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Eur J Nutr (2007) 46:418–427
DOI 10.1007/s00394-007-0681-8

ORIGINAL CONTRIBUTION

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Trends in food availability in Portugal in 1966–2003

Comparison with other Mediterranean countries

Received: 2 May 2007
Accepted: 22 August 2007
Published online: 19 September 2007

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Abstract *Background* Dietary intake has changed considerably in South European countries, but whether those changes were similar between countries is currently unknown. *Aim of the study* To assess the trends in food availability in Portugal and four other Mediterranean countries from 1966 to 2003. *Methods* Food and Agricultural Organization food balance sheets from Portugal, France, Italy, Greece and Spain. Trends were assessed by linear regression. *Results* The per capita availability of calories has increased in Portugal, France, Greece, Italy and Spain in the past 40 years. Portugal presented the most rapid growth with an annual increase of 28.5 ± 2.2 kcal (slope ± standard error), or +1000 kcal overall. In animal products, Portugal had an annual increase of 20.7 ± 0.9 kcal, much higher than the other four countries. Conversely, the availabilities of vegetable and fruit only showed a slight growth of 1.0 ± 0.1 kcal/year and 2.5 ± 0.4 kcal/year, respectively, thus increasing the ration of animal to vegetable products. Olive oil availability increased in all countries with the notable exception of Portugal, where a significant decrease was noted. Wine supply decreased in all five countries; in contrast, beer supply started to take up more alcohol share. Percentage of total calories from fat increased from nearly 25% to almost 35% in Portugal during the study period, mainly at the expenses of calories from carbohydrates, whereas the share of protein showed just a slight increase. Furthermore, fat and protein were increasingly provided by animal products. *Conclusions* Portugal is gradually moving away from the traditional Mediterranean diet to a more Westernized diet as well as France, Greece, Italy and Spain. Noticeably, the trends of diet transition were observed relatively faster in Portugal than in the other four Mediterranean countries.

Key words dietary trends – food habits – Mediterranean diet – Food Balance Sheets – dietary transition

EJN 681

Introduction

Diet-related obesity has been increasing notably worldwide. By 2015, approximately 2.3 billion adults will be overweight and more than 700 million will be obese [46]. In Europe, the epidemic of obesity is one of the most serious public health problems. Its prevalence has tripled in many European countries in the last two decades. Now almost 400 million adults in the Region are estimated to be overweight and about 130 million obese; about 20% of children are overweight, and a third of these are obese [46]. This global problem has been being discussed comprehensively throughout these years since this problem leads to serious health consequences (cardiovascular disease, type II diabetes and cancers) and enormous economic costs [4, 14, 47].

'Mediterranean diet' has been well known as a model for healthy eating which is associated with low rates of obesity and related chronic diseases [48]. It refers to dietary patterns found in olive-growing areas of the Mediterranean region whose common characteristics are: a high monounsaturated/saturated fat ratio; moderate consumption of ethanol, mainly in the form of wine, moderate consumption of diary products, mainly in the form of cheesse; low consumption of meat; high consumption of vegetables, grains and fruit [40, 48]. Thus, the Mediterranean diet is ideally in coincidence with the healthy eating guidelines from WHO: a high intake of vegetables, fruits, pulses, grains and nuts, a high intake of unsaturated fat (olive oil), and a low intake of animal fat. However, while this healthy diet is being widely promoted outside the Mediterranean countries, Mediterranean people are gradually moving away from its traditional and beneficial characteristics [39]. Studies revealed that Mediterranean countries have followed the trend towards higher shares of energy-dense foods, and their intakes of saturated fats, cholesterol and sugar increased in the past years [1, 34], namely among younger generations [41].

Portugal is among one of the countries with the reputation of so-called traditional 'Mediterranean diet'. However, with the great social and economic changes, the prevalence of overweight and obesity has been increasing considerably [22]. This growing trend of overweight and obesity indicates the ongoing diet changes in Portugal. These diet transitions have been described in some studies; however, none has mentioned how fast these diet changes are taking place [24, 33]. Therefore, the objective of the present study was to assess the trends in dietary intake in Portugal for the past 40 years, and to compare these trends with those from other Mediterranean countries.

Methods

Dataset

Dataset used in the present study was derived from the FAO's food balance sheets [9]. Food Balance Sheets are compiled every year by FAO, mainly with country-level data on the production and trade of food commodities. Using these data and the available information on seed rates, waste coefficients, stock changes and types of utilization (feed, food, processing and other utilization), a supply/utilization account is prepared for each commodity in weight terms. The food component of the commodity account, which is usually derived as a balancing item, refers to the total amount of the commodity available for human consumption during the year. Besides commodity-by-commodity information, the FAO food balance sheets also provide total food availability estimates by aggregating the food component of all commodities including fishery products. From these values and the available population estimates, the per person dietary energy, protein and fat supplies are derived and expressed on a daily basis[1]. The food balance sheets thus provide comprehensive data on food availability at country level. The data on population estimates (per capita availability of energy, protein and fat on a daily basis from food commodities) were imported into our dataset to analyze the dietary trends. Five countries typical for the 'Mediterranean diet' were selected: France, Greece, Italy, Spain and Portugal.

The food groups used in the analyses were those of the FAO: for instance, "meat" included beef, mutton, pig, poultry and other meat (not defined by FAO); "vegetables" included tomatoes, onions and other vegetables; "fruits" included oranges, bananas, apples, grapes (not intended for wine making), and other fruits; "pulses" included beans, peas and other pulses; "cereals" included wheat, rice, barley, maize, rye, oats and other cereals. It should be noted that the "other" items were not precisely defined in the food balance sheets. We also analyzed some selected items characteristic of the Mediterranean diet such as wine, fish (freshwater, demersal, and pelagic) and olive oil.

Statistical analysis

Analyses were performed with SPSS version 14.0. Linear Regression was used in SPSS to calculate the slopes of the trends of different food availabilities, expressed as number of kilocalories *per capita* per day (kcal/person/day). Percentage of calories from fat or

[1]http://www.faostat.fao.org/site/379/default.aspx assessed 21st August 2007

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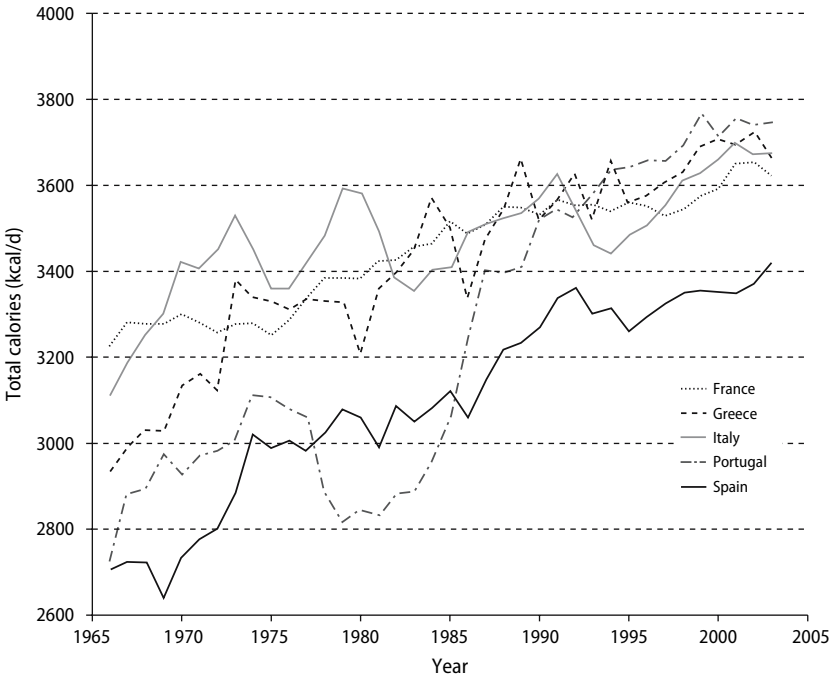

Fig. 1 Per capita availability of daily calories from 1966–2003 in five Mediterranean countries

protein was calculated by dividing the *per capita* availability of calories from fat or protein by total calories. Similarly, the contribution of animal or vegetable products to the total energy increase was calculated by dividing the slope of animal or vegetable products availability by the slope of total caloric availability (see annex). Results were expressed as slopes ± SD and as 95% confidence intervals.

Results

Trends of daily calories supply from 1966 to 2003 in France, Greece, Italy, Spain and Portugal are summarized in Fig. 1. Overall, total daily calories supply increased in all five countries with a converging trend, although these countries were at different levels of food supply at the beginning of the period. Portugal experienced the most notable increase, from the lowest caloric supply in 1966 (around 2700 kcal/d) to the highest in 2003 (nearly 3800 kcal/d, a +1000 kcal increase).

The slopes and related 95% confidence intervals for different food availabilities in the five countries are indicated in Table 1. Portugal presented the most rapid growth in total caloric supply, significantly higher (by circa 50%) than neighbor Spain, which had the second fastest growth. As to the other three countries, Greece had a similar increasing speed relative to Spain, whereas France and Italy showed relatively slower growth (Table 1).

In parallel with total caloric supply, availabilities of vegetable and animal products also rose, although with different magnitudes (Table 1). For instance, in France and Greece the increase in vegetable products was comparable to that of animal products, while in Spain and Portugal the increase in animal products was much steeper than for vegetable products. Italy was the only country where the availability of animal products increased but the availability of vegetable products did not change. Again, Portugal had the strongest increase in animal products, almost double of the other countries (Table 1 and Fig. 2). Overall, animal products represented 59%, 46%, 100%, 65% and 73% of the increase in total caloric availability in France, Greece, Italy, Spain and Portugal respectively. The very high contribution of animal products in total caloric availability in Italy was actually due to a decrease in vegetable products.

The increase in the availability of animal products was mainly due to an increase in meat and dairy products and much less to fish, which was 4 to ten-fold lower than the increase in meat. Again, the highest increases in meat availability were noted for Portugal and Spain, almost two-fold higher than for the other countries (Table 1). In Portugal, a considerable increase in milk availability was also noted, almost two-fold higher than in Greece, which ranked second regarding the increase.

Regarding fat or fat-rich foods, vegetable oils presented a steeper increase than animal fat or butter in all countries but Portugal, where the increase in animal was two-fold higher than the increase in vegetable fat (Table 1). Sunflower oil accounted for most of the increase in the availability of vegetable oils (82%,

Table 1 Trends of different food availabilities in five Mediterranean countries, 1966 to 2003

Food item	France	Greece	Italy	Spain	Portugal
Total calories	11.4 ± 0.5 [10.3–12.5]	18.7 ± 1.2 [16.3–21.1]	9.5 ± 1.3 [6.9–12.0]	19.6 ± 0.9 [17.7–21.5]	28.5 ± 2.2 [24.0–33.1]
Animal products	6.7 ± 0.6 [5.5–7.9]	8.6 ± 0.5 [7.6–9.6]	10.8 ± 0.7 [9.4–12.2]	12.7 ± 0.4 [12.0–13.5]	20.7 ± 0.9 [18.9–22.5]
Vegetable products	4.7 ± 0.6 [3.5–5.9]	10.1 ± 0.9 [8.2–12.0]	−1.3 ± 1.2 [−3.9–1.2]	6.9 ± 0.8 [5.3–8.5]	7.9 ± 1.6 [4.5–11.2]
Protein-rich foods					
Meat (all)	1.7 ± 0.4 [0.9–2.4]	4.2 ± 0.2 [3.8–4.7]	5.2 ± 0.3 [4.6–5.8]	9.5 ± 0.1 [9.2–9.8]	7.8 ± 0.4 [7.1–8.6]
Fish (all)	0.4 ± 0.1 [0.4–0.5]	0.4 ± 0.1 [0.2–0.5]	0.7 ± 0.1 [0.6–0.8]	1.0 ± 0.1 [0.9–1.2]	0.7 ± 0.2 [0.3–1.1]
Milk	1.7 ± 0.3 [1.0–2.3]	3.5 ± 0.3 [3.0–4.1]	2.0 ± 0.3 [1.5–2.5]	0.8 ± 0.3 [0.1–1.5]	5.6 ± 0.3 [5.1–6.2]
Fat-rich foods					
Animal fat	2.4 ± 0.1 [2.1–2.7]	0.4 ± 0.2 [0.0–0.8]	2.6 ± 0.2 [2.2–2.9]	1.0 ± 0.1 [0.7–1.3]	5.3 ± 0.2 [4.8–5.7]
Butter	−0.4 ± 0.1 [−0.6–0.1]	0.2 ± 0.1 [0.1–0.3]	0.3 ± 0.1 [0.1–0.4]	0.2 ± 0.1 [0.1–0.2]	0.7 ± 0.1 [0.6–0.8]
Vegetable oils	6.5 ± 0.4 [5.7–7.2]	6.1 ± 0.6 [5–7.3]	6.5 ± 0.4 [5.6–7.3]	9.2 ± 0.3 [8.5–9.9]	2.0 ± 0.4 [1.1–2.8]
Sunflower oil	5.3 ± 0.3 [4.7–5.9]	4.2 ± 0.3 [3.6–4.7]	2.6 ± 0.2 [2.2–3.1]	6.8 ± 0.4 [5.9–7.7]	3.6 ± 0.6 [2.3–4.9]
Olive oil	0.6 ± 0.1 [0.5–0.8]	-0.7 ± 0.6 [−1.9–0.5]	1.9 ± 0.3 [1.4–2.5]	1.9 ± 0.2 [1.5–2.4]	−2.4 ± 0.3 [−3–1.8]
Cereals	3.6 ± 0.4 [2.7–4.5]	−4.9 ± 0.7 [−6.3–3.5]	−5.8 ± 0.8 [−7.4–−4.2]	−3.6 ± 0.5 [−4.7–−2.6]	−1.6 ± 0.7 [−3.1–0.2]
Wheat	−0.2 ± 0.4 [−1.0–0.6]	−6.5 ± 0.6 [−7.7–−5.4]	−5.9 ± 0.7 [−7.3–−4.4]	−4.2 ± 0.5 [−5.1–−3.2]	5.4 ± 0.5 [4.3–6.4]
Maize	3.1 ± 0.3 [2.5–3.8]	0.1 ± 0.1 [0.0–0.2]	-0.4 ± 0.1 [−0.5–−0.2]	0.1 ± 0.05 [−0.01–0.2]	−5.8 ± 0.4 [−6.5–5.0]
Rice	0.8 ± 0.1 [0.7–0.9]	0.8 ± 0.1 [0.6–1.1]	0.6 ± 0.1 [0.4–0.7]	0.8 ± 0.1 [0.6–0.9]	1.2 ± 0.2 [0.7–1.6]
Vegetables	0.2 ± 0.1 [0.0–0.4]	1.7 ± 0.2 [1.3–2.0]	0.5 ± 0.1 [0.3–0.6]	0.3 ± 0.1 [0.1–0.5]	1.0 ± 0.1 [0.7–1.3]
Fruits	−0.2 ± 0.2 [−0.5–0.1]	0.2 ± 0.3 [−0.5–0.8]	0.2 ± 0.2 [−0.1–0.6]	1.1 ± 0.2 [0.7–1.5]	2.5 ± 0.4 [1.8–3.3]
Pulses	−0.01 ± 0.03 [−0.07–0.04]	−0.9 ± 0.1 [−1.0–0.7]	0.3 ± 0.1 [0.03–0.5]	−0.5 ± 0.1 [−0.8–−0.3]	−0.8 ± 0.1 [−1.1–0.6]
Sugar	−0.9 ± 0.4 [−1.6–−0.2]	2.4 ± 0.5 [1.4–3.4]	-0.4 ± 0.3 [−1.0–0.2]	0.6 ± 0.3 [−0.1–1.3]	2.1 ± 0.3 [1.6–2.7]
Alcoholic drinks					
All	−4.2 ± 0.2 [−4.6–3.9]	1.9 ± 0.2 [1.4–2.3]	−3.4 ± 0.2 [−3.7–−3.0]	0.0 ± 0.2 [−0.4–0.4]	−0.4 ± 0.3 [−1.0–0.3]
Wine	−3.3 ± 0.1 [−3.5–3.1]	−0.5 ± 0.1 [−0.7–−0.2]	−3.7 ± 0.2 [−4.0–−3.4]	−1.4 ± 0.1 [−1.7–−1.2]	−2.2 ± 0.2 [−2.7–−1.7]
Beer	−0.6 ± 0.1 [−0.7–−0.4]	1.3 ± 0.1 [1.1–1.4]	0.6 ± 0.1 [0.6–0.7]	1.6 ± 0.1 [1.3–1.8]	2.4 ± 0.1 [2.1–2.7]

Results are expressed as mean slope (kcal/day/year) ± standard error and [95% confidence interval]

69%, 40%, 74% and over 100% in France, Greece, Italy, Spain and Portugal, respectively), whereas the contribution of olive oil was much smaller (9%, −17%, 29%, 21% and −100% in France, Greece, Italy, Spain and Portugal, respectively). The over 100% figures for Portugal indicate that the increase in vegetable oil consumption is due to two strong diverging trends: a decrease in olive oil overcompensated by a stronger increase in sunflower oil availability. Noticeably, Portugal was the only country where the availability of olive oil actually showed a significant decrease (Table 1).

Overall cereal availability decreased in all countries but France. Interestingly, the decreases were due to different cereals according to country studied: in Greece, Italy and Spain the decrease was mainly due to wheat, whereas in Portugal it was due to maize; conversely, a significant increase for the availability of rice was noted in all countries (Table 1). Vegetables (tomatoes, onions,…) availability increased slightly but significantly in all countries, whereas for fruit availability no changes were found in France, Greece and Italy and only slight increases in Spain and Portugal (Table 1). The availability of pulses decreased in

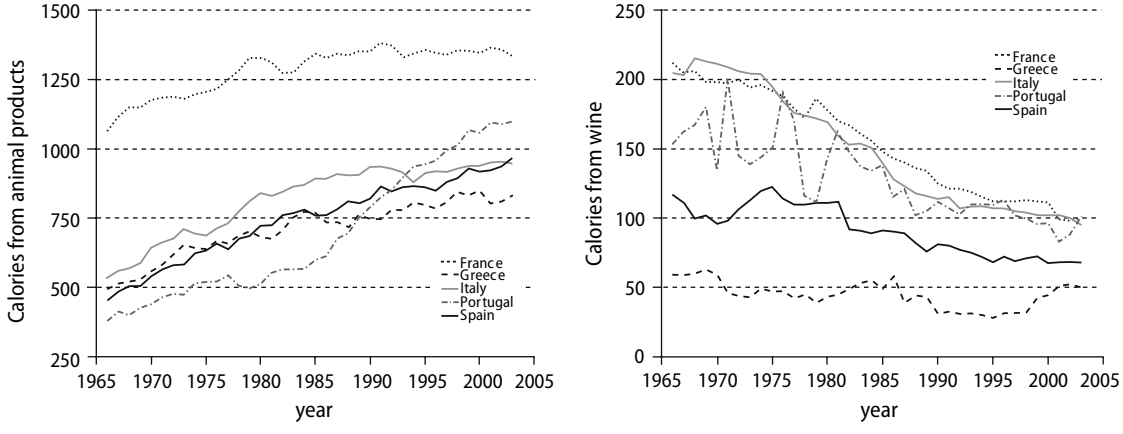

Fig. 2 Trends in the availability of animal derived foods and wine from 1996 to 2003 in five Mediterranean countries

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Greece, Portugal and Spain, increased in Italy and remained stable in France; the strongest decreases were observed in Greece and Portugal (Table 1). Conversely, sugar availability showed different trends according to the country: decrease in France, stability in Italy and Spain, and increase in Greece and Portugal (Table 1).

The availability of alcoholic drinks decreased in most countries, with the exception of Greece where a significant increase was noted. Interestingly, a shift in the roles of wine and beer was noted: wine supply decreased in all five countries (Fig. 2), especially in France and Italy. Conversely, beer supply increased in most countries, the fastest growth being for Portugal, while France presented a slight decline. In Spain and Portugal, the increase in beer availability actually more than compensated the decrease in wine and spirits availability, leading to a non-significant trend (Table 1).

Expressed as percentage of total calories supply, fat supply increased considerably from 1996 to 2003. While in 1966 most countries were below the 30% mark, in 1990 all countries were above 30%, and in 2000 this percentage was over 40% for France and Spain. Protein supply also showed significant increases for all countries excepting Greece; still, those increases were much smaller than for fat, and no country had protein availability over 15% of total caloric supply (Fig. 3).

Discussion

Our results indicate that among the selected Mediterranean countries the availability of calories per capita has increased considerably in the last 40 years and that the foods traditionally related with the Mediterranean diet have been decreasing (wine) or increasing at a smaller rate (fish, olive oil) than other foods more characteristic of a Westernized diet (meat, animal fat, beer), indicating a considerable and unfavorable shift in dietary patterns These unfavorable trends were also observed to occur faster in Portugal than in the other countries.

The Mediterranean diet has been shown to decrease overall mortality, namely by decreasing mortality from cardiovascular disease and certain types of cancer. Randomized interventional studies have shown that a Mediterranean-type diet successfully decreases mortality after myocardial infarction and might also protect against obesity [31, 35]. Thus, in Mediterranean countries, the maintenance of the traditional diet would be paramount in the prevention and reduction of the burden of chronic diseases; still, many if not all studies indicate that the traditional Mediterranean diet is disappearing.

At least three studies have used FAO's Food Balance Sheets to analyze the dietary trends in Mediterranean countries [1, 10, 34]. These studies showed that Mediterranean countries have followed the trend towards higher shares of energy-dense foods, and presented greater similarity to the high-intake Northern European countries [10, 34]. Still, none of those publications actually quantified the trends or assessed their components. Our data thus brings new insights regarding the evolution of food availability in five Mediterranean countries, and shows that although those trends might be initially considered as equal, actually their determinants are quite different according to the country studied. For instance, the increase in total caloric availability was comparable between France and Italy, but in France it was due both to animal and vegetable products, while in Italy it was almost exclusively due to animal products.

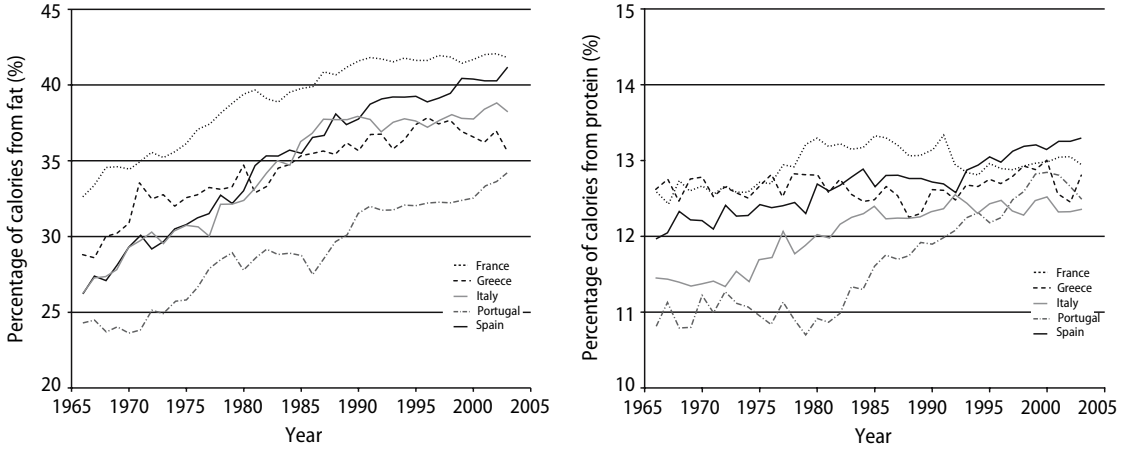

Fig. 3 percentage of total calories supply from fat and protein from 1996 to 2003 in five Mediterranean countries

Further, the increase in total vegetable oils was smaller for Portugal than for the other countries, but this smaller increase was actually due to a considerable decrease in olive oil, whereas the increase in sunflower oil was stronger than in Greece.

Energy supply rose in all countries, the steepest increase being found in Portugal, where energy supply rocketed from the last to the first among these five countries: in 2003, it amounted to 3800 kcal.person^{-1}.day^{-1}, an increase of 37.4% compared with the 1966 data. This rapid growth had also been mentioned in a previous study [34]; a possible reason is that the initially poorer Mediterranean countries at the beginning of the period rapidly caught up with and often exceeded richer countries in terms of energy supply [34] with increased wealth. Indeed, after a decrease following the revolution of 1974, caloric availability in Portugal showed a slight increase which was considerably accelerated after 1986 when the country entered the European Union, leading to an overall improvement in socio-economic conditions[2]. Further, and contrary to the other Mediterranean countries, this increase concerned mainly animal products, which are usually more expensive and less affordable than vegetable products. Indeed, a recent study conducted among Portuguese conscripts [29] showed that, contrary to other countries, the increase in the prevalence of obesity was stronger among higher educated subjects, who usually benefit from better economic status. This large increase in caloric availability might also explain the increase in overweight and obesity in the Portuguese population, both among adults [22] and children [30]. Interestingly, in the conscripts study, the increase in overweight and obesity accelerated after 1995, circa 10 years after the increase in total caloric availability; since mean age at examination was 18, these data suggests that children aged 8 submitted to rapid changes in dietary patterns might develop obesity in later years, as suggested by others [8].

Portugal was the sole Mediterranean country where animal fat increased more steeply than vegetable fat. Further, Portugal was also the sole Mediterranean country where a significant decrease in olive oil was noted. The decrease in olive oil consumption was also reported in one European cross-sectional study on dietary patterns using the DAFNE database [27] and from the Portuguese Household Budget Surveys in 1989/90 and 1994/95 [33], although an increasing trend has been reported by others [42]. A possible explanation for this decrease is the higher cost of olive oil relative to other vegetable oils, and the replacement of olive oil by other vegetable oils for frying, although other reasons such as changes in foodstuffs consumed cannot be ruled out. This change from vegetable to animal sources of fat lead to an increase in the availability in saturated fat at the expenses of mono or polyunsaturated fat [34]. Indeed, a study assessing serum phopholipid fatty acid composition showed that Portuguese pre-school children presented lower levels of monounsaturated and n−3 polyunsaturated fatty acids than their German counterparts, indicating considerable changes in dietary intake [13]. Overall, our results indicate not only that fat availability is increasing in Portugal, but also that the relative amounts of saturated to mono- and polyunsaturated fatty acids are evolving unfavorably. It is also worth indicating that the percentage of fat in total calories supply increased nearly to 35% in Portugal; though this figure was the lowest among other Mediterranean countries, the increasing trend is not optimistic. It should also be noted that for all Mediterranean countries studied, the percentage for year 2003 considerably exceeded the maximum 30% of total energy intake from healthy eating guidelines [45], and that the pace of increase for meat products was considerably higher than for fish, a source of n−3 and n−6 fatty acids. Increased meat intake has been related to a higher incidence of certain types of cancer [20], whereas increased saturated fatty acid intake and decreased unsaturated fatty acid intake have been shown to be related with increased coronary heart disease risk [19]. The health consequences of such dietary changes could be considerable but their assessment awaits further investigation.

In agreement with other studies [24, 42], milk availability increased considerably in Portugal. Milk and calcium consumption have been shown to protect against osteoporosis [17, 18] and obesity [23, 44], although the results regarding obesity have been questioned [3]. Further, the increase in milk availability does not mean that all Portuguese subjects have an adequate calcium intake, as it has been shown that Portuguese elderly have an intake below the recommended levels [25], partly due to a low milk intake [24]. Thus, although our results do indicate a favorable trend regarding availability of milk in the Portuguese population, efforts are still needed to increase milk consumption in the elderly.

Fruit and vegetable availability increased in all countries, Portugal showing the steepest increase. Those findings are in agreement with data from the late Portuguese National Health Interview Surveys [24] and other studies [42, 49] but not with others [33]. Indeed, the consumption of fruit decreased in the National Health Interview Survey of 1998–9 relative to the one of 1995–6. Still, based on the available information from the food balance sheets and other studies, it can be inferred that fruit consumption in

[2]http://www.mongabay.com/reference/country_studies/portugal/GOVERNMENT.html, assessed March 19, 2007

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Portugal is high and probably in agreement with European recommendations.

The trends of alcohol consumption in Portugal are noteworthy; contrary to other studies [12, 42], no significant downward trend was noted for total alcohol availability, which showed only a minor, non-significant decrease of 0.4 kcal.person^{-1}.day^{-1}. Still, assessing individual alcoholic beverages lead to a completely different picture, with a significant decrease in wine consumption, fully compensated by an increase in beer availability. This increase in beer availability was the strongest among all countries analyzed, suggesting a rapid and considerable shift in drinking habits in the Portuguese population, as already suggested previously [16, 21]. Similar findings were obtained for Spain, whereas for the other countries more complex patterns were found; still, the main pattern was the replacement of wine by beer, a trend already reported in the literature [12, 32]. The most likely explanation for this shift is the lower cost of beer, which can also be purchased in individual units, making it more accessible to the younger age groups. Other driving forces such as marketing, environmental effects (higher consumption of beer in summer [36]), advertising [38] or the adoption of new, fashionable beverages by younger age groups cannot be ruled out [37].

The changes in foodstuff availability led to significant changes also in diet composition in all Mediterranean countries. The faster increase in animal products availability led to an increased share of animal products in the total energy supply, a feature already reported [34], but also to an increased share of fat in total caloric supply. This increase share of fat occurred at the expenses of carbohydrates, while the share of protein remained below the 15% mark. Although our results indicate that more than 30% of total caloric availability in Portugal is made of fat, still other studies indicate that this share might be as low as 19% [42], which is rather unlikely taking into account the data from dietary surveys [5, 11].

This unfavorable dietary shift has been acknowledged by some Mediterranean countries, and preventive measures have been taken [15, 26, 28]. In Portugal, preventive measures directed against unfavorable dietary habits have also been set [6] but, to our knowledge, have been little implemented [2, 7]. This would be of outstanding Public Health importance as, in agreement with other studies [24, 33], our results indicate that major unfavorable changes in diet are under way in Portugal.

The findings in this study are subject to some limitations. FAO's Food Balance Sheets are based on food availability at country level. Although they provide comprehensive information on food supply in different countries, they cannot present the actual dietary intake at the household or individual level. The reason is that different post-retail losses can happen before the food is consumed [34]. For example, frying oil is always discarded rather than consumed, which means calories from this amount of oil are wasted rather than taken by people. Therefore, data on food availability actually overestimate the actual dietary intake. However, the data from the Food Balance Sheets has been compiled since 1960s, and the present study is focusing on dietary trends at the population level; we believe that trends in food availability can depict dietary trends appropriately over this period of time [43]. In addition, previous studies using food balance sheets and studies using other databases or methods were compared with the findings in this study, which in return increased the validity. The second limitation is that no analysis was conducted on the correlations between the dietary trends and prevalence of overweight and obesity in Portugal. Lack of national representative data on diet-related disease while this study was carried on was the main obstruct and further studies are needed to assess this point. Finally, the slopes of the time trends were calculated using linear regression, which actually supposes a linear relationship between food availability and time and might not be the best method to analyze some of the trends. For instance, the trends in total caloric availability in Portugal show a considerable decrease during period 1975–1979, followed by a steep increase afterwards (Fig. 1), which might not be adequately assessed using linear regression. Still, most of the relationships actually showed a linear relationship and it would be very difficult if not impossible to compare trends between countries or to assess the effect of several foodstuffs on the trends in caloric/nutrient availability if different regression methods were used.

In summary, we have shown that similar trends in food availability between countries can actually be due to different underlying causes, both regarding the foodstuffs implicated or their individual trends. The results also show that Portugal is consistently and rapidly moving away from the traditional Mediterranean diet to a more Westernized diet at a much faster pace than any other Mediterranean country. Although the effects of such a dietary shift are still being investigated, it is of great importance to advocate the benefits from the 'abandoned' traditional Mediterranean diet.

Acknowledgements The Centro de Nutrição e Metabolismo of the Instituto de Medicina Molecular is partially funded by a grant from the Fundação para a Ciência e a Tecnologia ref. RUN 437. Conflict of interest: none.

Annex

Assessing the effect of several foodstuffs on the trends in caloric/nutrient availability

Briefly, let the timely change in total caloric availability be modeled by a simple linear regression:

$$\text{Total caloric availability} = \alpha_t + \beta_t.(\text{time}) \quad (1)$$

Where a_t is the total caloric availability at time 0 and β_t is the slope (increase/decrease) for the change in total caloric availability, for example an increase in 50 kcal/year. The time changes for animal and vegetable-derived caloric availabilities can be calculated similarly:

$$\text{Animal caloric availability} = \alpha_a + \beta_a.(\text{time}) \quad (2)$$

$$\text{Vegetable caloric availability} = \alpha_v + \beta_v.(\text{time}) \quad (3)$$

Supposing alcohol-derived caloric availability is negligible or included in vegetable caloric availability, one can postulate that:

$$\text{total caloric availability} = \text{animal + vegetable caloric availability} \quad (4)$$

Introducing (1), (2) and (3) into (4) leads to the equation

$$\alpha_t + \beta_t.(\text{time}) = \alpha_a + \beta_a.(\text{time}) + \alpha_v + \beta_v.(\text{time}) \quad (5)$$

At time = 0, equation (5) simplifies into

$$\alpha_t = \alpha_a + \alpha_v \quad (6)$$

indicating that the total caloric availability at time zero (and actually at any time) should be equal to the sum of animal and vegetable caloric availability, as stated in equation (4). Using (6) and (5) we obtain for any time

$$\beta_t = \beta_a + \beta_v \quad (7)$$

Which indicates that the changes in total caloric availability can be expressed as the sum of the changes in animal and vegetable caloric availabilities. Thus, the percentage of change in total caloric availability explained by changes in vegetable-derived calories can be easily calculated as

$$\frac{\beta_v}{\beta_a + \beta_v} \quad (8)$$

For example, for an increase in total caloric availability of 50 kcal/year and a corresponding increase of 30 kcal/year in vegetable caloric availability, then the percentage of total caloric availability change explained by changes in vegetable-derived caloric availability is

$$\frac{30}{50} = 0.6 \text{ or } 60\% \quad (9)$$

Which indicates that most of the increase in total caloric availability is due to vegetable products. Actually, equation (8) is not limited to positive (increasing) trends as, using another example, the previous increase of 50 kcal/year in total caloric availability could also be obtained by an increase of 80 kcal/year in vegetable and a decrease of 30 kcal/year in animal availability. Thus, a similar change in total caloric/nutrient availability can be obtained by completely different trends as regards the foodstuffs analyzed.

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