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ORIGINAL CONTRIBUTION

F.J. Sánchez-Muniz
S. Bastida
C. Cuesta
A. Domingo

Lipaemia and lipoproteinaemia in a Spanish male nonsmoker population consuming sunflower oil

Lipämie und Lipoproteinämie bei spanischen männlichen Nichtrauchern, die Sonnenblumenöl verzehren

Summary The aim of this study was to assess the prevalence of altered levels of serum lipids, lipoproteins and apolipoprotein (Apo) B in very active, 20 to 65 year-old, Spanish male nonsmokers who consumed sunflower oil. Among the 169 participants, total serum cholesterol (TC), triglycerides (TG), LDL-C, and TC/HDL-C were found to be age-dependent variables. A detailed study over a 12-day period showed that this population displayed a Mediterranean dietary pattern, with the exception of the substitution of sunflower for olive oil. Saturated, monounsaturated and polyunsaturated fatty acids represented 9.9 %, 12.7 % and 8.8 % of the total amount of energy, respectively. The cholesterol-saturated fat index of the average diet was 19.2 per 1 000 kcal, whereas the Keys index of the diet was 27.1. Daily intakes of fibre, ascorbic acid and vitamin E were 25.1 g, 89.6 mg and 28.3 mg, respectively. The calcium/magnesium ratio of the average diet was 1.54. The low percentage of individuals with high TC levels (5.4 % with TC ≥ 6.49 mmol/L), high TG levels (3.7 % with TG ≥ 2.25 mmol/L), high Apo B levels (3.0 % with ≥ 1.5 g/L), low levels of HDL-C (0.7 % with ≤ 0.91 mmol/L), high LDL-C levels (1.4 % with ≥ 4.94 mmol/L or a high TC/HDL-C ratio (2.8 % with ≥ 5.0) suggest a reasonable protection against coronary heart disease in this Spanish population.

Zusammenfassung Die Absicht dieser Studie war es, die Prävalenz der veränderten Serumspiegel von Lipiden, Lipoproteinen und Apolipoproteinen (Apo) B bei 169 spanischen, männlichen, sehr aktiven Nichtrauchern im Alter von 20 bis 65 Jahren, die Sonnenblumenöl verzehren, zu erforschen. Die Serumwerte, die für Cholesterin (TC), Triglyceride (TG), LDL-Cholesterin und für den TC/HDL-Cholesterin-Quotient erhalten wurden, waren altersbedingt unterschiedlich. Ein detailliertes Ernährungsprotokoll über einen Zeitraum von 12 Tagen zeigte, daß die Diät der Probanden typisch mediterran war, mit der Ausnahme des Verzehrs von Sonnenblumenöl – statt Olivenöl. Der Beitrag von gesättigten, einfach- und mehrfach ungesättigten Fettsäuren zur gesamten Kcal-Aufnahme war je 9,9 %, 12,7 % und 8,8 %. Der Index Cholesterin/gesättigtem Fett in der Diät betrug im Mittel 19,2 per 1 000 Kcal, während der Keys-Index der Diät 27,1 war. Die tägliche Aufnahme an Ballaststoffen, Ascorbinsäure und Vitamin E betrug jeweils 25,1 g, 89,6 mg und 28,3 mg. Der Kalzium/Magnesium-Quotient betrug 1,54. Der niedrige Anteil an Männern mit hohem Cholesterinspiegel (5,4 % mit TC ≥ 6,49 mmol/L), hohen TG-Werten (3,7 % mit TG ≥ 2,25 mmol/L), hohen Apo B-Werten (3,0 % mit ≥ 1,5 g/L), niedrigen HDL-Cholesterin-Werten (0,7 % mit ≤ 0,91 mmol/L), hohen LDL-Cholesterin-Werten (1,4 % mit ≥ 4,94 mmol/L) oder mit einem hohen Wert des TC/HDL-Cholesterin-Quotienten (2,8 % mit ≥ 5,0) läßt einen ausreichenden Schutz gegen zukünftige koronare Herzleiden erwarten.

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Prof. F.J. Sánchez-Muniz (✉) · S. Bastida
Departamento de Nutrición I
Sección Lípidos
Facultad de Farmacia
Universidad Complutense
28040 Madrid, Spain

C. Cuesta
Instituto de Nutrición y Bromatología
Consejo de Investigaciones Científicas
Facultad de Farmacia
Universidad Complutense
28040 Madrid, Spain

A. Domingo
Grupo de Estudios Cardiovasculares de las Fuerzas Armada
Servicio de Medicina Interna
Hospital Militar Generalísimo Franco
28015 Madrid, Spain

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Schlüsselwörter Diät – Cholesterinspiegel – Serumtriglyceride – HDL-Cholesterin – LDL-Cholesterin – Apo B – Hyperlipoproteinämie – Nichtraucher

Introduction

Epidemiological studies have demonstrated that low concentrations of high-density lipoprotein (HDL) cholesterol and/or high concentrations of low-density lipoprotein (LDL) cholesterol in plasma are associated with an increased risk of coronary heart disease (CHD) (5, 16). The involvement of dietary components as well as dietary habits in the major public diseases has been demonstrated. Fatty acids are one of the most important dietary factors determining plasma lipid concentrations, and consequently CHD (11, 16, 19, 20, 33). Other dietary components such as fibre, types of protein, minerals and vitamins have also been related to plasma lipid concentrations and CHD development (1, 15, 21, 24, 39).

Although CHD morbidity and mortality are still rather low in Spain (3), a dramatic increase was seen between 1970 and 1983, and only minor changes have occurred from that period to the present (3). As yet, however, it has not been possible to determine a cause-and-effect relationship with the intake of any foodstuff or nutrient which might explain this situation. Experts have claimed the need to avoid further changes in the current Spanish diet (3). In Spain, the use of vegetable oils other than olive oil has recently increased considerably. Both for direct consumption and for frying purposes, sunflower oil in particular has substituted olive oil (23). At present, in many Spanish Autonomous Communities sunflower oil is the oil most consumed at home. Economic reasons are related to this important change in Spanish dietary habits. A decreased consumption of legumes and cereal products and an increased intake of milk and other dairy products has also been reported (23).

Cigarette smoking is considered to be a major CHD risk factor (16). Smoking may be associated with a change in dietary habits, both in food pattern and in nutrient intake, which could contribute to the increased risk of CHD in smokers as compared to nonsmokers. Conversely, giving up the habit may be followed by dietary changes that are likely to reduce the risk of CHD. Thus, dietary modifications after giving up smoking may account for a decrease in CHD (38). These were the main reasons for using nonsmokers in this study.

The purpose of the current study was to assess the lipid and lipoprotein profile of very active, Spanish male nonsmokers, and to learn the percentage of individuals with altered serum lipid and lipoprotein levels. The men chosen ranged from 20 to 65 years of age, led a similar life-style and consumed diets containing sunflower oil. The results obtained from this population will serve as a standard for future studies.

Subjects and methods

Population sample

The sampling frame was the male military population in the Madrid, Spain area. A barracks in this area was selected at random. Smokers, men who had stopped smoking less than 5 years before, individuals whose daily ethanol intake was over 40 g (41), diabetics, defined according to the criteria of the National Diabetes Data Groups (26), those whose body mass index (calculated as weight [kg] divided by height^2 [m^2]) exceeded 30 (29), and those whose diastolic blood pressure was above 95 mm Hg (36) were excluded from the study.

A total of 164 male, 20 to 65 year-old nonsmokers, who resided in the barracks during the entire study were tested. The response ratio was 100 %. Participants were considered very active individuals, taking into account their energy expenditure throughout an average day. Some anthropometric characteristics and clinical data are presented in Table 1.

Dietary sampling and dietary assessment

Dietary intake was measured according to the weighed inventory method (16). All ingredients used in the preparation of the dishes were weighed. Cooked food was weighed immediately before its consumption, and plate waste was determined from aliquot samples and weighed at the end of each meal. Served helpings were given to study participants, who were seated 6 to 8 per table. Each table was served 6–8 similar portions of meat fillets, fish or eggs, whereas "paellas" and stews were presented in serving dishes from which individuals were able to help themselves. The diet over a period of 12 days was recorded and studied.

Daily energy and nutrient intakes per person were calculated by dividing the total food consumed by the number of men in the study, as every participant ate more or less the same amount, and therefore shared the same nutrient intake. To this effect, a computer program compiled from food tables for raw food weights was used (22). Sixty-nine different foods were recorded. The cholesterol-saturated fat index (CSFI) of the average diet was calculated using Connor et al.'s equation (4): CSFI = [1.01 x saturated fat (in g) + 0.05 x cholesterol (in mg)] per 1 000 kcal. The Keys et al. index (Grande, 10) was calculated as: 1.35 (2 % kcal from saturated fatty acids – % kcal from polyunsaturated fatty acids) + 1.5 $Z^{1/2}$,

Table 1 Anthropometric and clinical characteristics and energy expenditure of 20 to 65 year-old male nonsmokers

	20–30 yrs		30–40 yrs		> 40 yrs	
	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
Age (years)	25.48 (2.33)	20–29	33.43 (2.52)	30–39	47.52 (6.95)	40–64
Weight (kg)	74.2 (6.5)	65–90	78.1 (9.0)	60–95	73.1 (5.7)	60–95
BMI (kg/m²)	24.16 (2.10)	19.2–29.0	25.50 (2.95)	20.5–28.9	25.32 (1.97)	20.9–28.3
Systolic blood pressure (mm Hg)	119.2 (13.0)	96–140	114.8 (10.5)	100–130	121.3 (14.6)	90–140
Diastolic blood pressure (mm Hg)	71.8 (8.0)	60–90	73.3 (8.6)	60–80	74.4 (9.5)	55–90
Energy expenditure (kcal/kg/day)*	48.5		46.3		43.3	

Values represent the mean (SD). * Calculated according to the different activities carried out in an average day

Z = mg of cholesterol per 1 000 kcal." Stearic acid and the short-chain fatty acids were not included in this index to calculate energy derived from saturated fatty acids. When data were referred to g of fatty acids in spite of total energy, Keys' lipidic factor (ø) (Fletcher et al., 8) was calculated as ø = (SFA – 1/2 PUFA) x 2 430/E + 1.5 $(1\,000\ C/E)^{1/2}$, where SFA = saturated fatty acids intake in g/day; PUFA = polyunsaturated fatty acids intake in g/day; E = energy intake in kcal/day; C = cholesterol intake in mg/day.

Lipids and lipoprotein analyses

Blood was collected after a 10–12 h fast from the antecubital fossa in fluoride-oxalated tubes for glucose determination, and in other tubes to measure total cholesterol (TC), triglycerides (TG) and HDL-cholesterol (HDL-C). Within 3 h after sampling, the tubes were centrifuged at 1 500 x g for 30 min, and stored at 4 °C. Measurements were completed within 24 h of the blood sampling. TG were assayed using the enzymatic glycerol-phosphate-oxidase method (GPO-PAP) (Boehringer-Mannheim, Germany). TC was determined by the enzymatic cholesterol esterase – cholesterol oxidase method (Boehringer-Mannheim, Germany). HDL-C was measured using the same technique after precipitation of VLDL and LDL using the dextran sulphate procedure (7). LDL-C was calculated according to Friedwald et al. (9). Apolipoprotein (Apo) B was determined by rocket electrophoresis (17).

Serum aliquots were accidentally mislaid on a few occasions, invalidating some of the results. For this reason, not enough serum was always available, which may explain the discrepancy in the number of observations.

Lipid quality control was carried out according to the laboratory manual of the Lipid Research Clinics Program. The interassay variation coefficients were: TG 3.9 %, TC 3.5 %, HDL-C 7.0 %, Apo B 3.7 %. Anova and Duncan's multiple range tests were used for statistical group comparison.

Following the guidelines of the National Institutes of Health (25), the Spanish Comité Organizador del Acuerdo del Consenso for cholesterolaemia control (3) and other studies (2), values above the following levels were taken into account to study the prevalence of hyperlipaemia, hypertriglyceridaemia and hyperapolipoproteinaemia B: TC ≥ 5.20 mml/L (200 mg/dL), ≥ 5.71 mmol/L (220 mg/dL) and ≥ 6.23 mmol/L (≥ 240 mg/dL) for subjects aged 20–29, 30–39 and ≥ 40 yrs, respectively. TC concentrations of ≥ 6.49 mmol/L (≥ 250 mg/dL) were also taken into consideration, since this value is widely considered as the limit for hypercholesterolaemia in adults (3). TG levels of ≥ 1.69 mmol/L (≥ 150 mg/dL) and ≥ 2.25 mmol/L (≥ 200 mg/dL) are generally accepted as hypertriglyceridaemia limits in adults. Concentrations of ≥ 3.90 mmol/L (≥ 150 mg/dL) and ≥ 4.94 mmol/L (≥ 190 mg/dL) were viewed as risk levels for LDL-cholesterol; risk levels for HDL-C involved concentrations of ≥ 0.91 mmol/L (≤ 35 mg/dL) and ≤ 1.17 mmol/L (≤ 45 mg/dL), while other risk values included indices of ≥ 4.5 and ≥ 5.0 for the TC/HDL-C ratio and concentrations of ≥ 1.2 g/L and ≥ 1.5 g/L for Apo B.

Results

Energy and nutrient intakes during the 12-day dietary-study period are presented in Table 2. Of the total energy intake, fat represents 34 %, carbohydrates account for

Table 2 Daily energy and specific nutrient intake for 20 to 65 year-old male nonsmokers

Energy (MJ)	14.2	(1.2)
Proteins (g)	123.4	(17.9)
Carbohydrates (g)	437.5	(47.3)
Lipids (g)	128.0	(23.6)
Cholesterol (mg)	563.4	(275.0)
Ethanol (g)	14.3	(2.0)
SFA* (g)	37.1	(9.3)
MUFA* (g)	47.7	(11.4)
PUFA* (g)	29.9	(4.2)
Dietary fibre (g)	25.1	(10.3)
Calcium (mg)	609.4	(104.8)
Magnesium (mg)	383.2	(58.7)
Ascorbic acid (mg)	89.6	(38.3)
Vitamin E (mg)	28.3	(5.7)

Values represent the mean (SD) of a 12-day dietary record.
SFA: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids.

Table 3 Some characteristics of the dietary fat consumed during a 12-day period by 20 to 65 year-old male nonsmokers

Cholesterol (mg/day)	563.4 (275.0)
Saturated fatty acids (% total energy)	9.9
Monounsaturated fatty acids (% total energy)	12.7
Polyunsaturated fatty acids (% total energy)	8.8
CSFI/1 000 kcal[a]	19.2
Keys index[b]	27.1
Keys index[c]	26.9
Saturated fatty acids (g)	
Myristic (C14:0)	2.3 (0.46)
Palmitic (C16:0)	19.0 (5.7)
Stearic (C18:0)	10.1 (2.7)
Monounsaturated fatty acids (g)	
Palmitoleic (C16:1, n-7)	2.3 (1.0)
Oleic (C18:1, n-9)	44.5 (10.3)
Polyunsaturated fatty acids (g)	
Linoleic (C18:2, n-6)	28.5 (4.1)
Linoleic (C18:3, n-3)	0.89 (0.22)
Arachidonic (C20:4, n-6)	0.13 (0.13)

Values represent the mean (SD) of a 12-day dietary record.
[a] CSFI/1 000 kcal: cholesterol-saturated fat index per 1 000 kcal.
[b] Keys et al. (according to Grande, 10).
[c] Lipidic index of Keys (according to Fletcher et al., 8).
For more details see Subjects and Methods.

48.4 %, proteins comprise 14.6 % and the remaining 3.0 % derives from ethanol.

Table 3 shows the amount of cholesterol and major fatty acids in the average diet, as well as the contribution of saturated fatty acids (SFA), MUFA and polyunsaturated fatty acids (PUFA) to the total energy intake. SFA represents 9.9 % of the total amount of energy, MUFA 12.7 %, and PUFA 8.8 %. Table 3 also indicates the quality of the lipids ingested, as expressed by the CSFI and Keys et al. indices.

The contribution of each of the food groups to the intake of energy, total protein, total carbohydrates, total fat, SFA, MUFA, PUFA, cholesterol, fibre, calcium, magnesium, ascorbic acid, and vitamin E is set forth in Table 4. Cereals and cereal products were major contributors to the intake of energy, carbohydrates, fibre and magnesium. SFA and MUFA derived mainly from meat and meat products and from oils and fats, whereas PUFA came especially from fats and oils, mainly sunflower oil. Fat from fish accounted for 1.99 g/day, and fish-derived PUFA amounted to 0.32 g (data not shown). The main sources of cholesterol were eggs, meat and meat products. Fruits and vegetables accounted for 93 % of the total ascorbic acid intake, whereas 91.4 % of the vitamin E consumed derived from fats and oils.

Table 4 Energy and nutrient contributions of the various food groups from a 12-day dietary record

	Cereals & cereal products	Milk & dairy products	Eggs	Fats & oils	Vegetables	Legumes	Fruits	Meat & meat products	Fish & fish products	Drinks	Others
Energy	41.4	4.6	2.1	14.1	2.4	3.7	3.7	16.5	2.2	3.0	6.3
Protein	32.6	6.5	4.8	0.05	2.6	4.7	0.6	36.5	10.6	0.05	1.0
Carbohydrates	67.2	1.9	–	–	3.9	3.7	7.2	0.4	0.1	2.3	13.3
Fat	11.6	6.5	4.1	41.4	0.2	0.5	–	33.5	1.6	–	0.6
SFA*	5.1	13.0	6.7	29.0	0.1	–	–	45.0	0.7	–	0.4
MUFA*	14.2	5.6	4.3	35.4	0.02	0.3	–	39.5	0.5	–	0.2
PUFA*	7.6	1.2	1.9	75.0	0.4	0.5	–	12.3	1.1	–	0.03
Cholesterol	–	6.3	42.3	4.2	–	–	–	38.3	8.9	–	–
Fibre	44.8	–	–	–	15.8	27.9	11.5	–	–	–	–
Calcium	18.2	48.9	4.0	0.3	4.2	6.6	5.6	4.6	5.6	1.8	0.2
Magnesium	46.2	11.4	1.5	0.05	7.6	12.8	3.3	9.9	5.2	2.0	0.03
Ascorbic acid	–	3.1	–	–	46.3	0.3	46.7	3.6	–	–	–
Vitamin E	1.4	0.8	2.8	91.4	0.8	–	1.1	0.7	0.7	–	0.4

Data in % of the total. *SFA, MUFA, PUFA: saturated, monounsaturated and polyunsaturated fatty acids, respectively

Table 5 Age dependence of serum lipids and lipoproteins in nonsmokers

	Age (yr)		
	20–29	30–39	≥ 40
Cholesterol (mmol/L)	4.63 ± 0.88[a] (69)	5.21 ± 0.90[b] (42)	5.40 ± 0.82[b] (36)
Triglycerides (mmol/L)	0.99 ± 0.33[a] (80)	1.25 ± 0.42[b] (42)	1.37 ± 0.58[b] (31)
HDL-cholesterol (mmol/L)	1.60 ± 0.26[a] (68)	1.50 ± 0.28[a] (42)	1.54 ± 0.33[a] (36)
LDL-cholesterol (mmol/L)	2.67 ± 0.90[a] (66)	3.17 ± 0.90[b] (42)	3.25 ± 0.92[b] (34)
Cholesterol/HDL-cholesterol	2.98 ± 0.75[a] (68)	3.60 ± 1.00[b] (42)	3.61 ± 0.93[b] (36)
Apolipoprotein B	0.88 ± 0.24[a] (80)	0.94 ± 0.2[ab] (42)	1.02 ± 0.28[b] (42)

Values represent the mean ± SD. Number of observations is given in parentheses. Values in horizontal row bearing a common letter are not-significantly different.

Serum TC, TG and LDL-C concentrations, TC/HDL-C ratio and Apo B increased significantly with age (Table 5). Serum HDL-C was not age-dependent. None of the lipid and lipoprotein variables studied was age-dependent in individuals over 30.

The prevalence of hyperlipaemia, hyperlipoproteinaemia and hyperapolipoproteinaemia B is displayed in Table 6. TC levels of 26.1 % of the population aged 20 to 29 were above 5.20 mmol/L, 28.6 % of the individuals between 30–39 years of age had TC levels of more than 5.71 mmol/L, while 13.9 % of the subjects 40 or older presented TC levels of over 6.23 mmol/L. The percentage of men with high TG levels (TG ≥ 1.69 mmol/L or TG ≥ 2.25 mmol/L) was 4.3 % or 3.7 %, respectively. Subjects with LDL-C levels ≥ 3.90 mmol/L or ≥ 4.94 mmol/L represented 14.1 % and 1.4 % of the total number of study participants, respectively. HDL-C levels of ≤ 0.91 or ≤ 1.17 mmol/L appeared in 0.7 % and 6.2 % of the population, respectively. A TC/HDL-C ratio of more than 4.5 or 5.0 was seen in 9.7 % and 2.8 % of the subjects, respectively. Apo B levels of over 1.2 g/L or 1.5 g/L were recorded in 11.8 % and 3.0 % of the subjects, respectively.

Discussion

The CHD mortality rates in Spain, as standardized by age, are currently among the lowest of all western countries. However, between 1970 and 1983 mortality due to CHD increased 49 % in men aged 30–69 (3). Despite the scarcity of epidemiological data in Spain, the Comité Organizador del Acuerdo del Consenso (3) has indicated that the average serum cholesterol levels during that period were as high as those of other European countries and continue to increase.

Table 6 Prevalence of hyperlipaemia, hyperlipoproteinaemia and hyperapolipoproteinaemia B in the nonsmoker population

		Age (yr)			
		20–29	30–39	≥ 40	20–65
Total cholesterol	(a)	26.1	28.6	13.9	23.8
	≥ 6.49 mmol/L	4.3	4.8	8.3	5.4
Triglycerides	≥ 1.69 mmol/L	2.5	2.4	9.8	4.3
	≥ 2.25 mmol/L	1.3	2.4	9.8	3.7
LDL-cholesterol	≥ 3.90 mmol/L	4.5	21.4	23.5	14.1
	≥ 4.94 mmol/L	1.4	0	2.9	1.4
HDL-cholesterol	≤ 1.17 mmol/L	1.5	11.9	8.3	6.2
	≤ 0.91 mmol/L	0	2.4	0	0.7
Total cholesterol/HDL-cholesterol	≥ 4.5	2.9	16.7	14.7	9.7
	≥ 5.0	0	7.1	2.9	2.8
Apolipoprotein B	≥ 1.2 g/L	8.8	4.8	26.0	11.8
	≥ 1.5 g/L	3.8	0	4.8	3.0

Data are in % of people tested. (a) ≥ 5.20 mmol/L (≥ 200 mg/dL), 5.71 mmol/L (≥ 220 mg/dL) and ≥ 6.23 mmol/L (≥ 240 mg/dL) for people aged 20–29, 30–39 and ≥ 40 years, respectively.

In this study, the effect of age on lipids was found to concur with that observed in other studies with the same age groups (2, 6) in which TC, TG and LDL-C were determined to be age-dependent. However, as in other studies, HDL-C concentrations appear to be unaffected by age (2).

Several comparative epidemiological studies have linked the serum lipid levels in a given population to dietary component intake (fat in particular) (16, 20). The detailed analysis of the diet consumed by this study population (very homogeneous as to occupation and life style) shows that, with the exception of the use of sunflower oil (with a high linoleic acid content), it resembled the Mediterranean dietary pattern (19, 23) recommended by several authors for the prevention of CHD (3, 14).

In the current study, the fat/carbohydrate/protein contribution to the total energy intake was 34/49.5/14.6. Fat intake was similar to that described for the overall Spanish population (23). The SFA/MUFA/PUFA ratio of the present study was 1.1/1.4/1. This differs from the 1.4/2.4/1 ratio attributed to the Spanish population (23), due to the lower oleic oil consumption in the current study.

The CSFI of the study diet was 19.2 per 1 000 kcal. A 1 000 kcal Western diet has an average CSFI of 24.6 (4). The cholesterol consumption per 1 000 kcal in the group studied is similar to that found in the Spanish population in general, but slightly higher than that recommended by experts (35). Applying the Keys et al. index (Grande et al., 10) to the study diet an index of 27.1 was observed, while with Keys' lipidic factor (8) an index of 26.9 was seen. Both indices were lower than those calculated for the average Spanish diet (23).

As the TC/HDL-C ratio is low, the cholesterol level in lipoproteins seen in the present study is suitable for the majority of the general population. Despite the relatively high consumption of linoleic acid ($\approx$ 26 g/day), the fatty acid pattern may be considered adequate to prevent the decrease of HDL-C which can occur after consuming diets with a high PUFA content, and to keep the LDL-C and Apo B levels relatively low (11).

A detailed study of the data shows that only 5.4 % of the participants had TC levels over 6.49 mmol/L, and that none exceeded 7.27 mmol/L (280 mg/dL). Thus, although a high percentage of these individuals are hypercholesterolaemics, most must be considered to have moderate hypercholesterolaemia.

The percentage of individuals with low HDL-C levels was lower than that of individuals with high LDL-C levels. In some Spanish epidemiological studies (6), young people tend to display high LDL-C and HDL-C levels, and this distribution of cholesterol in lipoproteins remains as age increases (13). Exercise has been found to increase HDL-C levels by increasing lipoprotein lipase and decreasing hepatic lipase activity (12), which in turn would explain the high levels of HDL-C seen in this very active population.

The low prevalence of hypertriglyceridaemia in this study population could be related to the diet, exercise and age of the individuals. However, although most men from the study group may be considered as very active, people over 40 exercise less on the whole, which in turn affects their TG level (40). The effect of age on TG levels, on the other hand, is very well known (2, 5), and could account for the higher prevalence of hypertriglyceridaemia in the 40 and older group. Among dietary components, carbohydrates, PUFA n-3 and alcohol are dietary factors known to determine TG concentrations. Data from fish and fish product consumption in the present study concur with that reported in Spain in 1981 and 1987 (23). The moderate alcohol intake in the study group also seems to be related to the rather low TG and high HDL-C levels observed (12).

A decrease in the consumption of cereals and cereal products and an increase in that of milk and meat products may be related to the increment of CHD incidence and mortality (24). An imbalance between calcium and magnesium would alter myocardial physiology, in that magnesium would act as an antiatherosclerotic and antispasmodic factor, while calcium would increase myocardial excitability (24, 34). In that respect, CHD incidence and mortality is somewhat higher in countries with a high calcium/magnesium ratio diet than in those whose diet is characterized by a low Ca/Mg ratio. In the present study, the calcium/magnesium ratio was 1.54. The Ca/Mg ratio in Spain, calculated from data of calcium and magnesium intakes (23), increased from 1.65 in 1964/65 to 2.78 in 1987. The fibre content of the daily ration can be considered as acceptable for CHD prevention (31). The soluble fibre (fruits plus legumes) to unsoluble fibre (cereals plus vegetables) ratio can also be considered acceptable and would also explain the lipoprotein pattern of the population studied (21).

The individual daily intake of ascorbic acid and vitamin E of the study group participants were above the minimum amounts recommended in Spain. An adequate supply of antioxidants such as ascorbic acid and vitamin E may be important in avoiding free radical formation from PUFA (32). The high ascorbic acid and vitamin E intake of these men could be useful in preventing CHD, as evidence suggests that oxidative modification of LDL converts it into a more atherogenic form (30). Moreover, oral tocopherol administration in healthy adults has been associated with increased red cell tocopherol concentrations, which in turn are correlated with HDL-C levels (28).

In conclusion, the prevalence of CHD risk factors found in the study population was rather low, with a diet which resembled that consumed in Spain over ten years ago (with the exception of sunflower oil consumption). This diet was characterized by a high cereal and cereal product component, a well-balanced energy distribution from carbohydrates, fat and protein, a suitable fatty acid profile, calcium/magnesium ratio, fibre, ascorbic acid and vitamin E content.

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