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Association between dietary and beverage consumption patterns in the SUN (Seguimiento Universidad de Navarra) cohort study

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Abstract

Objective: The objective of the present study was to determine the dietary patterns of a Mediterranean cohort and relate them to the observed patterns of beverage consumption.

Design: Prospective cohort study. Dietary habits were assessed with a semi-quantitative FFQ validated in Spain. A principal components factor analysis was used to identify dietary patterns and to classify subjects according to their adherence to these patterns. The association between adherence to each dietary pattern and beverage consumption was assessed cross-sectionally. In a longitudinal analysis (2-year follow-up), the relationship between adherence to the baseline dietary patterns and the likelihood of changing alcohol consumption was ascertained.

Setting: The SUN (Seguimiento Universidad de Navarra) study is conducted in Spain.

Subjects: In total, 15 073 university graduates were included in the analyses.

Results: Two major dietary patterns were identified. We labelled them as 'Western dietary pattern' (WDP) and 'Mediterranean dietary pattern' (MDP). Higher adherence to the WDP was associated with higher consumption of carbonated beverages and whole-fat milk (P for trend $<0{\cdot}001$), while higher adherence to the MDP was associated with higher consumption of decaffeinated coffee, orange juice, other natural juices, diet carbonated drinks, low-fat milk and bottled water (P for trend $<0{\cdot}001$). Participants with higher adherence to the WDP were less likely to decrease their alcohol consumption during follow-up (OR between extreme quintiles = 0·68; 95 % CI 0·56, 0·84). By contrast, participants with higher adherence to the MDP were less likely to increase their alcohol consumption (OR = 0·66, 95 % CI 0·46, 0·95).

Conclusion: In this cohort of university graduates, a healthier dietary pattern was associated with a healthier pattern of beverage consumption.

Keywords
Diet
Mediterranean
Cohort
Milk
Alcohol
Carbonated beverages

In the examination of the relationship between diet and disease, interest has drifted from the study of single nutrients to analysis of the adherence to different dietary patterns. In this context, two different food patterns have been defined because they are related to the risk of different diseases: (i) a protective 'prudent pattern' rich in fruits, vegetables, fish, poultry and whole grains; and (ii) a deleterious 'Western' pattern rich in red meat, processed meat, French fries, high-fat dairy products, refined grains, and sweets and desserts[1]. In southern Europe, interest has focused on the so-called 'Mediterranean diet', similar to the 'prudent pattern' but rich in olive oil[2], which has also been associated with a decreased risk of CVD, cancer and other illnesses[3,4]. In contrast, although several studies have reported major dietary patterns among adults, very little information discussing dietary patterns among young people or analysing beverage patterns is available.

As far as beverage consumption is concerned, in the context of the current overweight and obesity epidemic, dietary strategies recommend a water intake of 1–2 litres

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daily and a higher consumption of beverages with no or little energy than of beverages with more energy[5]. However, according to current beverage patterns, water is being replaced by other less healthy, high-energy beverages. In the US population, the consumption of soft drinks has risen[6]. This increase has also been observed in Europe and, specifically, in Spain where the consumption of sugar-sweetened soft drinks has grown by 21 % from 1991 to 2001[7].

Sugar-sweetened soft drinks have been shown to be associated with a higher risk of weight gain[8–10]. Other beverages, such as red wine and tea, have been reported to have some potentially beneficial effects on vascular reactivity[11]. Furthermore, moderate consumption of red wine has been associated with a reduced risk of type 2 diabetes mellitus[12].

Some authors have linked beverage and dietary patterns in order to determine a relationship between them, finding that subjects with healthier food patterns have also healthier beverage patterns[13].

The aim of the present study was to assess the adherence to different dietary patterns of a free-living Mediterranean cohort of university graduates and to relate them to their beverage consumption patterns.

Materials and methods

Study population

The SUN (Seguimiento Universidad de Navarra) study is a prospective cohort study based on university graduates and designed in collaboration with the Harvard School of Public Health. Its methodology is similar to that used in the two large American cohorts, the Nurses' Health Study and the Health Professionals' Follow-up study. Information is collected using self-administered questionnaires sent by postal mail every two years. The recruitment of participants started in December 1999 and is permanently ongoing, as this is a dynamic cohort study. Up to January 2007, 16 431 participants had answered both the baseline and the first 2-year follow-up questionnaire (hereafter, baseline = Q_0 and follow-up = Q_2).

Those participants who reported extremely low or high values for total energy intake ($<2{\cdot}51$ MJ/d (<600 kcal/d) in men and $<1{\cdot}67$ MJ/d (<400 kcal/d) in women or $>17{\cdot}57$ MJ/d (>4200 kcal/d) in men and $>14{\cdot}64$ MJ/d (>3500 kcal/d) in women; n 1358) were excluded. Finally, data from 15 073 participants remained available for the analysis.

The Institutional Review Board of the University of Navarra (Clínica Universitaria) approved the study protocol. Voluntary completion of the first self-administered questionnaire was considered to imply informed consent.

Dietary patterns assessment

Dietary habits were ascertained at baseline (Q_0) through a semi-quantitative FFQ (136 food items) previously validated in Spain[14]. Nutrient scores were calculated as frequency multiplied by nutrient composition of specified portion sizes, where frequencies were measured in nine categories (6+ times daily/4–6 times daily/2–3 times daily/once daily/5–6 times weekly/2–4 times weekly/once weekly/1–3 times monthly/never or almost never) for each food item. Nutrient intake scores were computed using an *ad hoc* computer program developed specifically for this aim. A trained dietitian updated the nutrient databank using the latest available information in food composition tables for Spain[15,16].

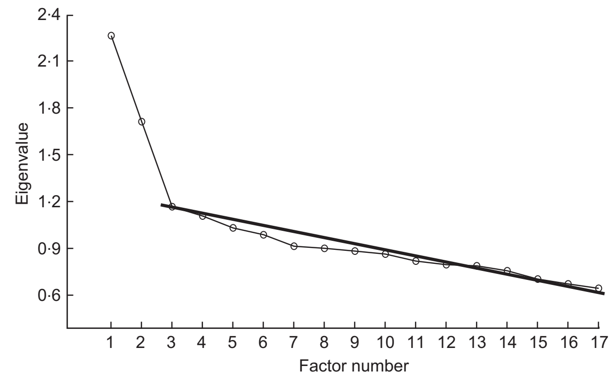

Fig. 1 Scree plot of eigenvalues plotted against their factors to identify the number of factors to be extracted

The 136 food items included in the semi-quantitative FFQ were grouped into twenty-five predefined food categories. A principal components analysis based on the stratified food groups was conducted to identify the major dietary patterns in the cohort[17]. The food groups 'other fats' and 'cooked potatoes' were excluded for the subsequent analyses because their measures of sampling adequacy were lower than 0·70. The approach used to determine the number of factors to be extracted was the scree plot examination[17]. This method consists of plotting the extracted factors against their eigenvalues to identify distinct breaks in the slope of the plot. To determine where the break occurs, a straight line is drawn through the lower eigenvalues. That point where the factors curve above the line identifies the number of factors to be extracted (Fig. 1). Afterwards, the two obtained factors were rotated using the Varimax orthogonal rotation.

We used the factor loading matrix to extract the weights (factor loadings) for each food group. Food groups such as 'butter', 'margarine', 'home-made pastries', 'chocolate and sweets', 'sugar' and 'legumes', with factor loadings lower than 0·30, were excluded from the final model[18]. After considering the weights of the food groups in each factor, we labelled the first factor as 'Western dietary pattern' (WDP) and the second factor as 'Mediterranean dietary pattern' (MDP) (Table 1). These variables were calculated as linear combinations of the standardized intake of the seventeen remaining food groups weighted

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Table 1 Factor loading matrix for the two major dietary patterns identified by using food consumption data: the SUN (Seguimiento Universidad de Navarra) prospective cohort study

	Dietary pattern	
	Western	Mediterranean
Processed meat products	0·55	
Red meat	0·57	
Poultry		0·32
Fast food	0·60	
Eggs	0·42	
Fish and seafood		0·55
Low-fat dairy products*		0·45
Whole-fat dairy products*	0·37	
Whole-wheat bread		0·35
Nuts		0·30
Processed meals	0·40	
Processed pastries	0·39	
Sauces	0·43	
Refined grains	0·33	
Vegetables		0·69
Fruits		0·59
Olive oil		0·34

Absolute values <0·30 were not included in the table.
The first factor explained 13·3 % of the total variance and the second factor explained 10·1 % of the total variance.
*Milk can be considered a beverage so it has been excluded from this food grouping.

by their factor score coefficients. These coefficients were generated automatically by the statistical software[17]. Finally, the continuous variables thus built were categorized into quintiles.

Beverages assessment

The baseline FFQ (Q_0) also collected information about habits of beverage consumption and included specific items for spirits, total wine, red wine, beer, soda drinks, diet drinks, coffee, decaffeinated coffee, natural orange juice, other natural juices, canned juices, whole-fat and low-fat milk, tap water and bottled water.

Assessment of changes in dietary habits

The follow-up questionnaire (Q_2) included questions regarding change in the consumption of several food items (dairy products, meat, fish, butter, olive oil, vegetables and alcohol) since Q_0 (no change, increase or decrease in consumption).

Assessment of other variables

The baseline assessment (Q_0) included other questions as well. Sociodemographic (e.g. gender, age, marital status), anthropometric (e.g. weight and height), lifestyle and health-related habits (e.g. smoking status and physical activity during leisure time) and medical history variables (e.g. prevalence of chronic diseases such as cancer, CVD or ulcer) were collected.

The physical activity questionnaire included information about seventeen activities including walking, jogging, bicycling, static bicycling, swimming, racquet sports, soccer, aerobic, judo, trekking, skiing, sailing and gardening. To quantify the volume of activity during leisure time, an activity metabolic energy equivalent task (MET) index was computed by assigning a multiple of the resting metabolic rate (MET score) to each activity[19], the time spent in each of the activities was multiplied by the MET score specific to each activity, and then the MET scores were summed over all activities to obtain a value of overall weekly MET-hours. In the validation study carried out in a sub-sample of the cohort, there was a significant correlation between the physical activity measured objectively through an accelerometer and the overall weekly MET-hours assessed using this questionnaire ($r = 0{\cdot}51$, $P < 0{\cdot}001$)[20].

Participants were classified as suffering from CVD at baseline if they had reported at least one of the following conditions: myocardial infarction, stroke, atrial fibrillation, paroxysmal tachycardia, coronary artery bypass grafting or other revascularization procedures, heart failure, aortic aneurism, pulmonary embolism or peripheral venous thrombosis.

Statistical analysis

Linear regression models were used to assess the association between adherence to the identified dietary intake profiles and the pattern of beverage consumption in Q_0. Tests of linear trend across increasing quintiles of dietary pattern adherence were calculated for each type of beverage. For that purpose, the median value of adherence was imputed for each quintile of adherence.

Non-conditional logistic regression models were fit to assess the relationship between adherence to the identified dietary patterns and the likelihood of changing alcohol consumption over two years in our cohort (reported in Q_2). The reference category was no change in consumption. Odds ratios and their 95 % confidence intervals were calculated by considering the lowest quintile of adherence as the reference category. Potential confounders included in both multivariate models (linear and logistic) were: gender, age, BMI, physical activity during leisure time, smoking, presence of any severe disease at baseline (cancer, CVD or ulcer) and total energy intake.

Results

Table 2 shows the main characteristics of the participants according to extreme quintiles of WDP and MDP adherence. WDP adherence was higher among younger participants, men, smokers and single persons.

Participants belonging to the highest quintile of MDP were older, physically more active, and more likely to be women, married subjects and ex-smokers. Moreover, the history of diseases such as CVD, cancer or ulcer was higher among those subjects with higher adherence to this dietary pattern.

Tables 3 and 4 show the associations between quintiles of WDP and MDP adherence and the baseline consumption

Table 2 Main characteristics of participants according to extreme quintiles of adherence* to the defined dietary patterns: the SUN (Seguimiento Universidad de Navarra) prospective cohort study

	Western dietary pattern					Mediterranean dietary pattern				
	Q1		Q5			Q1		Q5		
	Mean	SD	Mean	SD	P†	Mean	SD	Mean	SD	P†
n	3014		3014			3014		3014		
Age (years)	42·2	13·2	34·5	11·2	<0·001	36·1	11·8	39·9	13·0	<0·001
Baseline BMI (kg/m^2)	23·7	3·7	23·7	3·6	0·78	23·5	3·7	23·6	3·6	0·13
Physical activity during leisure time (MET-h/week)	24·0	22·5	25·0	23·2	0·10	20·4	18·9	27·7	26·5	<0·001
Energy intake (MJ/d)	7·44	2·32	12·79	2·03	<0·001	8·50	2·79	11·41	2·44	<0·001
Energy intake (kcal/d)	1777·8	555·6	3057·5	485·0	<0·001	2031·4	666·8	2725·9	584·0	<0·001
Gender (%)										
Women	65·0		42·9		<0·001‡	46·9		68·6		<0·001‡
Marital status (%)					<0·001‡					<0·001‡
Single	39·4		56·5			52·2		41·9		
Married	53·5		41·3			43·8		52·5		
Divorced	3·8		0·9			2·0		2·9		
Widowed	1·9		0·4			0·9		1·6		
Other	1·3		0·9			1·0		1·1		
Smoking (%)					<0·001‡					<0·001‡
Never smoker	43·8		49·9			48·8		45·5		
Ex-smoker >10 years	17·0		7·6			8·5		15·3		
Ex-smoker 3–9 years	11·0		6·8			7·2		10·3		
Ex-smoker <3 years	8·5		7·7			8·5		8·7		
Current smoker	19·7		28·0			27·0		20·2		
History of diseases (%)										
Cardiovascular	6·1		3·6		<0·001‡	3·2		5·2		<0·001‡
Cancer	5·0		1·8		<0·001‡	2·8		4·1		0·003‡
Ulcer	6·7		4·8		0·002‡	4·5		5·5		0·08‡

*Q1, 1st quintile (lowest); Q5, 5th quintile (highest).
†*P* from Student *t* test.
‡*P* from χ^2 test.

of several beverages in the cohort. Subjects in the lowest quintile of adherence were considered as the reference category. Higher adherence to the WDP was associated with higher consumption of sugared soda drinks (mean consumption (g/d): 22·7, 24·8, 28·2, 30·4 and 43·8 for increasing quintiles, *P* for trend <0·001) and whole-fat milk (mean consumption (g/d): 47·5, 61·1, 65·9, 67·7 and 71·1 for increasing quintiles, *P* for trend <0·001). Furthermore, the consumption of other beverages considered healthy beverages, such as decaffeinated coffee, orange and other natural juices, diet soda drinks and low-fat milk, was lower among those subjects with high adherence to this pattern (*P* for trend <0·001 in all analyses). The consumption of tap water increased monotonically while the consumption of bottled water decreased significantly across increasing quintiles of adherence to the WDP (Table 3). Consumption of alcoholic beverages such as spirits, wine and beer was lower in the upper quintiles of WDP adherence although a non-significant linear trend was observed for spirits consumption (*P* for trend <0·001 for wine and beer, *P* for trend = 0·165 for spirits).

In our cohort, the consumption of healthy beverages such as decaffeinated coffee, orange and other natural juices, sugarless soda drinks, low-fat milk and also of bottled water was higher among subjects with higher adherence to the MDP (Table 4). An inverse statistically significant dose–response relationship was found for whole-fat milk, soda drinks and alcoholic beverages, except red wine, and MDP adherence (red wine, mean consumption (g/d): 25·3, 26·9, 26·2, 28·1 and 22·4 for increasing quintiles, *P* for trend = 0·105).

Participants with high adherence to the WDP showed a lower probability of decreasing alcohol consumption during the first two years of follow-up. Specifically, the multivariate OR of decreasing alcohol consumption for the highest quintile of adherence to the WDP was 0·68 (95 % CI 0·56, 0·84). On the contrary, participants with high adherence to the MDP showed a higher probability of decreasing alcohol consumption (adjusted OR = 1·31; 95 % CI 1·11, 1·56).

Discussion

Two major dietary patterns were found in the present analysis of the first 15 073 participants of the SUN cohort study with 2 years of follow-up. This finding is consistent with a previous report of our group assessing 3847 university graduates[21]. Adherence to a Western diet (WDP) was associated with the consumption of several kinds of beverages such as sugar-sweetened soft drinks and

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Table 3 Consumption of beverages according to quintiles of adherence* to the Western dietary pattern: the SUN (Seguimiento Universidad de Navarra) prospective cohort study

	Western dietary pattern										
	Q1		Q2		Q3		Q4		Q5		
	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	*P* for trend
Total alcohol consumption (g/d)	5·7	5·4, 6·1	5·8	5·3, 6·3	5·3	4·8, 5·9	4·7	4·1, 5·2	3·6	2·9, 4·3	<0·001
Spirits (g/d)	2·8	2·5, 3·1	3·2	2·7, 3·7	2·8	2·2, 3·3	2·5	1·9, 3·0	2·6	1·9, 3·2	0·165
Total wine (g/d)	32·2	29·7, 34·8	32·4	28·7, 36·1	29·9	26·0, 33·8	25·0	20·9, 29·2	18·8	13·9, 23·7	<0·001
Red wine (g/d)	27·2	24·9, 29·6	27·7	24·5, 30·9	25·6	22·2, 29·0	22·0	18·3, 25·7	16·3	12·0, 20·5	<0·001
Beer (g/d)	45·2	41·5, 48·8	43·7	37·7, 49·6	41·4	35·2, 47·6	38·0	31·3, 44·7	25·6	17·8, 33·4	<0·001
Carbonated drinks (g/d)	22·7	20·4, 25·0	24·8	20·6, 29·1	28·2	23·7, 32·6	30·4	25·5, 35·2	43·8	38·2, 49·4	<0·001
Diet drinks (g/d)	25·0	21·8, 28·2	20·2	16·0, 24·3	16·0	11·7, 20·4	17·0	12·3, 21·7	12·7	7·2, 18·2	<0·001
Coffee (g/d)	58·6	56·3, 60·9	59·1	55·8, 62·4	56·8	53·4, 60·3	56·0	52·3, 59·8	51·1	46·7, 55·4	<0·001
Decaffeinated coffee (g/d)	15·5	14·3, 16·7	12·1	10·5, 13·7	11·4	9·7, 13·1	10·6	8·8, 12·4	6.5	4·4, 8·5	<0·001
Natural orange juice (g/d)	60·8	56·8, 64·9	46·1	41·3, 50·9	33·4	28·4, 38·5	22·6	17·1, 28·1	3·9	0, 55·2	<0·001
Other natural juices (g/d)	12·4	10·5, 14·3	8·7	6·4, 11·0	4·4	2·0, 6·8	0·8	0, 3·4	0	0, 0	<0·001
Canned juices (g/d)	17·3	15·1, 19·5	14·8	11·5, 18·1	14·1	10·6, 17·5	13·9	10·1, 17·6	10·1	5·7, 14·4	0·002
Whole-fat milk (g/d)	47·5	43·3, 51·8	61·1	52·8, 69·4	65·9	57·1, 59·6	67·7	62·3, 81·2	71·1	60·2, 82·0	<0·001
Low-fat milk (g/d)	200·6	192·5, 208·7	174·5	163·3, 185·7	140·6	128·9, 152·3	110·4	97·7, 123·0	44·1	29·5, 58·9	<0·001
Tap water (g/d)	502·3	484·2, 520·5	536·4	492·5, 580·5	538·4	493·2, 583·8	566·8	519·4, 614·3	559·8	507·6, 612·1	<0·001
Bottled water (g/d)	311·0	294·2, 327·8	251·5	212·1, 290·2	214·6	174·4, 254·8	179·7	137·6, 221·8	147·1	101·0, 192·3	<0·001

Adjusted for age (years), gender, energy intake (MJ/d), BMI (four categories), physical activity during leisure time (quartiles, MET-h/week), smoking (six categories), marital status (four categories) and several diseases (CVD, cancer and ulcer).
*Q1–Q5, 1st quintile (lowest)–5th quintile (highest).

Table 4 Consumption of beverages according to quintiles of adherence* to the Mediterranean dietary pattern: the SUN (Seguimiento Universidad de Navarra) prospective cohort study

	Mediterranean dietary pattern										
	Q1		Q2		Q3		Q4		Q5		
	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI	*P* for trend
Total alcohol consumption (g/d)	6·6	6·2, 7·0	6·9	6·4, 7·4	6·6	6·1, 7·1	6·5	6·0, 7·0	5·1	4·6, 5·7	<0·001
Spirits (g/d)	4·5	4·0, 4·9	4·5	4·0, 5·0	4·6	4·1, 5·2	4·1	3·5, 4·6	3·7	3·2, 4·3	0·001
Total wine (g/d)	30·1	27·4, 32·7	31·6	28·0, 35·3	30·8	27·0, 34·5	33·0	29·2, 36·8	25·0	20·9, 29·0	0·012
Red wine (g/d)	25·3	22·9, 27·6	26·9	23·7, 30·1	26·2	23·0, 21·0	28·1	24·7, 31·4	22·4	18·9, 26·0	0·105
Beer (g/d)	57·2	52·8, 61·7	61·0	55·1, 66·8	54·4	48·5, 60·4	52·4	46·3, 58·6	38·9	32·5, 45·4	<0·001
Carbonated drinks (g/d)	60·3	56·1, 64·5	43·3	39·2, 47·5	38·4	34·1, 42·6	28·2	23·9, 32·6	17·6	13·0, 22·1	<0·001
Diet drinks (g/d)	16·7	13·8, 19·6	16·3	12·2, 13·1	22·3	18·1, 26·5	25·8	21·5, 30·1	37·8	33·3, 42·3	<0·001
Coffee (g/d)	57·5	55·3, 59·8	59·6	56·3, 62·8	60·1	56·8, 63·4	58·3	54·9, 61·7	56·7	53·1, 60·3	0·336
Decaffeinated coffee (g/d)	9·9	8·9, 10·9	10·3	8·8, 11·9	10·3	8·7, 11·9	12·2	10·6, 13·8	14·1	12·4, 15·8	<0·001
Natural orange juice (g/d)	36·2	33·0, 39·3	43·7	38·9, 48·5	49·2	44·3, 54·1	57·0	52·0, 62·0	65·8	60·5, 71·0	<0·001
Other natural juices (g/d)	8·0	6·6, 9·3	7·4	5·2, 9·7	9·0	6·7, 11·3	11·9	9·6, 14·3	16·1	13·6, 18·6	<0·001
Canned juices (g/d)	22·0	19·8, 24·3	20·4	17·2, 23·7	20·6	17·2, 23·9	18·3	14·9, 21·8	17·7	14·1, 21·3	0·011
Whole-fat milk (g/d)	131·5	124·6, 138·3	96·3	88·3, 104·3	74·3	66·1, 82·5	50·6	42·2, 59·0	15·0	6·2, 23·9	<0·001
Low-fat milk (g/d)	123·3	116·2, 130·3	149·2	138·1, 160·3	164·5	153·1, 175·8	180·9	169·2, 192·5	210·4	198·2, 222·7	<0·001
Tap water (g/d)	549·2	531·6, 566·7	606·7	563·7, 649·6	591·2	547·6, 634·7	582·5	538·1, 626·8	585·6	539·7, 631·4	0·213
Bottled water (g/d)	201·1	187·4, 214·7	216·6	181·1, 252·0	257·6	221·6, 293·6	306·2	269·5, 342·8	371·2	333·2, 409·1	<0·001

Adjusted for age (years), gender, energy intake (MJ/d), BMI (four categories), physical activity during leisure time (quartiles, MET-h/week), smoking (six categories), marital status (four categories) and several diseases (CVD, cancer and ulcer).
*Q1–Q5, 1st quintile (lowest)–5th quintile (highest).

whole-fat milk. On the other hand, adherence to a Mediterranean diet (MDP) was associated with the consumption of healthier beverages such as decaffeinated coffee, orange and other natural juices, diet soda drinks and low-fat milk.

The WDP identified in our cohort shares common characteristics with those found in other large cohort studies such as the Nurses' Health Study and the Health Professionals' Follow-up Study[1]. These patterns are characterized by a high consumption of certain food items such as red and processed meats, refined grains, sweets and desserts. The harmful effect of the so-called Western diet has been documented in several studies. Recently, Esmaillzadeh *et al.* reported that women in the highest quintile of adherence to the WDP had greater probability of developing the metabolic syndrome (OR = 1·68; 95 % CI 1·10, 1·95) compared with women in the lowest quintile[22]. Deleterious effects of this pattern have also been reported for other disorders such as cancer[23,24], CVD[25–27], obesity[28] and diabetes[29], as well as for different biomarkers of pathological conditions[30–32].

The defined MDP found in the present study is characterized by a high consumption of low-fat dairy products, fish, whole-wheat bread, nuts, vegetables, fruits and olive oil. Similar components are included in the traditional Mediterranean diet defined a priori by Trichopoulou *et al.*[3]. The beneficial effects of the Mediterranean diet have been widely examined[3,4,33–35]. Prospective studies such as the EPIC (European Prospective Investigation into Cancer and Nutrition)–Greek cohort have shown a decrease in mortality for all causes, CVD and cancer among subjects who follow this dietary pattern[3]. The ATTICA study found lower levels of C-reactive protein, IL-6, homocysteine and fibrinogen among those subjects with high adherence to the Mediterranean diet[33]. Recently, similar results have been obtained in the PREDIMED (Prevención con Dieta Mediterránea) study, a clinical trial of primary prevention of CVD[34].

The current interest of nutritional epidemiology is the study of these and other dietary patterns and their relationship with several diseases or health conditions. But what is the role of different beverage consumption patterns on disease risk? And what is the contribution of beverage patterns to the health effects reported for several dietary patterns? Although these questions have not been disentangled yet, the role of different beverages on health outcomes has been analysed in several studies.

An increased risk of weight gain has been observed among subjects with high consumption of sugar-sweetened drinks[8,36]. Artificially sweetened soft drinks have been associated with increased risk for different types of cancer and mortality[37,38]. The consumption of cola, but not of other soft drinks, has also been related to lower bone mineral density in women[39]. Drinking patterns are associated with the risk of developing dental caries as well. Specifically, this risk is increased when soft drinks are predominant and is decreased when water, juices and milk are prevailing[40]. Moreover, an inverse relationship between juice consumption and metabolic syndrome prevalence has been reported[41]. Nevertheless, juice consumption has been related to increased weight gain among children with established overweight or at risk of developing it[42]. The consumption of low-fat dairy products has been inversely associated with hypertension[43]. Although coffee intake elevates blood pressure acutely, no association has been found between its intake and incident hypertension[44]. What is more, coffee consumption may reduce the risk of type 2 diabetes[45,46]. With regard to mortality, coffee has shown an inverse relationship with mortality due to cardiovascular and inflammatory diseases[47].

However, the association between the consumption of a specific beverage and the consumption of others has not yet been clearly elucidated. Similarly and as far as we know, scarce data exist regarding the relationship between the consumption of a type of beverage and the adherence to a particular dietary pattern, and information is lacking on the characteristics of populations who consume different types of beverages[13,48–50]. Duffey and Popkin found that people with adherence to an unhealthy dietary pattern had also an unhealthy beverage pattern[13]. However, whereas an inverse relationship between coffee consumption and adherence to the WDP and no significant association between its consumption and adherence to the MDP were found in the present SUN data analysis, coffee consumption has been inversely associated with the so-called Healthy Eating Index (HEI)[48]. Forshee *et al.* also reported a positive association with the HEI for fruit drinks, carbonated soft drinks, tea and low-energy fruit drinks consumption, although the associations for tea and low-energy fruit drinks were statistically significant only among women[48]. In pre-school children, a beverage pattern rich in fruit juice was associated with high HEI and high nutrient intake, whereas HEI was lower in pre-school children consuming more high-fat milk[49]. In addition, in school-aged children, a beverage pattern rich in high-fat milk was related to a high micronutrient intake while soda and sweetened drinks were related to a lower micronutrient intake[49]. As far as the HEI is concerned, this index was higher in school-aged children with a beverage pattern rich in high-fat milk[49]. It has also been observed that high-energy and soft/juice drinks consumption is lower among people with a healthier dietary pattern[50], a finding which is consistent with our data. Beside this, moderate wine consumption has been related to a healthier dietary pattern whereas beer and spirits consumption has been inversely associated with salad consumption[51]. In the present study we also found an inverse linear trend between beer and spirits consumption and adherence to the MDP, whereas the linear trend for red wine consumption was not statistically significant. Moderate red

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wine consumption (around 25 g/d) was found in all quintiles of adherence.

The present results suggest that consumers of sugar-sweetened beverages like soft drinks have a different food pattern from those who consume non-energy and diet beverages. This particular population is the same population whose subjects follow a WDP rich in fast foods, processed meals, processed pastries, refined grains, red meat, meat products and other food factors that have been shown to be associated with long-term weight gain[27] with similar effect to that of sugar-sweetened beverages[8,35]. Therefore, the risk of adverse health outcomes might be increased among this particular population. This fact should be taken into account as one of the best ways to decrease energy intake in the implementation of health policy programmes targeting these particular populations, because food and beverage consumption seem to be closely linked. Thus, it seems that dietary patterns are predictors of beverage consumption and both dietary and beverage consumption patterns could be used to predict disease risk.

A potential limitation of the present study is related to the use of self-reported information. Although the validity and reliability of our semi-quantitative FFQ have been demonstrated[14], the validation study was conducted prior to the development of our cohort and did not include any of its members. Therefore, non-differential misclassification may exist and would be likely to bias the estimates towards the null. However, if that were the case, we would expect the true associations to be higher than those found in the present analyses.

For future analyses regarding diet–disease associations in epidemiological studies not only dietary patterns and lifestyle-related variables should be considered. Beverage patterns should be considered as well, because of the probability that all of them operate together on disease risk.

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