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Food and nutritional profile of high energy density consumers in an adult Mediterranean population

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Objective: To test if an adult Mediterranean population consumes different food volumes while spontaneously ingesting diets of different energy density and to estimate which are the food and nutritional profiles of these diets.
Design: A cross-sectional study of food consumption.
Setting: Faculty of Medicine and Health Sciences, Universitat Rovira i Virgili, Reus.
Subjects: Five hundred and seventy two adult individuals (25–65 y) randomly selected from the population census of Reus.
Intervention: 24 hour recall method for 3 non-consecutive days including one holiday. The population was classified into three groups of differing energy densities by simple linear regression analysis. Means were compared by ANOVA.
Results: Both sexes consume similar food volumes across the different levels of energy density. High energy density consumers ingest significantly more red meat, olive oil, sweet cereals, cereals and sugars and less reduced fat milk, green vegetables and fruit compared to low energy density consumers. Male and female high energy density consumers show a significantly higher consumption of energy (1686 kJ and 2200 kJ, respectively) ($P < 0.001$), a 5.2% ($P < 0.001$) and 2.3% ($P < 0.05$) respectively higher energy intake derived from fat and a 1.3% ($P < 0.05$) and 1.3% ($P < 0.05$) respectively higher energy intake derived from saturated fatty acids compared to low energy density consumers.
Conclusions: Our adult Mediterranean population normally consumes similar food volumes, independently of the energy density ingested. High energy dense diets in our population could represent an important health risk because they are excessively rich in energy, fats and saturated fatty acids.
Sponsorship: City Council of Reus.
Descriptors: energy density; food volume; energy intake; nutrition; population; health
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Introduction

The high prevalence of obesity is a public health problem in wealthy countries. Obese people have many metabolic alterations that increase their risk of developing other chronic diseases that have important consequences to health such as cardiovascular diseases and diabetes (Grundy, 1998).

The aetiology of obesity is multifactorial. The increase in the incidence of obesity to epidemic levels in some countries cannot be attributed to genetic factors alone. The large decrease in physical activity due to sedentary lifestyle has had an important contribution. We must also consider that in order to produce obesity, energy intake must exceed energy expenditure (Hill & Peters, 1998).

Recently there has been an increased interest in the factors that contribute to energy intake regulation. One of them has been the energy density of the diet or the amount of energy ingested per unit of amount of food consumed (weight or volume). Various studies, carried out under controlled laboratory conditions, have observed that people tend to consume similar amounts of food although their diets are of differing energy densities. Consequently high energy dense diets imply more energy intake and an increase in body weight (Stubbs *et al*, 1998; Stubbs *et al*, 1995a,b). Therefore, the habitual consumption of high energy dense diets could facilitate the risk of developing obesity.

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In order to achieve high energy dense diets, from a nutritional point of view, either a high energy intake is required or a small amount of food, albeit rich in energy, must be consumed. Theoretically, it is feasible to achieve an increase in energy density from a high consumption of any macronutrient of the diet, either proteins, carbohydrates or fats. Nevertheless, as fat is more energetic per unit of weight it facilitates more than the other macronutrients to an increase in the energy density of the diet. However, it is also possible to increase the energy density of the diet with proteins, as is the case when these are introduced during diet diversification in the first year of life (Capdevila *et al*, 1998) or with the addition of simple carbohydrates such as in controlled laboratory studies (Stubbs *et al*, 1998). It is probable that a high energy dense diet could be obtained by varying macronutrient proportions according to the physiological situation and/or the energetic needs of the situation (diet diversification in the first year of life, adolescence, pregnancy, physical activity, etc.).

Some studies conducted under laboratory controlled conditions have attributed the amount of food consumed to a compensatory property: people tend to adjust the amount of food consumed depending on the changes of the energy density of their diet. For example, to achieve a specific energy intake in low energy dense diets a higher amount of food would be consumed than in higher energy dense diets (Tremblay *et al*, 1991; Lissner *et al*, 1987; Kissileff & Van Itallie, 1982; Speigel, 1973). In the case of high energy dense diets the reverse applies. In contrast, other studies, also under controlled laboratory conditions, have observed that people tend to consume a similar amount of food independently of the energy density of their diet, and suggest that most adults are accustomed to the consumption of a specific amount of food (Prentice, 1998; Bell *et al*, 1998; Stubbs *et al*, 1998; Stubbs *et al*, 1995a,b; Rolls *et al*, 1988).

Such studies have been carried out with the subjects under controlled laboratory conditions, and the diets administered have been prepared with a specific food composition to achieve diets of differing energy densities. For that reason it is difficult to extrapolate the results of these studies to the population. These studies reflect a situation that is very different from reality where people, in addition to their level of physical activity, have the ability to choose freely the food composition, both quantitative and qualitative, of their daily menus.

The aim of this study was to test if an adult Mediterranean population consumes a different food volume while spontaneously ingesting diets of differing energy densities and to estimate which food and nutritional profile determines the achievement of diets of differing energy densities.

Methods

This work is part of a longitudinal study on food consumption conducted in Reus, a Spanish Mediterranean city of approximately 91 000 inhabitants, between 1983 and 1993. During 1993, 572 adults (age range: 25–65 y) were studied from a randomly selected cohort of 1167 subjects from the population census. The cohort included subjects representative of all ages, sex, and of distinct socio-economic and education levels (Arija *et al*, 1996a,b).

Food intake was quantified by the 24-h recall method, for 3 non-consecutive days including one holiday (Beaton *et al*, 1979; Pekkarinen, 1970). An extensive photographic record, with different portion-sizes of distinct foods, and a standardised table to evaluate the edible part of the food, were used to achieve a better assessment of the quantity of food ingested (Salas *et al*, 1985). The interview was conducted in the subject's home with the person responsible for the food preparation and cooking in the family. The information was collected all year round to allow for seasonal variability.

Foods were grouped as follows: red meat, poultry and game, eggs, white fish, blue fish, whole fat milk, reduced fat milk, whole fat dairy products, reduced fat dairy products, olive oil, seed oils, animal fats and margarines, dried fruits and nuts, sweet cereals, cereals (all cereals with the exception of breakfast cereals, biscuits and pastries which are classified as sweet cereals), dried pulses, green vegetables (all vegetables with the exception of root and tuber vegetables which are classified separately), roots and tubers, fruit, sugars and alcoholic beverages.

The INSERM-ISTNA (France, 1977) food composition table was used. The percentage of energy derived from the distinct macronutrients and the percentage of energy derived from the distinct foods groups were calculated. The total daily energy ingested (kJ) was divided by the food volume consumed (cm^3) to quantify the energy density of the diet. We created the variable food volume to estimate the volume that the food occupies in the stomach. In order to do this, we converted the grams to cubic centimeters in all of the food groups with the following adjustments: in the case of sweetened drinks, the weight of sugar content was only included and for those uncooked foods whose weight increases after cooking, due to the incorporation of water between their molecules (such as pasta, rice and dried pulses), we applied a correction factor (3.5). We calculated this factor, to correct for the change in food volume, following experimentation in our cooking laboratory.

Body weight (kg) and height (m) were recorded and subsequently the body mass index, BMI, (kg/m^2) was also calculated.

The study population was classified into three groups (diets of low, medium and high energy density) according to the tertiles of the residual of energy density corrected for age in each sex.

The data was analysed with the software SPSS 8.0 for Windows. Simple linear regression analysis was also used to obtain the residual corrected for age in each sex and analysis of variance (ANOVA) was used for the comparison of means. When the ANOVA test reached the significance level, multiple comparisons between pair means were performed by means of posthoc contrasts. In the cases where assumptions had not been fulfilled, non parametric tests were conducted (Kruskall–Wallis' H and Mann–Whitney's U). The level of significance $P < 0.05$ was assigned to all the statistical tests used in the analysis. In the multiple pairs comparisons made with Mann-Whitney's U-test, the level of significance $P < 0.05/3$ (Bonferroni correction), was used to maintain the global significance level at $P < 0.05$.

Results

We described the intake of animal products (Table 1), animal fats and vegetable products (Table 2) of our adult population by energy density of the diet (low, medium or high). We observed that men and women who ingest a high energy dense diet consume more red meat, olive oil, sweet cereals, cereals, sugars and less reduced fat milk, green vegetables and fruit in relation to the population that consume medium and/or low energy dense diets. Moreover, women that ingest a high energy dense diet have significantly higher consumption of animal fats and margarines, dried fruits and nuts and less reduced fat dairy products than their low energy dense counterparts. Male high energy density consumers ingest more alcoholic beverages than low energy density consumers.

Table 3 shows the nutritional profile in relation to the consumption of energy density of the diet. Men and women who ingest high energy dense diets show a significantly higher consumption of energy, proteins and fats (1686 kJ and 2200 kJ; 12 g and 10 g; 32 and 28 g, respectively) than those who consume low energy dense diets. Moreover, women who have a high energy dense diet have a high consumption of carbohydrates (52 g more). Furthermore, men and women who consume a diet of high energy density, have a 5.2% and 2.3%, respectively, higher energy intake derived from fat and a 1.3% and 1.3%, respectively, higher energy intake derived from saturated fatty acids, compared to low energy density consumers. The food volume consumed by men is only different between low and high energy dense diets, and in women there are no significant differences between the various levels of energy density consumption. We did not observe differences between the anthropometric variables studied in both sexes.

The differences in the percentage of energy derived from the distinct food groups with respect to the different energy dense diets of the population are illustrated in Figures 1 and 2. Men (Figure 1) with a high energy dense diet show a significantly higher percentage of energy derived from red meat, sweet cereals and sugars and less deriving from whole fat milk, reduced fat milk, green vegetables, fruit and alcoholic beverages compared to those with low energy dense diets. Women (Figure 2) with a high energy dense diet have significantly more energy derived from red meat, sweet cereals, cereals, animal fats and margarines and sugars and less derived from reduced fat milk, green vegetables, root and tuber vegetables and fruit compared to those who consume a low

Table 1 Intake of animal products according to energy density consumption. Men and women (25–65 y)

	Men					*Women*				
		Energy density					*Energy density*			
Food groups (g/d)	*Mean food intake*	*Low*[a]	*Medium*[b]	*High*[c]	P	*Mean food intake*	*Low*[a]	*Medium*[b]	*High*[c]	P
Red meat	115.4	83.1	119.0	144.2	***(a,b)	80.5	59.5	83.8	97.8	***(a,b)
	(68.3)†	(48.9)	(58.0)	(80.2)	***(a,c)	(53.0)	(41.0)	(43.3)	(64.6)	***(a,c)
Poultry and game	52.5	51.8	46.9	58.8		44.4	45.8	44.5	42.9	
	(58.7)	(51.9)	(51.6)	(70.7)		(46.2)	(45.6)	(46.7)	(46.7)	
Eggs	29.6	27.6	32.0	29.3		23.6	22.2	22.8	25.8	
	(26.7)	(24.0)	(29.8)	(26.2)		(21.8)	(21.1)	(19.2)	(24.7)	
White fish	29.8	29.9	28.2	31.4		23.7	24.1	23.8	23.2	
	(42.0)	(36.6)	(39.8)	(49.0)		(31.7)	(32.4)	(28.4)	(34.2)	
Blue fish	35.9	38.2	34.4	35.1		25.4	23.9	28.6	23.8	
	(44.7)	(50.5)	(41.3)	(42.3)		(35.7)	(36.1)	(38.7)	(32.0)	
Whole fat milk	146.8	149.1	159.7	131.5		158.4	137.3	171.5	166.2	
	(140.7)	(139.6)	(136.6)	(145.8)		(170.7)	(195.3)	(168.1)	(145.0)	
Reduced fat milk	32.4	63.9	14.0	19.2	**(a,b)	77.9	140.1	65.3	28.9	***(a,b)
	(97.2)	(147.8)	(46.8)	(54.6)		(122.5)	(154.1)	(99.8)	(72.2)	**(b,c)
										***(a,c)
Whole fat dairy products	38.7	40.3	35.4	40.5		32.3	31.6	29.5	35.7	
	(50.6)	(53.6)	(52.8)	(45.4)		(45.8)	(53.5)	(41.9)	(41.4)	
Reduced fat dairy products	7.4	13.5	4.9	3.9		8.3	15.8	5.9	3.2	**(a,c)
	(33.0)	(52.5)	(18.4)	(11.9)		(26.5)	(40.1)	(17.9)	(11.0)	

†Mean (standard deviation). The number of cases in each tertile are in men, 89/89/89, in women, 101/102/102.
Significant differences between groups a, b and c. $^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

Table 2 Intake of animal fats and vegetable products according to energy density consumption. Men and women (25–65 y)

	Men					Women				
		Energy density					Energy density			
Food groups (g/d)	*Mean food intake*	*Low*[a]	*Medium*[b]	*High*[c]	P	*Mean food intake*	*Low*[a]	*Medium*[b]	*High*[c]	P
Olive oil	36.3 (19.1)[†]	32.4 (17.5)	35.2 (17.7)	41.5 (21.0)	**(a,c)	29.6 (15.2)	24.7 (14.0)	32.8 (14.3)	31.3 (16.2)	**(a,b) **(a,c)
Seed oils	6.2 (12.9)	4.1 (8.6)	7.1 (14.1)	7.4 (15.0)		3.6 (7.9)	3.2 (7.1)	2.8 (6.9)	4.8 (9.3)	
Animals fats and margarines	1.4 (4.2)	1.4 (3.8)	1.4 (4.7)	1.3 (4.0)		2.2 (4.9)	0.8 (2.0)	2.2 (4.7)	3.6 (6.5)	***(a,c)
Dried fruits and nuts	6.3 (15.3)	4.1 (11.0)	5.8 (13.1)	8.8 (20.1)		5.4 (14.5)	3.6 (10.6)	3.6 (9.0)	8.9 (20.5)	*(b,c) **(a,c)
Sweet cereals	28.9 (35.7)	20.9 (29.3)	28.9 (39.0)	36.8 (36.6)	*(a,c)	30.0 (34.3)	15.7 (19.5)	31.8 (38.3)	42.4 (36.6)	**(a,b) *(b,c) ***(a,c)
Cereals[‡]	157.1 (76.6)	134.6 (65.0)	157.6 (75.6)	179.1 (82.3)	***(a,c)	102.8 (56.7)	73.6 (45.9)	100.6 (45.9)	134.0 (60.4)	***(a,b) ***(b,c) ***(a,c)
Dried pulses	14.6 (20.3)	16.3 (21.4)	14.6 (20.1)	12.9 (19.4)		13.0 (18.6)	11.1 (16.3)	15.2 (18.2)	12.6 (20.8)	
Green vegetables[§]	117.4 (83.8)	139.4 (108.6)	114.2 (58.0)	98.7 (72.4)	**(a,c)	111.3 (67.0)	132.2 (70.8)	117.3 (63.7)	84.8 (57.4)	***(b,c) ***(a,c)
Roots and tubers	64.9 (53.4)	73.9 (63.5)	62.8 (46.6)	58.0 (47.7)		48.7 (40.4)	52.5 (41.7)	48.9 (37.1)	44.9 (42.1)	
Fruit	257.7 (186.6)	342.4 (253.7)	231.1 (128.6)	199.6 (113.6)	***(a,b) ***(a,c)	239.6 (130.2)	293.4 (136.2)	240.7 (116.3)	185.1 (114.9)	*(a,b) **(b,c) ***(a,c)
Sugars	34.1 (36.5)	24.6 (23.3)	32.1 (28.0)	45.6 (49.7)	***(a,c)	26.6 (28.7)	15.2 (16.2)	26.7 (29.6)	37.9 (33.0)	**(a,b) **(b,c) ***(a,c)
Alcoholic beverages	158.9 (174.3)	201.4 (196.7)	175.42 (183.2)	100.0 (117.9)	**(b,c) ***(a,c)	42.4 (83.6)	37.7 (73.5)	49.0 (101.2)	40.6 (73.2)	

[†]Mean (standard deviation). [‡]All cereals with the exception of breakfast cereals, biscuits and pastries which are classified as sweet cereals. [§]All vegetables with the exception of root and tuber vegetables which are classified separately. The number of cases in each tertile are in men, 89/89/89, in women, 101/102/102.
Significant differences between groups a, b and c: *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

energy dense diet. There are no significant differences, in both sexes, in the percentage of energy derived from olive oil and seed oils between high and low energy density consumers.

Discussion

This project is the first to study the energy density of the diet of a developed Mediterranean society (Martí-Henneberg *et al*, 1999). Most of studies in the literature about energy density of the diet have been conducted under controlled laboratory conditions (Bell *et al*, 1998; Stubbs *et al*, 1998; Stubbs *et al*, 1995a,b; Lissner *et al*, 1987) that assure the internal validity of the research. However their lack of external validity complicates the extrapolation of the results of the study to the general population. In a population investigation like this one it is easier to apply the results to the population, although the causal evidence is minimal. Besides, the method used to determine food consumption, allows the estimation of the habitual consumption without interfering with the food habits of interviewed people. Therefore it enables the illustration of spontaneous consumption of diets of differing energy densities.

Our population is classified according to their high, medium or low energy dense diets and adjusted for age by means of a simple linear regression analysis in each sex. This has been done because the age range (25–65 y) was wide enough to introduce differences in food and nutritional consumption.

We are aware of the inaccuracy with the conversion of grams to cubic centimetres in all of the food groups. In some foods the volume may be overestimated and in others underestimated. However it is possible that in terms of overall food volume the differences between them would be compensated.

We believe that in our sample, subjects have diets of spontaneously different energy densities which are not influenced by different energy needs as we have not observed significant differences in weight nor body mass index between subjects who consume diets of different energy densities. But as we have not measured the physical activity of the population, we can not discard the possibility that the lack of significant differences in these anthropometric variables could be explained partially by differences

Table 3 Nutritional intake according to energy density consumption. Men and women (25–65 y)

	Men					Women				
		Energy density					Energy density			
	Mean food intake	*Low*[a]	*Medium*[b]	*High*[c]	P	*Mean food intake*	*Low*[a]	*Medium*[b]	*High*[c]	P
Energy (kJ/d)	9178.3 (2445.4)[†]	8383.5 (2199.3)	9081.0 (2141.8)	10070.4 (2682.9)	***(a,c) *(b,c)	7072.2 (2130.7)	5897.2 (1888.9)	7210.7 (1728.6)	8097.1 (2164.1)	***(a,b) ***(a,c) **(b,c)
Proteins (g/d)	79.4 (22.6)	73.9 (21.6)	78.1 (17.5)	86.3 (26.4)	**(a,c)	64.1 (18.0)	58.6 (19.2)	65.2 (14.7)	68.3 (18.6)	**(a,b) ***(a,c)
CHO (g/d)	216.1 (74.7)	205.9 (65.4)	211.3 (73.7)	231.1 (82.5)		168.6 (63.2)	142.1 (56.4)	169.2 (61.1)	194.2 (61.4)	**(a,b) ***(a,c) *(b,c)
Fat (g/d)	97.2 (30.3)	81.8 (24.6)	96.5 (24.3)	113.4 (32.6)	***(a,c) ***(a,b) ***(b,c)	77.1 (25.9)	61.7 (21.7)	79.4 (19.5)	90.2 (27.5)	***(a,b) ***(a,c) **(b,c)
Proteins (%)	15.6 (2.6)	16.0 (3.0)	15.6 (2.1)	15.2 (2.7)		16.1 (3.1)	17.5 (3.5)	16.1 (2.8)	14.8 (2.3)	**(a,b) ***(a,c) **(b,c)
CHO (%)	41.9 (7.7)	44.3 (7.4)	41.2 (8.1)	40.1 (7.0)	*(a,b) **(a,c)	41.1 (7.7)	41.4 (8.3)	40.2 (7.8)	41.6 (6.7)	
Fat (%)	42.6 (7.2)	39.6 (6.5)	43.3 (7.5)	44.8 (6.6)	**(a,b) ***(a,c)	42.8 (7.0)	41.2 (7.1)	43.8 (6.9)	43.5 (6.4)	*(a,b) *(a,c)
SFA (%)	13.2 (2.9)	12.5 (3.0)	13.4 (2.9)	13.8 (2.6)	*(a,c)	13.9 (3.2)	13.1 (3.4)	14.1 (3.0)	14.4 (3.2)	*(a,c)
ED (kJ/g)	6.3 (1.0)	5.2 (0.6)	6.2 (0.3)	7.3 (0.7)	***(a,b) ***(a,c) ***(b,c)	5.8 (1.0)	4.7 (0.5)	5.7 (0.3)	6.9 (0.7)	***(a,b) ***(a,c) ***(b,c)
FVC (cm^3/d)	1488.3 (407.3)	1618.7 (471.1)	1460.2 (335.4)	1385.8 (372.0)	**(a,c)	1227.9 (315.3)	1247.7 (345.3)	1258.4 (286.1)	1177.8 (309.0)	
Weight (kg)	75.8 (9.3)	76.3 (9.9)	74.9 (9.3)	76.4 (8.6)		62.6 (10.7)	63.9 (10.9)	62.8 (11.3)	61.3 (9.9)	
BMI (kg/m^2)	26.1 (3.0)	25.8 (3.1)	26.1 (2.7)	26.5 (3.2)		24.9 (4.4)	25.1 (4.1)	24.9 (4.6)	24.6 (4.4)	
Age (y)	43.0 (10.1)	42.6 (10.1)	43.8 (10.4)	43.0 (10.2)		41.6 (9.9)	41.8 (9.6)	41.7 (10.0)	41.2 (10.1)	

[†]Mean (standard deviation). The number of cases in each tertile are in men, 89/89/89, in women, 101/102/102.
CHO = Carhohydrates, SFA = Saturated fatty acids, ED = Energy density, FVC = Food volume consumed, BMI = Body mass index.
Significant differences between groups a, b and c. *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

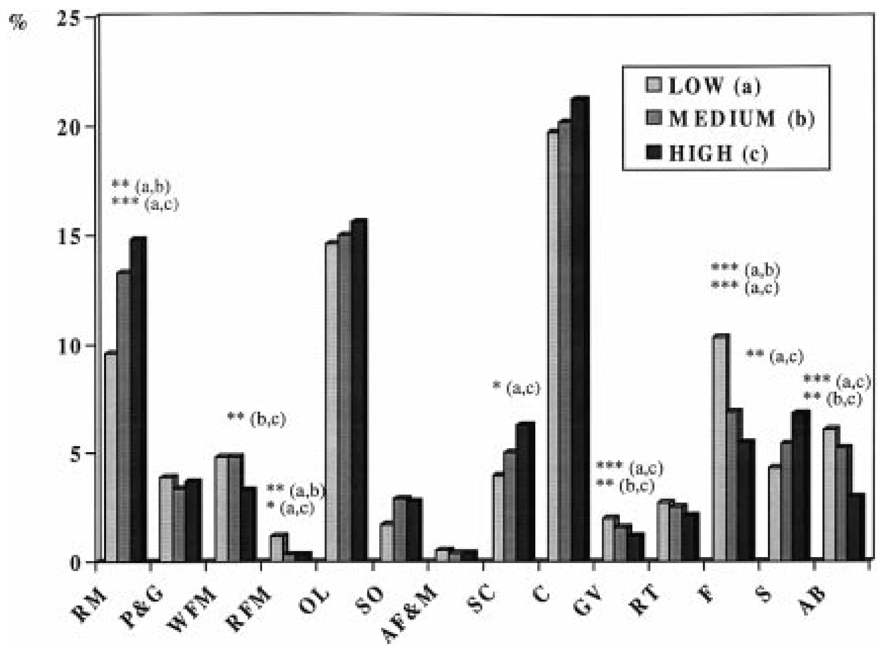

Figure 1 Percentage of energy derived from food groups according to energy density consumption. Men (25–65 y). Significant differences between groups a, b and c: $*P<0.05$, $**P<0.01$, $***P<0.001$.
LOW = low energy density. MEDIUM = medium energy density. HIGH = high energy density. RM = red meat. P&G = poultry and game. WFM = whole fat milk. RFM = reduced fat milk. OL = olive oil. SO = seed oils. AF&M = animal fats and margarines. SC = sweet cereals. C = cereals (all cereals with the exception of breakfast cereals, biscuits and pastries which are classified as sweet cereals). GV = green vegetables (all vegetables with the exception of root and tuber vegetables which are classified separately). RT = roots and tubers. F = fruit. S = sugars. AB = alcoholic beverages.

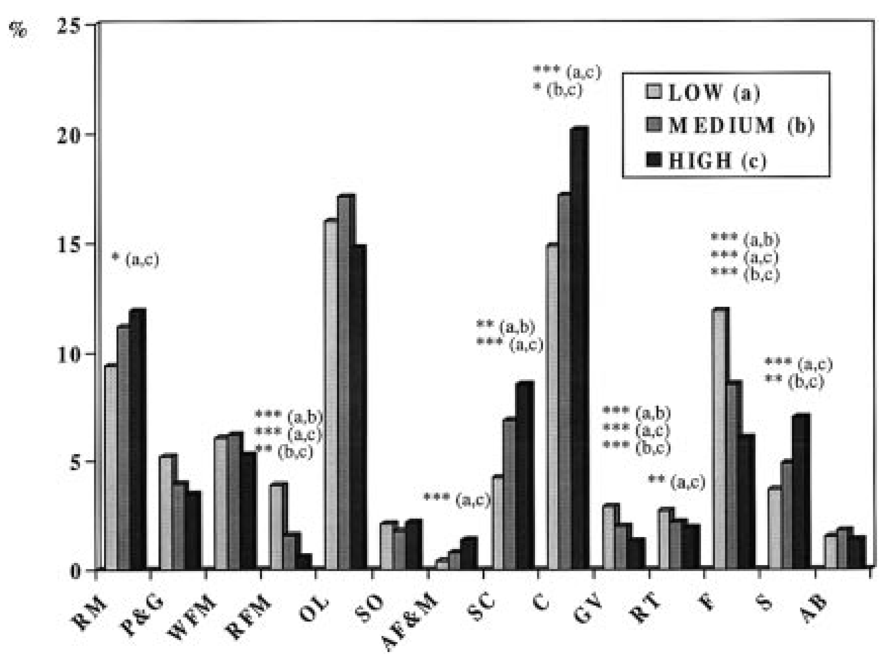

Figure 2 Percentage of energy derived from food groups according to energy density consumption. Women (25–65 y). Significant differences between groups a, b and c: $*P<0.05$, $**P<0.01$, $***P<0.001$.
LOW = low energy density. MEDIUM = medium energy density. HIGH = high energy density. RM = red meat. P&G = poultry and game. WFM = whole fat milk. RFM = reduced fat milk. OL = olive oil. SO = seed oils. AF&M = animal fats and margarines. SC = sweet cereals. C = cereals (all cereals with the exception of breakfast cereals, biscuits and pastries which are classified as sweet cereals). GV = green vegetables (all vegetables with the exception of root and tuber vegetables which are classified separately). RT = roots and tubers. F = fruit. S = sugars. AB = alcoholic beverages.

in physical activity. Also, ours is a cross-sectional study, without subject follow up so we can't determine whether the consumption of high energy dense diets by the population also implies an increase in their weight like Stubbs *et al* (1998; 1995a,b) have observed. Neither we can ascertain if the consumption of low energy dense diets by the population implies a weight loss, which would seem feasible in theory (Drewnowski, 1999).

In accordance with findings of various controlled laboratory studies (Bell *et al*, 1998; Prentice, 1998; Stubbs *et al*, 1998; Stubbs *et al*, 1995a,b; Rolls *et al*, 1988) our population tends to consume a similar food volume independently of the energy density of the diet consumed. Consequently in high energy dense diets people consume significantly more energy. Although there is little difference between the food volume ingested by male high and low energy dense diet consumers, a significantly higher amount of energy is ingested in high compared to low energy dense diets. Our results don't support the existence of spontaneous tendency to adjust the volume of food consumed depending on whether the diet is of high or low energy density as various authors suggest (Tremblay *et al*, 1991; Lissner *et al*, 1987; Kissileff & Van Itallie, 1982; Speigel, 1973).

As has been suggested in animal (Gibbs *et al*, 1973) and also human (Rolls *et al*, 1998) experiments, the volume of food consumed plays an important role in the mechanisms of satiety due to our limited gastric capacity. If we are used to consuming similar food volumes then this wouldn't be crucial to the determination of the energy density of our diet. Consequently, it would be logical to think that the energy density of the diet would directly depend on the ingested energy derived from the different macronutrients. In contrast with other periods of life, like in the first year where proteins and carbohydrates are essential to increase the energy density of the diet (Capdevila *et al*, 1998) the third of our adult population with high energy dense diets consumes a much greater quantity of total fat (32 g more in men and 28 g more in women) and fat energy intake (5.2% more in men and 2.3% more in women) and also of saturated fatty acids (1.3% more in both sexes) compared to subjects with low energy dense diets. They achieve this with their food pattern which is characterised by a superior consumption of animal products, such as red meat, an inferior consumption of vegetable products, such as green vegetables and fruit, and a superior consumption of sugars and olive oil. But there are some differences between male and female high and low energy density consumers. To achieve a high energy density, men, despite increasing the energy derived from all cereals (3.6% more) are consuming more energy derived from red meat (5% more) and sugars (2.5% more) than their low energy density counterparts. Women with high energy dense diets only increase by 2.5% the energy derived from red meat and also increase the energy derived from all cereals (9.7%) more than men and from sugars (3.3%) compared with their low energy density ingesting counterparts.

Men and women with high energy dense diets consume significantly less reduced fat milk and lower quantities of all milks compared to those that have low energy dense diets. This suggests the possible existence of intrinsic physiological regulators of our nutritional intake, such that the consumption of a food rich in nutrient (eg protein derived from milk) would be reduced when the organism already obtains it efficiently from another food source (eg meat).

Olive oil is the visible fat largely consumed in the overall population. Both male and female high energy density consumers have a higher intake of olive oil than their low energy density counterparts. But we have observed that both high and low energy density diets contain a similar percentage of energy derived from olive oil. This suggests that in contrary to what we may think, olive oil is not fundamental in the achievement of a diet of high energy density in our population. In fact, in our Mediterranean culinary tradition, dressing with olive oil is practised very frequently by all of the population.

Men with low energy dense diets consume more alcoholic beverages than their high energy dense counterparts but these beverages contain a low percentage of alcohol (ie beer, wine) because in our country these are the more frequently consumed.

The sources of energy intake in low energy dense diets (Table 3) are different from those recommended by the experts: 12–13% of proteins, 55–60% of carbohydrates, 30–35% of fat, and saturated fatty acids must be a maximum of 10% of fat (Aranceta, 1995; WHO, 1990). But the origin of the energy of the third of the population who consumes a high energy dense diet is even further still from the recommendations (fat energy is 9.8% higher in men and 8.5% higher in women). We think that the nutritional profile of this group constitutes a health risk since high fat diet contents have been related with the development of obesity, cardiovascular diseases, diabetes mellitus and some types of cancer (Pi-Sunyer, 1993). Moreover, the information coming from biochemical, metabolism, epidemiological and food behavioural investigations support the casual role of high energy dense diets and fat rich diets in the development of obesity (Mela, 1997; Poppitt & Prentice, 1996).

The consumption of a diet rich in fat agrees with observed trends in wealthy countries during the last decades: in Mediterranean countries energy derived from fats has increased from 30 to 40% between 1960 and 1980 (Helsing, 1995). In recent decades in Spain similar tendencies have been observed (Arija *et al*, 1996a; Serra-Majem *et al*, 1993). In parallel, the prevalence of obesity is increasing importantly: in Europe it is estimated that half of all adults suffer excess weight and that obesity is approximately 10–20% in adult men and 15–25% in adult women (Seidell & Flegal, 1997); in the United States it is estimated that 54% of the population have excess weight, 22% is obese and they also estimate that if this trend continues the entire adult population of the United States could suffer excess weight in a few generations to come (Hill & Peters, 1998). We should consider that on top of the progressive increase in fat energy observed in

Western societies, the consumption of high energy dense diets rich in fat and in saturated fatty acids by part of the population would represent a greater health risk to them.

In conclusion, our adult Mediterranean population normally consumes a similar food volume, independently of the energy density ingested and therefore consumes more energy in high energy dense diets. Moreover, people who usually consume high energy dense diets have a diet that is eminently rich in fats and saturated fatty acids. Consequently, high energy dense diets in our adult population can represent a health risk due to the relationship between fats and chronic diseases such as cardiovascular, obesity, diabetes and cancer.

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