Public Health Nutrition: 10(2), 168–176 DOI: 10.1017/S1368980007246592

Trends in food availability determined by the Food and Agriculture Organization's food balance sheets in Mediterranean Europe in comparison with other European areas

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Submitted 29 November 2005: Accepted 19 July 2006

Abstract

Objective: The aims of this study were to assess the changes that have occurred in food patterns in Europe over the last 40 years based on food availability data and to compare the stability of the traditional Mediterranean diet in the south of Europe in this period.
Design: An ecological study carried out on the basis of Food and Agriculture Organization food balance sheets for three geographical areas of Europe (Mediterranean, north and east) over two time periods: 1961–1963 and 1998–2000. The average availability of total energy, energy provided from macronutrients and food groups was calculated for each area and each period studied.
Results: Over the last 40 years total energy availability and energy availability from lipids have increased considerably in the three European areas, while the percentage of energy from carbohydrates has fallen. The greatest changes have occurred in Mediterranean Europe, with an increase of 20.1% in total energy availability, an increase of 48.1% in energy availability from lipids and a fall of 20.5% from carbohydrates. Moreover, Mediterranean Europe showed a significant fall in the energy supplied by cereals (29.9%) and wine (55.2%), while the contribution of milk (77.8%) and dairy products (23.6%) increased.
Conclusions: The results of this study suggest that European Mediterranean countries should take nutrition policy action to maintain their traditional healthy food pattern, with a cultural added value. This implies actions at all levels, including raising awareness of consumers, collaboration with the food sector and a call to set the agenda of the concerned politicians and stakeholders.

Keywords
Food availability
Mediterranean diet

Different epidemiological studies and some intervention trials suggest that the so-called 'Mediterranean diet' is a protective factor against major chronic diseases[1–7].

The Seven Countries Study carried out in the late 1970s[2] showed that life expectancy was much greater in the Mediterranean region than in Northern European countries, the USA or Japan, while the rates of ischaemic heart disease, certain types of cancer and other chronic illnesses were lower. The authors suggested that these differences might be due to several lifestyle factors, in particular the food pattern typical of these populations. Similar results have been observed in other ecological studies such as the MONICA project[5].

No generally accepted definition of the Mediterranean diet exists, although it has been defined as the traditional food pattern typical of Mediterranean countries in the mid-20th century[8,9]. The most significant features attributed to the pattern are a high intake of vegetables, legumes, fruits, nuts and unrefined cereals, a high intake of olive oil, but a low intake of saturated lipids, a moderately high intake of fish, a low to moderate intake of some dairy products (mostly in the form of cheese or yoghurt), a low intake of meat, and a regular but moderate intake of wine[8].

However, debate continues among the scientific community with regard to its defining features because of the enormous differences between food patterns in the region and the potential development of these patterns over time[10–14]. Several authors have attempted to find an objective definition to compare the so-called Mediterranean diets and eventual changes. This is the case of the Mediterranean Adequacy Index (MAI), suggested by Fidanza and colleagues, which relates the percentage of energy provided to the average diet by food items traditionally present in Mediterranean diets versus the percentage of energy provided by food items that are not typically Mediterranean[15].

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In recent years, food patterns have been defined on the basis of how food items are grouped by means of either classificatory or data-reducing statistical techniques, rather than *a priori* definitions of food patterns. Thus, the aims of this study were to assess the changes that have occurred in food patterns based on food availability in Europe over the last 40 years, and to compare the stability of the traditional Mediterranean diet in the south of Europe in this period.

Methods

On the basis of the Food Balance Sheets (FBSs) which form part of the statistical databases of the FAO[16] (Food and Agriculture Organization of the United Nations), the evolution of food availability over time (between the period 1961–1963 and the period 1998–2000) in three geographically and culturally different groups of European countries is compared. Average food availability was estimated for each of the two 3-year periods studied.

The three areas studied were: Southern or Mediterranean Europe (Spain, Portugal, Italy, Greece, France, Cyprus and Albania), Northern Europe (the UK, Sweden, Norway, Finland, Germany, Ireland, Denmark and Iceland) and Eastern Europe (Czechoslovakia, Poland, Bulgaria, Hungary and Romania). The data for Czechoslovakia in the period 1998–2000 were an arithmetical average, weighted by the number of inhabitants in this period in the present Czech Republic and Slovakia. Criteria of geographical, socio-economic and cultural similarity were applied to select the countries in each group. The countries grouped in the Mediterranean area include all the European countries in geographical contact with the Mediterranean Sea, with the exception of the former Yugoslavia, where reliable data are difficult to obtain because of the recent political changes and the fragmentation into several countries. The Northern European group consists of countries that are grouped together for geographical and socio-economic reasons, and which have remained in a relatively stable position in recent decades. Finally, the Eastern European group of countries is smaller, due to the political changes which have led to the separation and appearance of several countries, which has made it difficult to monitor food availability over such a long time scale in countries such as Russia.

The information supplied in FBSs considered for this study was the following: (1) the total food supply available in each country, estimated as the sum of production and imports minus exports; (2) food use, including animal feed, seed for agricultural use and human food, plus losses during food transport, storage and processing; and (3) the available food supply per capita per day, in grams and kilocalories of macronutrients from different foodstuffs. The per capita amounts offered by FBSs are the result of dividing the annual totals for each foodstuff by the population of the country in the year in question. The total energy contribution from carbohydrates was estimated as the difference between total energy and the sum of energy from fat, protein and alcohol. This study deals with the same food groups classification used in the original FBS.

To obtain the arithmetical average for each group of countries analysed, the figures were weighted according to the number of inhabitants in each country during the period studied, according to the statistical databases of the FAO World Health Organization. The average number of inhabitants in the three groups of countries studied over the periods 1961–63 and 1998–2000 were, respectively, 148 614 000 and 180 934 336 for Mediterranean Europe, 150 757 659 and 169 319 990 for Northern Europe and, finally, 80 997 660 and 94 842 036 for Eastern Europe.

The results for macronutrients (lipids, proteins and carbohydrates) and for each food or group of foods were expressed as an energy percentage of the total caloric value of the diet (TCV, or total available energy) per capita per day.

Statistical methods

Statistical analysis of the data was carried out using the statistical software package SPSS (v 12.0). The results obtained for each nutrient and foodstuff are expressed as the mean $\pm$SD (standard deviation), together with the percentage of change in each group of countries during the time periods studied. Univariant analysis of variance with *post hoc* analysis by the Bonferroni test, weighted by the average number of inhabitants in each geographical area over the period of time, was used to compare results between the groups of countries. The level of statistical significance was set at $P < 0.05$.

On a second level of analysis, we computed the MAI as defined by Alberti-Fidanza *et al.*[15] for each country in both periods of study. The MAI compares the percentage of energy supplied to the average diet by food groups that traditionally belong to the so-called Mediterranean diet, i.e. bread, cereals, legumes, potatoes, vegetables, fruit, fish, red wine, olive oil and seed oils, in relation to the percentage of energy supplied by non-traditional Mediterranean foods, i.e. milk, cheese, meat, eggs, animal fat and margarines, sweet beverages, cakes, pies, cookies (biscuits) and sugar. This approach allows for standardisation between countries. Paired *t*-tests were used to compare mean computed indices in both study periods.

We also performed an *a posteriori* definition of food patterns by means of factor analysis. Data on the structure of nutrient intake were analysed in conjunction with data on per capita food consumption for both study periods. Thus, a wide set of sample characteristics was selected to describe the multidimensional phenomenon of food consumption patterns.

Factor analysis aims to identify underlying dimensions behind a set of variables, i.e. factors. These factors explain the relationships amongst an original set of variables with a minimum loss of information or maximum explained variance. The communality indicates the proportion of the variance of original variables explained by the factor solution. The cumulative variance reflects the proportion of total variance of all original variables explained by the set of derived factors. Factor scoring coefficients can be regarded as correlation coefficients between the original variables and the factors extracted. A positive scoring coefficient indicates that the original variable is positively associated with the factor component; a negative coefficient indicates an inverse association. In this study, the variables are the contribution of food groups to energy intake and the percentage of energy provided by macronutrients. The method used for extraction was principal components with Varimax rotation. Only loadings >0.70 were considered significant, given the relatively small sample size. The factor scores generated were subsequently used in cluster analysis to classify countries according to the homogeneity of the factor scores related to the dimensions of food consumption patterns. Factor scores used in cluster analysis are calculated by multiplying the original value of the variable by the coefficient of the factor score corresponding to the relationship between the variable i and the factor j. The aim of cluster analysis in this case is to group countries according to their characteristics as measured through a set of indicators, in this case factor scores identify sets of countries that display homogeneity in food patterns.

Results

When the overall food availability results were analysed, the trend observed in the three groups of countries studied was similar. Total energy and percentage energy from fat available have considerably increased over the last 40 years, while the percentage energy from carbohydrates has fallen and that of proteins has remained practically constant.

Total energy availability per person per day was lower in the Mediterranean countries in the 1960s than in the other two European areas (Table 1). Over the last 40 years, there has been a major increase in energy availability in all the three areas analysed, though the increase was quantitatively greater in the Mediterranean countries.

Energy availability from fats (Table 1) was significantly lower in the Mediterranean ($P < 0.001$) and eastern countries than in the north in the period 1961–1963. During the last 40 years, energy from fat has considerably increased in all three European regions. The greatest increase occurred in the Mediterranean area, where the average increase was 48.1%, compared with a 3.8% increase in the north ($P < 0.001$) and 25.6% in the east ($P = 0.007$), close to the values for Northern Europe.

The increase in energy from vegetable fats had the greatest contribution to the observed higher energy from fat. This source is still greater in the Mediterranean countries (Table 1). Nevertheless, it should be pointed out that in the Mediterranean area the availability of fat from animal sources has increased the most (average increase of 50.4% versus a fall of 17% in the north and an increase of 4.1% in the east), and is even greater than the increase in the availability of fats from vegetable sources (average increase of 45.7%).

In the 1960s, energy availability from carbohydrates was significantly higher in the Mediterranean and Eastern Europe than in the north. Over the period studied, a general reduction in the availability of carbohydrates was observed in all three European regions. The greatest changes occurred in Mediterranean Europe, with an average fall of 20.5%, compared with a 7.2% fall in the north ($P < 0.001$) and 12.7% in the east ($P < 0.072$), which resulted in current values that are practically identical to those in Northern Europe (Table 1).

Cereals were staple foods in the 1960s both in the Mediterranean countries and in the east, and provided greater energy availability than in the northern countries. Cereals were the main source of energy in these two areas (Table 2). The availability of cereals, especially in

Table 1 Total energy availability and percentage of energy availability from fat, protein, carbohydrate and alcohol per capita per day in the periods 1961–1963 and 1998–2000 in the three European regions

	Mediterranean		Northern Europe		Eastern Europe	
	1961–1963	1998–2000	1961–1963	1998–2000	1961–1963	1998–2000
Total energy (kJ)	12 343 ± 1046	14 819 ± 753	12 765 ± 794	14 070 ± 439	13 292 ± 786	13 602 ± 828‡
Total fats (%)	26.4 ± 3.1	39.1 ± 2.8	36.9 ± 1.5*	38.3 ± 1.2	23.8 ± 3.8§	29.9 ± 3.7*,§
Vegetable	12.9 ± 3.7	18.8 ± 4.1	10.4 ± 2.4	16.3 ± 2.1	6.9 ± 2.3‡	12.2 ± 1.8‡
Animal	13.5 ± 6.1	20.3 ± 4.9	26.5 ± 3.0*	22.0 ± 1.3	17.0 ± 5.3‖	17.7 ± 3.1
Total protein (%)	11.9 ± 0.7	12.9 ± 0.3	11.3 ± 0.4	11.7 ± 0.6†	11.6 ± 0.4	11.8 ± 0.6‡
Vegetable	6.8 ± 0.9	5.1 ± 0.6	4.7 ± 0.2*	4.8 ± 0.3	7.2 ± 1.1§	6.0 ± 0.9‖
Animal	5.1 ± 1.4	7.7 ± 0.8	6.6 ± 0.4	6.9 ± 0.6	4.4 ± 0.9‖	5.8 ± 0.5†
Carbohydrates (%)	54.5 ± 5.3	43.3 ± 3.4	46.9 ± 1.5†	43.5 ± 1.6	61.2 ± 4.1§	53.4 ± 4.3*,§
Total ethanol (%)	7.2 ± 2.1	4.8 ± 1.0	4.9 ± 1.2	6.5 ± 1.3	3.4 ± 1.2†	5.0 ± 1.4
Wine	5.8 ± 1.6	2.6 ± 0.6	0.4 ± 0.3*	1.0 ± 0.3*	0.8 ± 0.8*	0.7 ± 0.6*

Mean ± standard deviation. Comparisons among groups were performed by univariant analysis of variance with *post hoc* analysis (Bonferroni test). Data were weighted by the average number of inhabitants in each geographical area over the period of time.
Comparisons versus Mediterranean Europe in the same period of time: *$P < 0.001$; †$P < 0.01$; ‡$P < 0.05$.
Comparisons between Northern and Eastern Europe in the same period of time: §$P < 0.001$; ‖$P < 0.05$.

Table 2 Percentage of energy availability in the form of various food groups per capita per day in the periods 1961–1963 and 1998–2000 in the three European regions

	Mediterranean		Northern Europe		Eastern Europe	
	1961–1963	1998–2000	1961–1963	1998–2000	1961–1963	1998–2000
Cereals	38.4 ± 7.1	26.9 ± 4.5	24.3 ± 1.8†	23.8 ± 1.5	47.5 ± 9.6§	36.0 ± 8.1‡,¶
Meat	7.2 ± 3.9	12.8 ± 2.2	10.5 ± 2.5	11.9 ± 1.4	6.7 ± 2.0	9.4 ± 1.5‡
Dairy products	7.2 ± 2.0	8.9 ± 1.8	10.0 ± 2.3	9.3 ± 1.8	7.8 ± 2.1	8.5 ± 1.4
Legumes	1.8 ± 0.9	1.2 ± 0.4	0.6 ± 0.3‡	0.9 ± 0.6	0.9 ± 0.7	0.7 ± 0.3
Nuts	0.9 ± 0.3	1.0 ± 0.3	0.4 ± 0.2†	0.7 ± 0.3	0.2 ± 0.2†	0.2 ± 0.1†,‖
Eggs	1.2 ± 0.2	1.4 ± 0.2	1.6 ± 0.2†	1.3 ± 0.2	1.0 ± 0.2¶	1.3 ± 0.4
Seafood	1.1 ± 0.6	1.5 ± 0.6	0.9 ± 0.4	1.1 ± 0.6	0.3 ± 0.1‡	0.6 ± 0.4
Sweets	8.4 ± 1.2	9.2 ± 1.1	13.2 ± 1.7†	11.7 ± 1.0‡	8.7 ± 3.1¶	11.3 ± 2.7
Olive oil	5.4 ± 3.8	5.6 ± 3.9	0.1 ± 0.1†	0.3 ± 0.1†	0.1 ± 0.1†	0.0 ± 0.1†
Fruit	3.7 ± 1.2	3.7 ± 1.0	3.3 ± 0.8	3.6 ± 0.8	1.8 ± 1.0‡	2.2 ± 0.4‡
Vegetables	3.0 ± 0.5	3.0 ± 0.4	1.2 ± 0.2*	1.7 ± 0.2*	1.7 ± 0.2*	2.5 ± 0.4‖

Mean ± standard deviation. Comparisons among groups were performed by univariant analysis of variance with *post hoc* analysis (Bonferroni test). Data were weighted by the average number of inhabitants in each geographical area for each period of time.
Comparisons versus Mediterranean Europe in the same period of time: *$P < 0.001$; †$P < 0.01$; ‡$P < 0.05$.
Comparisons between Northern and Eastern Europe in the same period of time: §$P < 0.001$; ‖$P < 0.05$; ¶$P < 0.01$.

Mediterranean Europe, has declined sharply over the last 40 years, with an average fall of 29.9% as opposed to a reduction of 2.1% in the north ($P < 0.001$) and 24.2% in the east (no significant difference).

Energy availability from meat and dairy products was lower in Mediterranean and Eastern Europe in the 1960s, but there are now no major differences between the three European regions studied (Table 2). On the other hand, energy availability from wine, which was much higher in Mediterranean Europe, has fallen sharply over the last 40 years, by an average of 55.2%. Energy availability in the form of legumes, nuts, eggs, seafood, sweets, olive oil, fruit and vegetables showed little variation over time (Table 2).

Table 3 shows descriptive results for the MAI computed for the three *a priori* defined regions for 1961–1963 and 1998–2000. For both periods, the computed MAI score was significantly higher in the Mediterranean region. The difference was particularly high between the Mediterranean and Northern European countries. In Southern European countries, the average MAI score decreased significantly by 1.91 score units (95% confidence interval (CI) of the difference 1.13–2.69; $t_{df6} = 5.99$; $P = 0.0009$). The MAIs tended to score higher in Northern European countries in 1998–2000 than in the early 1960s, although the difference was not statistically significant (mean difference −0.08; 95% CI of the difference −0.17 to −0.02). The MAI index computed for Eastern European countries tended to have lower values at the end of the study period, but the difference was not statistically significant.

Factor analysis for the first study period (i.e. 1961–1963) identified four different components, which explained 86.84% of the variance in the model. The Kaiser–Mayer–Olkin test (0.45) suggested a satisfactory fit of the model to the data. Table 4 shows factor scoring coefficients generated from the estimated factor structure.

The first factor was characterised by a greater percentage of energy from total fat and particularly from animal fat and animal protein (animal calories), but showed an inverse relationship with the percentage of energy provided by plant protein, carbohydrates and cereals. The second component was correlated with the percentage of energy supplied by plant fats and oils, calories from nuts, olive oil and fruit (olive oil and nuts). The third component was characterised by higher intakes of ethanol and wine (wine) and the fourth component was characterised by the percentage of energy from protein, dairy products and fish (dairies and fish).

Factor analysis for the second study period (i.e. 1998–2000) identified three different components, which explained 74.15% of the variance in the model (Table 5).

Table 3 Comparison of the Mediterranean adequacy index (MAI computed) between countries in the study in the periods 1961–1963 and 1998–2000

			95% CI			
		Mean ± SD	Lower bound	Upper bound	*F*	*P*
MAI 61–63	Mediterranean Europe	3.39 ± 1.12	2.35	4.42		
	Eastern Europe	2.67 ± 1.45	0.87	4.47		
	Northern Europe	0.78 ± 0.18	0.63	0.93	14.27	0.0002
MAI 98–00	Mediterranean Europe	1.48 ± 0.39	1.12	1.84		
	Eastern Europe	1.36 ± 0.52	0.72	2.00		
	Northern Europe	0.86 ± 0.14	0.74	0.98	6.53	0.0079

SD – standard deviation; CI – confidence interval.

Table 4 Principal components in factor analysis for the period 1961–1963; rotated component matrix of factor scoring coefficients

	Component			
	1	2	3	4
Total energy		−0.7120		
% energy from fat	0.9605			
% energy from animal fat	0.7319			
% energy from seeds and plant fat		0.8889		
% energy from carbohydrates	−0.9649			
% energy from protein				0.9035
% energy from animal protein	0.7309			
% energy from plant protein	−0.9013			
% energy from ethanol			0.9280	
% energy from cereals	−0.9668			
% energy from pulses		0.7719		
% energy from nuts		0.8968		
% energy from olive oil		0.7357		
% energy from fruit		0.8757		
% energy from vegetables				
% energy from wine			0.8872	
% energy from sweets	0.8529			
% energy from meat				
% energy from milk and dairy products				0.7418
% energy from eggs				
% energy from fish				0.7859
% Variance explained	51.25	15.27	11.87	8.44

Extraction method: principal components analysis.
Rotation method: Varimax with Kaiser normalisation.
Percentage variance explained: 86.84.

Table 5 Principal components from factor analysis for the period 1998–2000; rotated component matrix of factor scoring coefficients

	Component		
	1	2	3
Total energy			
% energy from fat	0.8139		
% energy from animal fat	0.7923		
% energy from seeds and plant fat		0.8737	
% energy from carbohydrates	−0.8685		
% energy from protein			0.8956
% energy from animal protein	0.8209		
% energy from plant protein	−0.9285		
% energy from ethanol			−0.7477
% energy from cereals	−0.9195		
% energy from pulses			
% energy from nuts		0.8411	
% energy from olive oil		0.9116	
% energy from fruit		0.8351	
% energy from vegetables			
% energy from wine			
% energy from sweets			
% energy from meat	0.8402		
% energy from milk and dairy products			0.7958
% energy from eggs			
% energy from fish			
% Variance explained	32.91	25.00	16.25

Extraction method: principal components analysis.
Rotation method: Varimax with Kaiser normalisation.
Percentage variance explained: 74.15.

The first factor was characterised by a higher percentage of energy from total fat and, particularly, from animal fats and animal protein and meat (animal source energy), but showed an inverse relationship with the percentage of energy provided by plant protein, carbohydrates and cereals. The second component was correlated with the percentage of energy supplied by plant fats and oils, energy from nuts, olive oil and fruit (olive oil and nuts). The third component was characterised by the percentage of energy from protein and dairy products (dairies), but showed an inverse relationship with ethanol intake. Significant Pearson correlation coefficients between factor scores for both periods were in the range 0.75–0.83.

Cluster analysis classified the countries in this study into two different groups, but the countries assigned to each cluster changed in each study period. Table 6 shows which countries were grouped together in each study period according to this statistical technique, based on estimated factor scores. While in the first period (1961–9163) Spain, Portugal, Italy, Greece, Cyprus, Albania, Romania and Bulgaria were clustered together, only Romania and Albania remained in the same cluster in the second period (1998–2000).

The computed MAI was significantly different between the clusters in each period. The mean MAI for cluster one in the period 1961–1963 was 3.86 ± 0.63, which was significantly higher than the mean index for cluster two (1.03 ± 0.42) in the same period. The MAI computed for cluster one in the 1961–1963 decreased significantly over time.

Discussion

The results of this study show that food habits in the Mediterranean countries have deviated enormously from the traditional pattern of the 1960s, which is generally considered to be the Mediterranean diet, and have tended to move towards the food pattern typical of the northern countries. Among the most significant changes observed in the Mediterranean countries is the fall in the availability of carbohydrates and the increase in the availability of fats, especially those of animal origin.

In fact, throughout the period studied, the average MAI score decreased dramatically in the Mediterranean European countries, whereas no changes in this score were observed in northern countries.

It has been suggested that MAIs, such as those proposed by Alberti-Fidanza *et al.*[15] or Trichopoulou *et al.*[4], could be used to evaluate dietary profiles and compare them with a reference Mediterranean diet. The evolution of these indices over time provides simple and objective information on food pattern changes that are important because these indices have been related to morbidity/mortality when derived from a validated food-frequency questionnaire[4] and when based on FBSs[16]. A thorough review comparing different approaches to computing

https://doi.org/10.1017/S1368980007246592 Published online by Cambridge University Press

Table 6 Countries classified in each cluster per period; comparison of mean ± SD of the MAI between clusters in each period considered

	Cluster 1960–1963		Cluster 1998–2000	
	1	2	1	2
	Spain			Spain
	Portugal			Portugal
	Italy			Italy
	Greece			Greece
	Cyprus			France
	Albania			Cyprus
	Romania			UK
	Bulgaria			Sweden
		France		Norway
		UK		Finland
		Sweden		Germany
		Norway		Ireland
		Finland		Denmark
		Germany		Iceland
		Ireland		Hungary
		Denmark		Bulgaria
		Iceland		Poland
		Hungary		Czech
		Poland	Albania	
		Czechoslovakia	Romania	
MAI 61–63	3.86 ± 0.63	1.03 ± 0.42*	4.30 ± 0.01	1.93 ± 1.39*
MAI 98–00	1.62 ± 0.38	0.92 ± 0.17*	2.00 ± 0.34	1.11 ± 0.36
	Cluster 1: difference MAI60–63/MAI98–00: 2.24 (1.79, 2.69) $t_{df7} = 11.70$ ($P = 0.0000$)	Cluster 2: difference MAI60–63/MAI98–00: 0.12 (−0.09, 0.32) $t_{df11} = 1.24$ ($P = 0.2424$)	Cluster 1: difference MAI60–63/MAI98–00: 2.30 (−0.72, 5.32) $t_{df1} = 9.67$ ($P = 0.0656$)	Cluster 2: difference MAI60–63/MAI98–00: 0.82 (0.27, 1.37) $t_{df17} = 3.13$ ($P = 0.0060$)

SD – standard deviation; MAI – Mediterranean adequacy index.
* $P < 0.001$ versus the cluster 1 in the same period.

indices for evaluating adherence to the Mediterranean diet and their uses has recently been published[17]. However, the MAI has several limitations. How appropiate it is to consider potatoes and seed oils in the numerator as typically healthy foods of the Mediterranean diet could be discussed. Despite limitations, using MAI as a reference standard captures major shifts in food availability trends in recent years, particularly the imbalance due to an increased availability of fat-rich refined products and a reduction in raw vegetable foods.

The present study is based on aggregated data, such as FBSs. The uses and limitations of the FAO's FBSs should be considered when interpreting the results. FBSs are the only source of standardised information on food consumption that enable longitudinal comparisons to be made between a large set of countries and populations and includes nearly all the food products in existence for consumption[18]. In addition, FBSs provide useful data for examining associations between diet and mortality at the national level[18–23].

Certainly FBSs have a number of inherent limitations such as the inaccuracy of data due to the heterogeneity of data sources between countries and over time within the same country. They provide data on food supply and food availability, but not on the amount of food actually consumed[24]. In addition, FBSs do not enable differences by age group, gender, socio-economic level, etc. to be analysed.

The methodology for data collection in FBSs is well established and standardised, but for less developed countries, the coverage and quality of the statistics – especially for food diverted for non-human food uses, such as animal feed, seed and manufacture – limits their reliability[25]. In these countries, FBSs tend to underestimate food availability, while in developed countries the trend is to overestimate food disappearance. A cross-country comparison of dietary estimates at different levels (i.e. FBSs, Household Budgetary Surveys (HBSs) and individual dietary surveys (IDSs)) concluded that FBSs overestimated food consumption compared with IDSs[26]. However, FBSs are the only source of data for all countries for the whole study period (1960–2000), and the data available in Spain from HBSs and IDSs show similar evolution trends[27]. Some authors have suggested that food disappearance data may not be a reliable indicator of change in the case of consumption of fats and oils[28]. The waste (or non-food use) portion of fat and oil disappearance can affect these data. Deep-frying, particularly in food service establishments, can generate significant amounts of waste[29].

However, a review of 52 studies carried out in 19 countries between 1975 and 1988 showed a weak but significant relationship between the FAO figures on the availability of saturated, polyunsaturated and monounsaturated fats and the actual intake of these nutrients in the same population[30].

The time scale covered by our study runs from the period 1961–1963 to the period 1998–2000, thus spanning the longest time scale allowed by this source of information. The reason three consecutive years were included in each period of study was to minimise inter-annual variability in the data.

Analysis of data from FBSs such as the percentage of total energy availability per capita is influenced much less by the age and sex of the population than the absolute values. This also minimises the influence of losses of food and/or nutrients, which also differ from one country to another[18,31–33]. The percentage of total energy is therefore considered a more suitable unit for comparison than the daily amount in grams, and is recommended to be used in epidemiological work[30,32,34].

Results from this study show that food availability in Europe in the early 1960s had different features in each of the three geographical areas studied. Thus, not only was total energy availability lowest in Mediterranean Europe, but energy availability of fats was also low (particularly those of animal origin) and the availability of carbohydrates high. Total energy availability in Eastern Europe was higher than in the Mediterranean area, while the availability of fats was similarly low.

Over the last four decades, the food consumption trend has been similar in the three European areas: (1) an increase in total energy availability; (2) an increase in energy availability from fats; (3) a reduction in energy availability from carbohydrates; and (4) stability in energy availability from proteins. Specifically, the greatest changes in food consumption over this period occurred in Mediterranean Europe. The main trends were: (1) a considerable increase in total energy availability (20.1%); (2) a notable increase in energy availability from lipids (48.1%), particularly those of animal origin (50.4%); and (3) a significant fall in energy availability from carbohydrates (20.5%). The greatest fall in energy availability from cereals (29.9%) and wine (55.2%) was also shown in Mediterranean Europe. Although these changes are a substantial modification of the traditional pattern, Mediterranean Europe still retains some differential traits in its food pattern, including: (1) greater energy availability from olive oil; (2) greater energy availability from wine, vegetables, fruit, nuts and legumes; and (3) lower energy availability from sweets.

Between-country differences in food availability trends between 1961 and 2001 have recently been reported (based on FBSs) among four European, three African Mediterranean countries and Turkey, probably because of the diversity of economic resources, and cultural and religious traditions. The food supply pattern in Greece in the 1990s was the closest to the traditional Mediterranean diet[35]. Other authors have reported similar transition trends in Sardinia and Malta, with the greatest departure from the traditional Mediterranean pattern being found in the latter country[36].

When the evolution trends in food patterns between the 1940s and 1980s were compared using different data sources (FBSs, HBSs and IDSs), consistent changes were found in the Spanish diet. All data sources suggested that the Spanish diet had changed with economic development, but it still maintained the characteristics of the Mediterranean diet[27]. The DAFNE project, which was based on HBSs, showed similar evolution trends in the countries studied to those described by FBSs between the 1980s and the 1990s[37].

Adherence to the Mediterranean diet (based on FBSs) has been compared between Mediterranean EU countries and the other EU countries between 1961 and 1999. The difference between the scores of the two groups of countries decreased from 2.9 in the 1960s to 1.6 in the 1990s, thus showing a gradual shift from the traditional Mediterranean pattern[16]. Similarly, Fidanza *et al.* have described a progressive abandonment of the nutritional characteristics of the reference Italian-Mediterranean diet[38]. Rapid urbanisation, increasing incomes, social, economic and technical changes, and globalisation have influenced these changes[39].

In the present study, we have defined food patterns *a posteriori* using factor analysis, which identified the main factors that explained the variance of the model (i.e. animal source energy, olive oil and nuts for both periods studied; wine, dairy products and fish in the 1960s and only dairy products in the 1998–2000 period). These factors are similar to those considered *a priori* in the definition of the 'Mediterranean diet'. Other studies based on food use data, such as food purchases from HBSs[37], or on individual food consumption[13,40] suggest similar trends. This approach to define food patterns based on FBSs has been used previously[41,42].

We also used cluster analysis to classify the countries in the present study into two groups according to food pattern. In the first period analysed, almost all the *a priori* Mediterranean countries were classified in the same group (except France, whose energy availability from animal fat was higher and whose availability of carbohydrates was lower than those of other Mediterranean countries; data not shown). In the second period analysed (1998–2000), only the Balkan Mediterranean countries with low national income (Albania and Romania) remained in the same group. Cluster analysis has been used in the past to classify countries according to the homogeneity of their dietary patterns and on the basis of both individual food consumption assessment in population studies[43] and FBSs data[44]. This is an objective *a posteriori* method of classification that builds on traditionally used, empirical *a priori* classifications.

Despite some limitations, therefore, this study shows that food availability in Mediterranean Europe, like that in Eastern Europe, has largely converged with the Northern European model. Moreover, the use of *a posteriori* techniques to define food patterns confirms the partial abandonment of the traditional 'Mediterranean diet' in the countries of Southern Europe, the potential health consequences of which have been the subject of many studies[16]. In fact, recent findings from large European cohort studies[4,45] suggest that a high degree of adherence to the Mediterranean diet is associated with a reduction in both total and coronary heart disease (CHD) mortality. In addition, a variant of this diet improved outcomes in patients with CHD[1]. Several mechanisms explaining the association between Mediterranean diet adherence and mortality have been suggested[46–51] which add biological plausibility to the epidemiological evidence that the Mediterranean diet has a protective effect.

Acknowledgements

We wish to thank Alberto Ameijide for his valuable assistance in the statistical analysis. This study was partly supported by two grants from the Instituto de Salud Carlos III, Red de Centros RCMN (C03/08), and Red de Grupos (G03/140), Madrid, Spain.

Contributors: The order in which the authors are listed has been agreed on by the investigators. The first, second and last authors have made the greatest contribution, and wrote the preliminary version. All the authors have contributed equally to the work by discussing and analysing the data and writing the definitive version.

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