small groups of, respectively, 54 aperitif drinkers and 61 table wine drinkers, who nonetheless had very specific profiles in terms of lifestyle characteristics, and who are probably quantitatively important in the general population. Identifying patterns is not a pure exercise in itself. It may prove important to identify high-risk groups and to set up specific prevention measures. This study was performed in order to identify whether drinking patterns influence the relationship between alcohol and cardiovascular diseases [29].

Our study of drinking patterns identified strong relationships between these patterns and sociodemographic and lifestyle variables such as area of residence, physical activity, but also body mass index and distribution of energy across meals. Some of these variables, although not all of them [30], have also been found to be related to drinking patterns, especially in heavy drinkers [12]. One of the reasons for these discrepancies might be the original approach that we used, which may discriminate more accurately between groups with different lifestyles and high-risk habits. We will further investigate our above-defined clusters in relation to clusters of dietary habits in order to better understand the relationship between drinking and food habits and in relation to risk factors or diseases, in order to help public health professionals set up preventive measures.

References

1. Rimm E (2001) Alcohol and coronary heart disease: can we learn more? Epidemiology 12:380–382
2. Rimm EB, Giovannucci EL, Willett WC, Colditz GA, Ascherio A, Rosner B, Stampfer MJ (1991) Prospective study of alcohol consumption and risk of coronary disease in men. Lancet 338: 464–468
3. Mukamal KJ, Conigrave KM, Mittleman MA, Camargo CA, Jr, Stampfer MJ, Willett WC, Rimm EB (2003) Roles of drinking pattern and type of alcohol consumed in coronary heart disease in men. N Engl J Med 348:109–118
4. McCann SE, Marshall JR, Brasure JR, Graham S, Freudenheim JL (2001) Analysis of patterns of food intake in nutritional epidemiology: food classification in principal components analysis and the subsequent impact on estimates for endometrial cancer. Public Health Nutr 4:989–997
5. Slater MD, Basil MD, Maibach EW (1999) A cluster analysis of alcohol-related attitudes and behaviors in the general population. J Stud Alcohol 60: 667–674
6. Epstein EE, Labouvie E, McCrady BS, Jensen NK, Hayaki J (2002) A multi-site study of alcohol subtypes: classification and overlap of unidimensional and multi-dimensional typologies. Addiction 97:1041–1053
7. Peters D (1997) A natural classification of alcoholics by means of statistical grouping methods. Addiction 92: 1649–1661
8. Hercberg S, Preziosi P, Briancon S, Galan P, Triol I, Malvy D, Roussel AM, Favier A (1998) A primary prevention trial using nutritional doses of antioxidant vitamins and minerals in cardiovascular diseases and cancers in a general population: the SU.VI.MAX study – design, methods, and participant characteristics. SUpplementation en VItamines et Mineraux AntioXydants. Control Clin Trials 19:336–351
9. Mennen LI, Bertrais S, Galan P, Arnault N, Potier DC, Hercberg S (2002) The use of computerised 24 h dietary recalls in the French SU.VI.MAX Study: number of recalls required. Eur J Clin Nutr 56: 659–665
10. Saporta G (1990) Probabilités, Analyse des Données et Statistique. Technip (ed), Paris, France
11. Landis RJ, Heyman ER, Koch GG (1978) Average partial association in three-way contingency tables: a review and discussion of alternative tests. International Statistical Review 46:237–254
12. Kraus L, Augustin R, Bloomfield K, Reese A (2001) Der Einfluss regionaler Unterschiede im Trinkstil auf riskanten Konsum, exzessives Trinken, Missbrauch und Abhängigkeit. Gesundheitswesen 63:775–782
13. Rodondi PY, Narring F, Michaud PA (2000) Drinking behaviour among teenagers in Switzerland and correlation with lifestyles. Eur J Pediatr 159: 602–607
14. Bennett ME, McCrady BS, Johnson V, Pandina RJ (1999) Problem drinking from young adulthood to adulthood: patterns, predictors and outcomes. J Stud Alcohol 60:605–614
15. Carpenter KM, Hasin DS (2001) Reliability and discriminant validity of the Type I/II and Type A/B alcoholic subtype classifications in untreated problem drinkers: a test of the Apollonian – Dionysian hypothesis. Drug Alcohol Depend 63:51–67
16. Johnson EO, Pickens RW (2001) Familial transmission of alcoholism among nonalcoholics and mild, severe, and dyssocial subtypes of alcoholism. Alcohol Clin Exp Res 25:661–666
17. Johnson EO, van den Bree MB, Pickens RW (1996) Subtypes of alcohol-dependent men: a typology based on relative genetic and environmental loading. Alcohol Clin Exp Res 20:1472–1480

18. Westerberg VS, Miller WR, Harris RJ, Tonigan JS (1998) The topography of relapse in clinical samples. Addict Behav 23:325–337
19. Schuit AJ, van Loon AJ, Tijhuis M, Ocke M (2002) Clustering of lifestyle risk factors in a general adult population. Prev Med 35:219–224
20. Ma J, Betts NM, Hampl JS (2000) Clustering of lifestyle behaviors: the relationship between cigarette smoking, alcohol consumption, and dietary intake. Am J Health Promot 15:107–117
21. Patterson RE, Haines PS, Popkin BM (1994) Health lifestyle patterns of US adults. Prev Med 23:453–460
22. Burke V, Milligan RA, Beilin LJ, Dunbar D, Spencer M, Balde E, Gracey MP (1997) Clustering of health-related behaviors among 18-year-old Australians. Prev Med 26:724–733
23. Cryer PC, Saunders J, Jenkins LM, Neale H, Cook AC, Peters TJ (2001) Clusters within a general adult population of alcohol abstainers. Int J Epidemiol 30: 756–765
24. Liang W, Shediac-Rizkallah MC, Celentano DD, Rohde C (1999) A population-based study of age and gender differences in patterns of health-related behaviors. Am J Prev Med 17:8–17
25. Hauser J, Rybakowski J (1997) Three clusters of male alcoholics. Drug Alcohol Depend 48:243–250
26. Chen H, Ward MH, Graubard BI, Heineman EF, Markin RM, Potischman NA, Russell RM, Weisenburger DD, Tucker KL (2002) Dietary patterns and adenocarcinoma of the esophagus and distal stomach. Am J Clin Nutr 75:137–144
27. Togo P, Osler M, Sorensen TI, Heitmann BL (2001) Food intake patterns and body mass index in observational studies. Int J Obes Relat Metab Disord 25: 1741–1751
28. Hercberg S, Galan P, Preziosi P, Roussel AM, Arnaud J, Richard MJ, Malvy D, Paul-Dauphin A, Briancon S, Favier A (1998) Background and rationale behind the SU.VI.MAX Study, a prevention trial using nutritional doses of a combination of antioxidant vitamins and minerals to reduce cardiovascular diseases and cancers. SUpplementation en VItamines et Mineraux AntioXydants Study. Int J Vitam Nutr Res 68: 3–20
29. Nanchahal K, Ashton WD, Wood DA (2000) Alcohol consumption, metabolic cardiovascular risk factors and hypertension in women. Int J Epidemiol 29: 57–64
30. de Bourdeaudhuij I, van Oost P (1999) A cluster-analytical approach toward physical activity and other health related behaviors. Med Sci Sports Exerc 31:605–612