Diabetologia (2004) 47:367–376
DOI 10.1007/s00125-003-1316-0

Diabetologia

Articles

Nutritional habits of subjects with Type 2 diabetes mellitus in the Mediterranean Basin: comparison with the non-diabetic population and the dietary recommendations. Multi-Centre Study of the Mediterranean Group for the Study of Diabetes (MGSD)

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Abstract

Aims/hypothesis. The aim of this study was to compare the nutritional habits of Type 2 diabetic patients among Mediterranean countries and also with those of their background population and with the nutritional recommendations of the Diabetes and Nutrition Study Group.
Methods. We did a cross-sectional study of 1833 non-diabetic subjects and 1895 patients with Type 2 diabetes, in nine centres in six Mediterranean countries. A dietary questionnaire validated against the 3-Day Diet Diary was used.
Results. In diabetic patients the contribution of proteins, carbohydrates and fat to the energy intake varied greatly among centres, ranging from 17.6% to 21.0% for protein, from 37.7% to 53.0% for carbohydrates and from 27.2% to 40.8% for fat, following in every centre the trends of the non-diabetic population. Furthermore, diabetic patients compared to the corresponding background population had: (i) lower energy intake, (ii) lower carbohydrate and higher protein contribution to the energy intake, (iii) higher prevalence of obesity, ranging from 9 to 50%. The adherence to the nutritional recommendations for proteins, carbohydrate and fat was very low ranging from 1.4 to 23.6%, and still decreased when fibre was also considered.
Conclusion/interpretation. In diabetic patients of the Mediterranean area: (i) dietary habits vary greatly among countries, according to the same trends of the background population; (ii) the prevalence of obesity is much lower than the 80% reported for patients with diabetes in Western countries; (iii) Carbohydrate intake is decreased with a complementary increase of protein and fat consumption, resulting to a poor compliance with the nutritional recommendations. [Diabetologia (2004) 47:367–376]

Keywords Dietary habits · Diabetes · Mediterranean Basin · Recommendations

Received: 4 August 2003 / Revised: 23 October 2003
Published online: 17 January 2004
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Abbreviations: MGSD, Mediterranean Group for the Study of Diabetes · DNSG, Diabetes and Nutrition Study Group · EASD, European Association for the Study of Diabetes · 3-DDD, 3-Day Diet Diary · BMR, basal metabolic rate · WHO, World Health Organization

Changes in the nutritional habits of many populations have been considered, among others, responsible for increased morbidity and mortality from various chronic diseases and also for increased incidence of Type 2 diabetes mellitus [1, 2, 3].

The Mediterranean diet is considered the gold standard of healthy nutrition and is associated with decreased morbidity and mortality, especially from cardiovascular causes [4, 5, 6, 7, 8, 9]. However, there are indications that the Mediterranean diet is changing fast towards a more "westernised" form, as it has been shown from studies in Greece [9, 10].

The rapid changes in dietary habits in the Mediterranean area over the last years and the lack of comparative studies among Mediterranean countries, carried out with the same protocol and methodology, urged the Mediterranean Group for the Study of Diabetes (MGSD) to organise the present Multicentre Study. The main aims were to compare the dietary habits among Mediterranean countries, both in the general and the diabetic population and define what exactly is the contemporary "Mediterranean diet".

Data from this study concerning the general population has shown considerable differences in the qualitative composition of the diet among Mediterranean countries and moreover the nutritional habits in most countries were not in agreement with the widely accepted nutritional recommendations [11], but more importantly, with the traditional Mediterranean diet [12].

In the EURODIAB study, significant differences in several nutrient intakes have been documented in Type 1 diabetic patients among countries in Europe [13]. Moreover, in the same study, low compliance of Type 1 diabetic patients to the nutritional recommendations has been observed. However, there is little evidence about the nutritional habits of subjects suffering of Type 2 diabetes mellitus in a large population sample.

The aim of our study is to compare the nutritional habits of subjects with Type 2 diabetes mellitus among six Mediterranean countries and also with the nutritional habits of their background population and finally to evaluate the compliance with the nutritional recommendations of the Diabetes Nutrition Study Group (DNSG) of the EASD.

Subjects and methods

The study protocol has been described in detail elsewhere [12]. In brief a total of 4254 subjects, 2090 non-diabetic and 2163 with known Type 2 diabetes mellitus were recruited in nine Centres in six Countries. There were three Centres in Greece, which were combined for the analysis, two in Italy and one in Algeria, Bulgaria, Egypt and Yugoslavia (from the regions: Serbia and Montenegro). In the Yugoslavian Centre only diabetic subjects were studied. At least 150 non-diabetic subjects, from a defined geographical region, were recruited in each centre. The subjects were randomly selected either from the electoral lists or other official record, according to the centre. Moreover at least 150 subjects with diabetes mellitus (followed either in diabetes centres or even by private doctors) were recruited from the same area. Only subjects with Type 2 diabetes were recruited. They should have a diabetes duration of at least 2 years, with an age of diagnosis older than 30 years and without a history of ketoacidosis. The present paper focuses on the nutritional data of the diabetic population. For the final evaluation, we studied 1833 non-diabetic subjects (916 men, 917 women) and 1895 diabetic patients (913 men, 982 women), all between 30 to 75 years of age, for whom complete data was available.

Subjects were asked not to change their regular diet before the examination and were studied after an overnight (12-h) fast. A venous blood sample was taken for biochemical measurements, which were done centrally, using standard autoanalyser methodology. A patient report form, comprising demographic data, medical and family history and smoking habits, was filled in. Anthropometric measurements comprised height without shoes, weight with light clothing, waist circumference (midway between the rib cage and the iliac crest), hip circumference (maximal circumference between the iliac crest and the thigh region) and blood pressure in the sitting position, after a 5-min rest (mean of two measurements).

A dietary history method was used to evaluate the dietary habits [12, 14, 15, 16]. The dietary questionnaire, comprising 78 questions, was translated into the local languages and was filled in by a trained examiner (dietician or nurse), during a 30- to 45-min session. The questions referred to the daily or weekly consumption of various foodstuffs (milk, meat, fish, etc) or groups of foodstuffs (fruit, pasta, etc). The estimation of the amounts consumed was based in all centres on standardised household measures and portion sizes were agreed during the training sessions of the examiners and translated into grams. The questionnaires were analysed centrally with a specially constructed computer programme at the Co-ordinating Centre (Diabetes Centre, Athens, Greece). The food composition tables used as database for the analysis were McCance-Widdowson's and Trichopoulou [17, 18] to which data for local specialties (bulgur, couscous, etc) was added, based on information on food composition, provided by each participating centre. Before starting the study the dietary questionnaire was validated, against the 3-Day Diet Diary (3-DDD), two weekdays and a holiday, which has been successfully used in the EURODIAB Study [19]. In a group of 100 subjects (50 non-diabetic and 50 diabetic) from all centres, the dietary questionnaire compared satisfactorily with the 3-DDD, for the parameters used in this study, namely Kcals/day, carbohydrates (g/day), fibre (g/day), proteins (g/day), total fat (g/day) and fat of plant or animal origin (g/day). The correlation coefficients between the two methods for the above parameters were 0.6066, 0.3627, 0.2734, 0.4517, 0.6138, 0.5716, and 0.3417 with a level of significance at least 1% for all. Moreover the mean values found with the two methods were not different for most of the parameters, except for carbohydrates and fibre, for which the mean values found with the questionnaire were higher (207 vs 179 g per day, $p<0.01$ and 21 vs 16 g per day, $p<0.001$, respectively) [12].

The results were expressed as daily intake of energy in Kcals, while the carbohydrate, protein, fat and alcohol intakes were expressed as percent contribution to the daily energy intake. Total fibre intake was expressed both as g/day and g/1000 Kcal of energy. Finally, the ratios of plant to animal fat and slow to fast carbohydrates intake were calculated. All results were adjusted for age.

Exercise was estimated as mild, moderate and vigorous (hours/week). An arbitrary exercise index was computed according to the formula: Exercise Index = (hours of mild exercise per week×1)+(hours of moderate exercise per week×2)+(hours of vigorous exercise per week×3).

Ethics approval for the study was obtained in each individual country, by the appropriate committee. All subjects, who participated to the study, gave their informed consent.

Statistical analysis. Data is presented as Means ± Standard Deviation. Carbohydrate, protein, fat and alcohol intake were expressed as percent contribution to daily energy intake. For continuous variables with normal distribution Student's *t* test was used, for the comparison of two individual groups. Continuous variables with skewed distribution were log-transformed before statistical analysis. Analysis of variance (ANOVA) was used for the evaluation of the differences among the centres. All tests were done after age standardisation in normal population and after age and diabetes duration standardisation in the diabetic population. For the analysis of the individual nutritional data the whole population studied, both diabetic and non-diabetic, was used as standard population. For the analysis of compliance of the diabetic patients to the dietary recommendations, the diabetic population studied was used as standard population. To avoid multiplicity errors, all *p* values were adjusted for multiple comparisons according to Bonferroni. Categorical variables that are presented as percentages and differences were evaluated by the chi-square test, Yate's correction. A *p* value of less than 0.05 was considered statistically significant. The statistical analysis was done with the SPSS 11.5 statistical package (Chicago, Ill.,USA).

Results

The characteristics of the diabetic patients studied are shown, by centre and sex (Table 1). Mean age differed between centres, ranging in men from 51.0 in Egypt to 62.4 in Rome, Italy and in women from 49.7 in Egypt to 63.6 in Rome, Italy thus all data was analysed after age adjustment. Obesity indices (BMI, waist circumference, waist-to-hip ratio) varied significantly among centres. The prevalence of obesity (BMI≥30 kg/m^2) varied also among centres and was generally higher in women in all centres. In men 9% of the subjects were obese in Algeria whereas Pavia, Italy showed the highest prevalence i.e. 35%. In women the prevalence of obesity ranged from 23% in Egypt to 50% in Yugoslavia. Exercise index values showed also great variations between centres. In men it ranged from 17.7 in Pavia, Italy to 73.2 in Egypt, whereas in women from 16.6 to 51.6 in the same centres. Diabetes dura-

Table 1. Characteristics of the diabetic patients by centre and sex

	Algeria	Egypt	Italy-Pavia	Italy-Rome	Greece	Bulgaria	Yugoslavia	p [g] value
Men								
n	89	232	186	57	123	143	83	
Age	54.2±7.5	51.0±7.6	57.1±6.8	62.4±10.6	56.1±6.6	57.7±6.0	59.3±5.5	<0.001
BMI	25.4±2.8[e]	26.4±3.0[f]	28.7±4.1[d]	28.1±3.8	26.9±3.3[f]	28.0±3.6	28.0±2.7	<0.001
Waist	92.3±11.3[e]	87.8±10.7[f]	100.6±10.9[e]	98.2±11.3	95.3±11.1	99.6±10.8	100.0±10.9	<0.001
WHR	0.94±.09[f]	0.90±.15	0.94±.1[f]	0.97±.1[f]	0.96±.11[f]	0.91±.1	0.92±.1	<0.001
Obesity %[a]	9[e]	11[f]	35	32	12[f]	28[d]	27[e]	<0.001
Exercise[b]	27.6±34.9	73.2±35.0[f]	17.7±10.9	28.8±27.9[f]	24.1±33.3	28.0±23.9	29.3±16.4	<0.001
Smoking %	23.5[f]	34.1[f]	34.4[f]	28.1[f]	32.8[f]	23.1[f]	17.3	<0.05
Diabetes duration	5.3±4.7	7.6±6.1	9.4±5.4	9.1±8.3	9.9±7.8	10.3±7.2	8.7±5.5	<0.001
Diet only %	11.4	0	18.3	12.3	23.0	4.9	21.7	<0.001
OHA %[c]	81.8	91.4	76.7	71.9	54.9	59.4	73.5	<0.001
Insulin %	6.8	8.6	5.0	15.8	22.1	35.7	4.8[d]	<0.001
Women								
n	125	221	132	125	149	145	85	
Age	50.3±10.1	49.7±7.4	57.4±5.7	63.6±10.1	57.2±6.1	57.9±6.0	58.5±5.5	<0.001
BMI	27.0±6.7	28.8±4.4	29.7±4.6	29.1±4.5	28.9±3.7	28.7±4.8	30.5±4.6	<0.001
Waist	88.4±11.2	91.4±11.9	95.1±11.5	95.8±11.2	92.2±11.0	94.2±10.8	96.9±11.1	<0.001
WHR	0.85±.1	0.90±.1	0.87±.1	0.89±.1	0.88±.1	0.83±.1	0.86±.1	<0.001
Obesity %[a]	23	33	46	42	41	41	50	<0.001
Exercise[b]	22.5±17.9	51.6±17.8	16.6±32.2	19.1±17.9	27.1±20.7	31.2±18.1	30.4±13.8	<0.001
Smoking %	0.9	0.9	11.5	3.3	12.2	11.8	14.3	<0.001
Diabetes duration	5.8±4.5	8.0±5.9	9.6±6.9	9.6±6.7	9.3±6.1	10.4±7.2	8.8±5.5	<0.001
Diet only %	7.9	0.9	25.4	2.4	22.1	6.9	11.6	<0.001
OHA %[c]	79.5	89.6	72.2	78.4	54.1	51.7	74.1	<0.001
Insulin %	12.6	9.5	2.4	19.2	23.8	41.4	14.3	<0.001

[a] BMI≥30.0, [b] Exercise Index, [c] Oral Hypoglycaemic Agents
[d] $p<0.05$, [e] $p<0.01$, [f] $p<0.001$ between sexes, adjusted for multiple comparisons according to Bonferroni, [g] p value with ANOVA among centers

Table 2. Daily energy intake and percent contribution of each individual nutrient to it in diabetic patients in comparison to their non-diabetic background population by center, in men

		Energy (Kcal/day)	Kcal\Kg	Prot%	Fat%	CHO%	Alcohol%	Fibre g/day
AL	D	2216.8±622[c]	30.1±8.6[c]	20.2±3.7[c]	37.5±6.4[b]	42.0±7.4[c]	0.3±4.6	19.7±7.4[c]
	N	2747.9±742	38.0±11.2	17.8±2.8	33.9±6.6	47.8±7.6	0.4±5.2	20.8±8.9
EG	D	1953.2±648[C]	24.6±9.1[c]	17.6±3.0[c]	29.3±7.5[b]	53.0±7.5[c]	0.1±4.5	28.6±7.5[a]
	N	2422.3±748	31.3±11.2	15.7±2.8	26.5±6.6	57.7±7.6	0.0	31.1±8.9
I-P	D	2004.3±617[c]	24.8±8.1[c]	17.7±3.5[c]	30.3±6.7[a]	44.3±6.7[b]	7.6±4.5[a]	19.8±7.8[a]
	N	3049.4±747	40.5±11.2	15.3±2.8	29.4±6.6	46.3±7.6	9.0±5.3	21.5±8.8
I-R	D	1514.0±629[c]	20.1±8.8[b]	20.5±3.6[c]	29.7±6.9	44.1±7.5	5.6±4.9[b]	19.0±7.9
	N	1824.8+745	23.8±11.1	17.4±2.8	28.3±6.6	45.5±7.6	8.8±5.3	18.6±8.8
GR	D	2192.7±616[a]	28.2±8.8[a]	18.1±3.5[c]	40.8±6.8[c]	38.4±7.3[c]	2.7±4.8[c]	25.2±7.8
	N	2545.5±746	32.0±11.2	13.4±2.8	36.5±6.6	45.1±7.6	5.0±5.2	23.6±8.8
B	D	2620.5±619[c]	31.6±8.2[c]	20.6±3.5[c]	38.9±6.8[a]	37.8±7.4[c]	2.7±4.8[c]	24.7±7.8[a]
	N	3322.3±744	40.8±11.1	15.6±2.8	37.2±6.6	42.4±7.6	4.8±5.2	21.8±8.8
Y	D	1933.3±621	23.8±8.5	20.3±3.6	27.2±6.8	51.7±7.4	0.8±4.8	26.3±7.8
	N	–	–	–	–	–	–	–
P[d]	D	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	N	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

AL=Algeria, EG=Egypt, I-P=Italy Pavia, I-R=Italy Rome, GR=Greece, B=Bulgaria, Y=Yugoslavia, D=diabetic patients, N=non-diabetic subjects
Age-standardised values using the pooled sample of all non-diabetic and diabetic subjects as standard. In diabetic subjects, in addition values were standardised for diabetes duration

[a] $p<0.05$, [b] $p<0.01$, [c] $p<0.001$ between diabetic patients and non-diabetic subjects, adjusted for multiple comparisons according to Bonferroni
[d] p value with ANOVA among centers

Table 3. Daily energy intake and percent contribution of each individual nutrient to it in diabetic patients in comparison to their non-diabetic background population by centre, in Women

		Energy (Kcal/day)	Kcal\Kg	Prot%	Fat%	CHO%	Alcohol%	Fibre g/day
AL	D	2030.5±558[c]	31.1±8.8[c]	19.2±3.6[a]	38.0±6.9	42.8±7.3[a]	0.0	18.2±7.5
	N	2549.9±672	39.1±11.3	17.6±3.1	35.4±6.9	46.7±6.9	0.02±2.9	21.6±9.0
EG	D	1866.4±574[c]	23.4±9.1[c]	18.0±3.7[c]	29.2±7.1[c]	52.9±7.5[c]	0.0	27.0±7.7[c]
	N	2403.6±667	31.2±11.2	16.0±3.0	25.3±6.7	58.6±7.2	0.0	31.7±8.9
I-P	D	1660.0±538[c]	23.1±8.5[c]	19.4±3.4[c]	33.8±6.6[a]	45.5±7.0[b]	1.3±1.4[c]	19.0±7.2
	N	2165.0±668	34.9±11.2	16.8±3.1	32.6±6.8	47.6±7.2	3.0±2.8	20.2±9.0
I-R	D	1357.7+576[b]	19.2±9.1[c]	20.9±3.7[c]	30.2±7.1	47.9±7.5[a]	0.9±1.5[b]	19.5±7.7
	N	1561.1±662	23.2±11.2	18.5±3.0	30.3±6.7	49.3±7.1	1.9±2.8	17.6±8.9
GR	D	1963.7±538[a]	27.7±8.5[b]	18.6±3.4[c]	39.6±6.6	41.2±7.0[c]	0.6±1.4[a]	23.4±7.2
	N	2244.6±665	31.8±11.2	13.8±3.0	39.4±6.7	45.6±7.2	1.3±2.8	22.8±8.9
B	D	2128.8±541[c]	28.9±8.6[c]	21.0±3.5[c]	40.3±6.7	38.3±7.1[c]	0.4±1.4[a]	20.6±7.3
	N	2503.2±667	36.9±11.2	16.7±3.0	40.2±6.7	41.5±7.2	1.4±2.8	21.1±8.9
Y	D	1711.4±740	22.7±8.6	20.5±3.4	27.5±6.7	51.7±7.0	0.2±1.4	24.3±7.2
	N	–	–	–	–	–	–	–
P[d]	D	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	N	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

AL=Algeria, EG=Egypt, I-P=Italy Pavia, I-R=Italy Rome, GR=Greece, B=Bulgaria, Y=Yugoslavia, D=diabetic patients, N= non-diabetic subjects
Age-standardised values using the pooled sample of all non-diabetic and diabetic subjects as standard. In diabetic subjects, in addition values were standardised for diabetes duration

[a] $p<0.05$, [b] $p<0.01$, [c] $p<0.001$ between diabetic patients and non-diabetic subjects, adjusted for multiple comparisons according to Bonferroni
[d] p value with ANOVA among centres

Table 4. Comparison of fibre intake (g/1000Kcals), plant to animal fat ratio and slow to fast carbohydrates ratio between diabetic patients and background population, by sex and centre

		Men			Women		
		Plant/ Animal Fat	Fibre g/ 1000 Kcal	Slow/ Fast CHO	Plant/ Animal Fat	Fibre g/ 1000 Kcal	Slow/ Fast CHO
Algeria	D	1.6±0.9	9.2±2.8[c]	3.4±1.8[c]	1.6±1.0[a]	9.2±3.4[a]	2.9±2.1[c]
	N	1.3±1.5	7.9±2.9	2.2±1.8	1.2±1.2	8.2±3.2	1.7±1.6
Egypt	D	1.5±0.9[c]	14.9±3.0[c]	4.6±2.0[c]	1.5±1.0[c]	14.8±3.5[c]	5.0±2.2[c]
	N	1.8±1.4	12.9±2.9	3.2±1.8	1.8±1.2	13.3±3.2	3.3±1.5
Italy—Pavia	D	1.1±0.9	10.0±3.2[c]	2.3±1.9[a]	1.4±0.9	11.6±2.3[c]	2.3±2.0
	N	1.2±1.4	7.4±2.9	2.8±1.8	1.2±1.2	9.5±3.2	1.9±1.6
Italy—Rome	D	1.1±0.9	13.0±3.2[c]	2.2±1.9	1.1±1.0	14.7±3.5[c]	2.2±2.2
	N	1.4±1.5	10.5±2.9	2.5±1.8	1.4±1.2	11.6±3.2	2.3±1.5
Greece	D	1.9±0.9[c]	11.7±3.2[c]	2.1±1.9	1.8±0.9[c]	12.1±3.3[c]	1.7±2.0
	N	2.8±1.4	9.7±2.9	2.2±1.8	2.7±1.2	10.6±3.2	1.8±1.6
Bulgaria	D	0.8±0.9[c]	9.7±3.2[c]	2.8±1.9	0.8±0.9[c]	9.9±3.3[c]	2.5±2.1
	N	1.2±1.4	6.8±2.9	3.1±1.8	1.2±1.2	8.6±3.2	2.6±1.6
Yugoslavia	D	0.8±0.9	14.1±3.2	3.9±1.9	0.8±0.9	14.8±3.3	3.0±2.0
	N	–	–	–	–	–	–
p [d]	D	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	N	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Age-standardised values using the pooled sample of all non-diabetic and diabetic subjects as standard. In diabetic subjects, in addition values were standardised for diabetes duration

[a] $p<0.05$, [b] $p<0.01$, [c] $p<0.001$ between diabetic patients and non-diabetic subjects, adjusted for multiple comparisons according to Bonferroni, [d] p value with ANOVA among centres, D=diabetic patients, N=non-diabetic subjects

tion varied also between centres but not between sexes and it ranged from 5.3 years in Algeria to 10.4 in Bulgaria. Most subjects were treated with oral hypoglycaemic agents (51.7 for Bulgarian women to 91.4 for Egyptian men).

The daily energy intake and percent contribution of each nutrient to it is shown, in men and women respectively, in comparison to the dietary habits of the background population (Tables 2 and 3). The daily energy intake, both in Kcals/day and in Kcals/kg of body weight, was generally less in diabetic patients compared to the non-diabetic subjects in both sexes, but varied between centres. Significantly less diabetic subjects (44.0 vs 67.6%) had energy intake higher than 1.2 times the Basal Metabolic Rate (BMR), as calculated by the WHO formula. Proteins contributed more to the daily energy intake of the diabetic patients in both sexes compared to the non-diabetic subjects, exceeding 15% in all centres, but showing variation among them. In contrast, carbohydrates contributed less to the daily energy intake of the diabetic patients in both sexes compared to the non-diabetic subjects, counting for less than 50% in most centres, except Egypt, but showing variations among centres. Fat also contributed more to the daily energy intake of the diabetic patients compared to the non-diabetic subjects in men and in some centres in women too, showing also variations among centres. Alcohol consumption was estimated only in the non-Islamic countries and was generally less in diabetic patients compared to their background population.

The plant to animal fat and slow to fast carbohydrates ratios as well as fibre consumption in grams per 1000 Kcals of energy are shown in diabetic men and women in comparison to the background population (Table 4). Diabetic subjects consume generally more fibres per 1000 Kcals than non-diabetic subjects in both sexes and all centres.

The proportion of subjects who meet the nutritional recommendations of the DNSG is shown, by centre and type of treatment (Tables 5, 6). Compliance differed significantly among centres for all nutrients, ranging for example, after age-standardisation, from 3.5% in Bulgaria to 56.4% in Egypt for carbohydrates, and from 5.7% in Bulgaria to 67.3% in Yugoslavia for fat. The proportion of subjects complying with the Recommendations for all four parameters is extremely low in all centres. Compliance according to the treatment of diabetes was not different in all centres, except in Egypt, where diet-treated patients showed the lowest compliance.

Table 5. Percent of the diabetic patients (crude and standardised values) who meet the nutritional recommendations of the DNSG by centre and treatment

		CHO		PROT		FAT	
		CRUDE	ST[a]	CRUDE	ST[a]	CRUDE	ST[a]
Algeria	Diet	15.6	11.8	68.8	70.2	15.6	14.1
	Tablets	18.5	18.6	54.1	55.4	11.5	10.4
	Insulin	20.8	11.2	75.0	49.4	12.5	9.8
	Total	**18.3**	**17.5**	**58.7**	**57.3**	**12.2**	**10.7**
Egypt	Diet	75.0	36.7	50.0	25.0	75.0	36.8
	Tablets	64.0	54.4	90.9	92.9	55.9	46.0
	Insulin	85.4	89.8	75.6	83.4	78.0	85.1
	Total	**66.1**	**56.4**	**89.1**	**91.5**	**58.1**	**48.2**
Italy-Pavia	Diet	27.0	26.3	67.6	68.1	44.6	44.5
	Tablets	21.2	20.7	66.5	65.7	36.3	33.7
	Insulin	46.2	43.3	76.9	81.6	53.8	49.5
	Total	**23.7**	**23.1**	**67.2**	**65.9**	**39.1**	**37.8**
Italy-Rome	Diet	20.8	13.5	41.7	38.3	45.8	48.2
	Tablets	31.4	25.3	42.4	35.8	50.0	51.3
	Insulin	36.4	52.0	39.4	38.7	45.5	58.4
	Total	**30.9**	**25.8**	**41.7**	**37.9**	**48.6**	**46.4**
Greece	Diet	9.7	9.2	76.4	77.6	8.3	8.1
	Tablets	7.9	6.1	69.1	65.9	8.6	6.8
	Insulin	11.1	9.4	57.1	56.1	7.9	7.8
	Total	**9.1**	**7.6**	**68.2**	**67.0**	**8.4**	**7.2**
Bulgaria	Diet	2.1	1.6	76.6	77.7	2.1	3.3
	Tablets	6.4	5.7	42.4	41.5	7.2	6.4
	Insulin	3.6	3.2	38.7	35.0	4.5	4.0
	Total	**4.6**	**3.5**	**46.6**	**47.1**	**5.3**	**5.7**
Yugoslavia	Diet	72.7	62.2	57.6	49.3	75.8	66.8
	Tablets	56.3	53.6	46.4	41.4	71.4	67.1
	Insulin	56.3	51.2	43.8	43.2	62.5	59.9
	Total	**59.6**	**56.2**	**48.4**	**42.9**	**71.4**	**67.3**
Grand total	Diet	22.7		67.8		29.4	
	Tablets	35.7		66.6		38.0	
	Insulin	25.6		51.9		25.9	
	Total	**32.0**		**64.4**		**34.7**	

[a] Standardised for age and diabetes duration using the pooled sample of all diabetic subjects as standard

Discussion

This study describes and compares the dietary habits of a large number of Type 2 diabetic subjects in Mediterranean countries, among them and with the corresponding background population, studied with the same standardised methodology. Previously there were only data deriving from small studies, using different methodologies and not primarily aiming at the comparison of dietary habits among countries [20, 21].

The dietary history method used is considered reliable, since it is a generally accepted method [22] and because it has been validated, especially for this study, against a frequently used method, the 3-DDD, in a representative group of subjects, both normal and diabetic, from all centres [12]. The use of the same Questionnaire and especially the same technique of completing it, by specially trained personnel, and the adjustment for age assure that the results are absolutely comparable among and within countries.

Although it is generally accepted that about 80% of Type 2 diabetic patients are obese [23, 24], this was not found in the Mediterranean countries studied. The

Table 6. Percent of the diabetic patients (crude and standardised values) who meet the nutritional recommendations of the DNSG by center and treatment

		FIBER		ALL[A]		ALL[B]	
		CRUDE	ST[a]	CRUDE	ST[a]	CRUDE	ST[a]
Algeria	Diet	9.4	13.8	9.4	7.5	0	0
	Tablets	6.5	5.8	3.1	3.5	2.5	2.2
	Insulin	16.7	9.2	8.3	4.9	4.2	4.9
	Total	**8.1**	**6.6**	**4.6**	**4.3**	**2.3**	**2.0**
Egypt	Diet	25.0	12.3	25.0	12.5	0	0
	Tablets	34.8	29.2	24.7	22.2	24.2	18.1
	Insulin	27.5	17.5	39.0	58.9	17.1	11.2
	Total	**34.1**	**28.5**	**26.0**	**23.6**	**23.3**	**17.2**
Italy-Pavia	Diet	6.7	6.0	18.7	18.0	2.7	2.5
	Tablets	13.0	13.9	10.0	8.9	3.7	3.9
	Insulin	0	0	30.8	31.0	0	0
	Total	**10.9**	**10.5**	**13.0**	**11.8**	**3.3**	**3.2**
Italy-Rome	Diet	0	0	8.0	5.4	0	0
	Tablets	2.4	3.1	15.3	10.3	0.8	0.9
	Insulin	6.5	13.9	15.2	24.3	0	0
	Total	**2.8**	**3.5**	**14.3**	**10.1**	**0.5**	**0.3**
Greece	Diet	26.8	26.6	2.8	2.8	0	0
	Tablets	22.6	22.9	1.4	2.7	2.1	1.3
	Insulin	24.2	24.4	0	0	0	0
	Total	**24.1**	**24.6**	**1.4**	**1.4**	**1.1**	**0.7**
Bulgaria	Diet	21.3	21.5	0	0	0	0
	Tablets	21.4	24.0	3.1	2.7	0	0
	Insulin	11.8	10.7	0.9	0.8	0.9	0.8
	Total	**17.7**	**18.7**	**1.7**	**1.5**	**0.3**	**0.3**
Yugoslavia	Diet	20.0	14.7	24.3	23.0	13.5	10.5
	Tablets	24.6	22.0	22.6	20.2	9.6	8.2
	Insulin	18.8	18.0	25.0	20.1	6.3	9.8
	Total	**23.0**	**19.5**	**23.2**	**20.1**	**10.1**	**8.2**
Grand total	Diet	15.6		10.6		2.4	
	Tablets	21.0		13.8		9.7	
	Insulin	16.4		10.8		3.4	
	Total	**19.5**		**12.8**		**7.5**	

[a] Standardised for age and diabetes duration using the pooled sample of all diabetic subjects as standard

[A] Recommendations for all nutrients except fibre
[B] Recommendations for all nutrients including fibre

prevalence of obesity varied greatly among centres, ranging from the lowest 9% in men in Algeria to the highest 50% in Yugoslavian women, which, is much lower than the 80% reported for subjects with diabetes. The reasons for the differences among countries could theoretically be ascribed to ethnic, genetic and environmental influences, determining the prevalence of obesity in each country. Thus, the prevalence of obesity in the diabetic patients should be considered in relation to its prevalence in the background population. With this kind of approach, the prevalence of obesity in diabetic patients is more than twice higher than that reported in earlier publications from this study for their background population [12]. This is observed in every centre considered individually, although differences among centres exist also in the background population.

The degree of obesity is influenced by the energy intake and the energy expenditure. The estimate of the amount of exercise in our cohort was not done with a very sensitive methodology; however, the method was the same for all centres and showed great differences among them. Certainly, the interactions between obesity, exercise and energy intake are very complicated and their effect is expressed over a long time and thus cannot be evaluated in a cross-sectional study.

The qualitative composition of the diet of Type 2 diabetic patients varied greatly among Mediterranean countries, probably reflecting geographic, cultural and socio-economic variations. The most striking differences were observed in the contribution of fat to the energy intake. Such differences in fat intake among countries in Europe have been already documented in Type 1 diabetic patients in the EURODIAB study [13]. However the effect of dietary fat on health is not only determined by the amount, but even more by the quality of fat [25]. The high-fat intake in Greece is in line with the findings of the EURONUT SENECA study [26] in non-diabetic elderly subjects and in the EURODIAB study [13] in Type 1 diabetic subjects. In the present study, the contribution of fat to the energy intake was similar in Bulgaria and Greece, but the source of origin of fat, as described by the plant to animal fat ratio was quite different. In Greece the ratio was the highest and in Bulgaria the lowest among the countries studied, meaning that the fat used in Greece was mainly of plant origin and in Bulgaria of animal origin. It is well known that olive oil is the predominant source of fat in Greece and the high-fat intake in this country is associated with decreased coronary heart disease morbidity and mortality in the non-diabetic population, as observed in the Seven Counties Study [6]. The association between the Mediterranean type of diet and decreased mortality has been recently reconfirmed in the general population in Greece [27]. Such a decrease is also expected, but still has not been documented for Type 2 diabetic patients. Furthermore, these patients could benefit even more by this kind of diet, since some studies have shown that high monounsaturated fat diets seem to be associated with a reduction of insulin resistance [28] and improvement of glucose disposal [29].

Carbohydrate contribution to the energy intake was far below the recommended range of 50% in all centres, except Egypt and Yugoslavia. This is in line with the findings in Type 1 patients, where in none of the 31 centres in Europe, carbohydrate contribution reached the desired 50% [13]. This fact might reflect the traditional "fear" of subjects suffering from diabetes to consume foods high in "sugars", despite the explanations given to them by doctors and dieticians regarding the beneficial effects of high carbohydrate diets [11, 29, 30]. The potential to reduce postprandial blood glucose peaks and to optimise diabetes control by selecting carbohydrate source, reflected by the glycaemic index, has been shown at least in Type 1 diabetes [31]. In the present study the glycaemic index was not calculated, but a slow to fast carbohydrate ratio was used as an indirect indicator of the rate of carbohydrate absorption. No difference was observed between normal and diabetic subjects, except for Egypt and Algeria. Another surrogate indicator of the glycaemic index, high fibre intake, is related to a reduction in HbA_{1c} values in European people with Type 1 diabetes [32]. In our cohort, Type 2 diabetic patients consume more grams of fiber per 1000 Kcals compared to their background population, showing an effort to comply with the nutritional instructions given to them.

Nutritional recommendations for diabetic patients resemble the "healthy pattern of diet" for the general population and they are quite flexible. Although dieticians and doctors try to adapt the instructions to each patient's individual needs, compliance to these recommendations seems to be quite difficult. Thus in a study of 92 Type 1 and Type 2 diabetic patients, less than 10% adhered to the recommendations for individual nutrients [33]. In the EURODIAB study, the proportion of Type 1 diabetic patients who achieved the recommended intake for protein was 77%, whereas for carbohydrates and fat it was very low (15% and 14% respectively). In contrast, in our study, the compliance varied greatly among centres but in most of them it was much better than in the EURODIAB study, reaching an overall compliance of 32% for carbohydrates and almost 35% for fat. Patients treated with insulin, as in the EURODIAB study, have a usually closer supervision and receive more frequently nutritional instructions, thus they are expected to adhere better to the nutritional recommendations. However, in our study, insulin-treated Type 2 diabetic patients did not show better compliance than subjects on diet or oral antidiabetic agents, although their compliance for carbohydrates and fat was much higher in at least four centres compared to that observed in the EURODIAB Study [13]. Thus it seems that Type 2 patients adhere much better to the nutritional recommendations compared to Type 1 diabetic patients, irrespective to the therapeutic regime they are following.

The standard of dietary habits is better reflected by the compliance to the recommendations concomitantly for the three major nutrients. Thus, in contrast to other studies, the compliance for protein, fat and carbohydrates together was also considered and it is of concern that very few diabetic patients comply for all three nutrients. Moreover, even fewer patients (less than 10%) comply with the recommendations for all nutrients plus fibre. This might reflect the general difficulty faced by adults to change their lifestyle, since eating habits are founded early in life. The higher rate of compliance in Egypt is probably due to cultural and socioeconomic reasons as well as local food specialities, since the dietary pattern of the background population is also much closer to the recommendations than in the other countries studied [12]. Yugoslavia has a very high rate of adherence to the recommendations, especially for fat, the importance of which in diabetes is well documented. This is encouraging since improvement of implementation, in clinical practice, seems feasible. Thus nutritional education must be reinforced and repeated regularly having good prospects for improvement of the dietary habits.

In summary, in the Mediterranean countries studied, the prevalence of obesity among diabetic patients is much lower than the 80% reported for patients with diabetes in Western countries. The dietary habits of the diabetic population vary greatly among countries, according to the same trends of the background population. However, the caloric intake is less in diabetic patients than in their background population in each centre, and moreover the carbohydrate contribution to the energy intake is less, reflecting the fear for starchy foods. Unfortunately, few diabetic patients adhere to the nutritional recommendations tailored for them, but improvement of their compliance seems feasible.

Acknowledgements. We thank all the subjects who took part in this study. The study is part of the Multicentre Nutritional Study of the Mediterranean Group for the Study of Diabetes (MGSD) and it was financially supported by the MGSD, NOVO NORDISK A/S and FARMASERVE HELLAS. We would like also to thank Prof. A. Tzonou for statistical help, Ms. E. Antoniadou and Ms. M. Panagiotopoulou for secretarial support and Ms. P. Maraki for laboratory assistance.

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