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Original

Compliance with dietary and nutrient recommendations in the European Prospective Investigation into Cancer and Nutrition (EPIC)-Granada cohort at recruitment

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Abstract

Background: **The overall intake of energy and nutrients in the Granada EPIC-cohort (European Prospective Investigation into Cancer and Nutrition) is examined in order to assess compliance with the Spanish Nutritional Objectives (NO) and the Recommended Intakes (RI).**

Methods: **During recruitment (1992-1996), 7,789 participants, aged 35-69, were asked about diet through a validated diet history questionnaire. Nutrient intake is compared to the NO and RI that were valid at that time. Risk of inadequate intake is estimated as the percentage of the sample with intakes: ≤ 1/3 RI (high risk), ≤ 2/3 RI-> 1/3 RI (moderate risk), ≤ RI- > 2/3 RI, > RI. Differences in intakes have been analyzed by sex and age, and by smoking status and BMI.**

Results: **The daily intake of nutrients did not meet the NO as the total contribution of energy from proteins and fats exceeded these guidelines. Whilst intake of most nutrients was above the RI, the amount of iron, magnesium and vitamins D and E provided by the diet was not enough to meet the RI: in women aged 20-49 years, about 55% were at moderate risk for iron inadequacy, and a 20% of women for magnesium. Both sexes were at high risk of inadequacy for vitamin D, although sunlight exposure may supply adequate amounts. Never smokers showed a higher compliance to the NO.**

Conclusion: **At recruitment, the nutrient profile of the diet was unbalanced. The observed nutrient inadequacy for iron, magnesium and vitamin E might be attributed to inappropriate dietary habits, and may have implications for future disease risk.**

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ADECUACIÓN DE LA INGESTA DIETÉTICA DE LA COHORTE DEL ESTUDIO PROSPECTIVO EUROPEO SOBRE NUTRICIÓN Y CÁNCER (EPIC)-GRANADA A LAS INGESTAS RECOMENDADAS Y OBJETIVOS NUTRICIONALES

Resumen

Introducción: **Se ha evaluado la ingesta de energía y de nutrientes de la cohorte EPIC-Granada (Estudio Prospectivo Europeo sobre Nutrición y Cáncer) en relación con la adecuación a los Objetivos Nutricionales españoles (ON) y a las ingestas recomendadas (IR).**

Métodos: **Durante el reclutamiento (1992-1996), 7,789 participantes (de 35-69 años de edad) fueron entrevistados sobre su dieta mediante el método de historia de dieta. La ingesta de nutrientes se ha comparado con los NO y con las IR. El riesgo de ingesta inadecuada se ha estimado como porcentaje de participantes con ingestas: ≤ 1/3 IR (riesgo elevado), ≤ 2/3 IR-> 1/3 IR (riesgo moderado), ≤ IR-> 2/3 IR, > IR. Se han analizado diferencias según sexo, edad, hábito tabáquico e Índice de Masa Corporal (IMC).**

Resultados: **La ingesta dietética no cumple los ON debido a que la contribución de proteínas y lípidos sobre la ingesta energética total excede estas recomendaciones. La mayoría de los nutrientes satisfacen las IR, excepto hierro, magnesio, vitamina D y E: entre las mujeres de 20-49 años un 55% presentaron riesgo moderado de ingesta inadecuada de hierro, y un 20% lo presentaron para el magnesio. En ambos sexos se encontró un elevado riesgo de ingesta inadecuada de vitamina D, que puede compensarse por la exposición solar. Los no fumadores mostraron un mejor cumplimiento de los ON.**

Conclusión: **El perfil calórico de la dieta en la cohorte EPIC está desequilibrado. La ingesta inadecuada de los nutrientes hierro, magnesio y vitamina E podría ser atribuible a hábitos dietéticos inadecuados, y podría tener implicaciones para el desarrollo futuro de enfermedades.**

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Palabras clave: *Valor nutritivo. Requerimientos nutricionales. Políticas de salud.*

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Abbreviations

EPIC: European Prospective Investigation into Cancer and Nutrition.
E: Energy.
NO: Nutritional Objectives for the Spanish population.
RI: Recommended Intakes for the Spanish population.
DH: diet history.
BMI: body mass index.

Introduction

Healthy diet is considered to be a key determinant of health status, but the maintenance of inadequate dietary habits can have serious negative effects on health.[1] It has been largely established that there is an association between diet and the occurrence of cancer, cardiovascular diseases and other chronic diseases that are currently recognized as major health problems in developed countries.[2] For instance, the World Health Organization (WHO) alerts that a great proportion of the morbidity and mortality of these diseases can be attributed to inadequate food habits and low physical activity levels in the population, amongst other well established risk factors.[3]

The National Research Council (NRC) and the Food and Agriculture Organization of the United Nations (FAO) published in 1941 the first edition of the dietary recommendations, The Recommended Dietary Allowances (RDAs). RDAs were defined as the average daily intake level that is sufficient to meet the nutrient requirement of nearly all (98 percent) healthy individuals in a particular age, gender or life-stage.[4] In 1992, several experts belonging to the NRC, FAO/WHO and other National Committees set these recommendations specifically for the European Population.[5] The RDAs were further integrated in what is nowadays termed the Dietary Reference Intakes (DRIs), aimed to define extended nutrient reference standards for use in planning and assessing diets of the apparently healthy population.[6,7] These recommendations are being thoroughly revised, in order to incorporate the new knowledge on associations between nutrients and disease.[8] The recommended dietary intakes for the Spanish population (RI) were first published in 1994,[9] and are being likewise updated every few years.[10] Promotion of adequate eating habits was another important goal to achieve. For this purpose, national health authorities and/or scientific societies developed dietary guidelines based on country or regional food consumption patterns.[11] Even so, the Spanish Society of Community Nutrition (SENC) developed the Nutritional Objectives (NO),[12] which have been recently revised and updated.[13]

The evaluation of the nutritional status of a population is usually measured through nutritional surveys, but can also be applied to other population samples. The European Prospective Investigation into Cancer and Nutrition study (EPIC) is a European multicenter study designed to examine the association between diet and cancer.[14] Because of the long time interval (10-15 years) that separates the exposure from the onset of the disease, the EPIC study was conceived and designed to prospectively investigate this relationship.[14] The dietary information that was collected at the recruitment of the cohort is being analyzed as it is particularly useful to understand this complex relationship.[15]

Spain is one of the participating countries contributing with about 40.000 participants to the European cohort, recruited in the 1990s from five centers: Asturias, Navarra and San Sebastian in the North, Murcia in the South-East, and Granada in the South.[16]

So far, the Spanish EPIC cohorts have not undergone an evaluation of the nutritional adequacy. To establish the nutritional profile and the proportion of subjects at risk for inadequate nutrient intakes would provide an estimate of the nutritional status of the cohorts at a regional level. Thus, the aim of this study is to evaluate the energy and nutrient intake in the Granada EPIC cohort by assessing the compliance with the nutritional objectives set for the Spanish population in 1995, as well as with the recommended nutrient intakes.

Methods

Study sample

7,789 participants (77% women), aged 35 to 69 years, were recruited during 1992-1996 from the population of Granada, including mainly local blood donors. The methods of recruitment and study design have been described elsewhere.[16,17]

Participants in the top (> 99 percentile) and bottom (< 1 percentile) of the energy intake were excluded to reduce the effect of implausible extreme values of energy intake, leaving a total of 7.723 subjects (1.735 men and 5.988 women).

Dietary assessment

Nutritional data of each subject was gathered by means of a diet history (DH) questionnaire which was validated using 24-hour recalls as the reference method.[18,19] The procedure of data collection of the diet has been reported in these previous studies. Briefly, participants were asked about their dietary intake during a typical week as representative of the dietary habits, over the year before recruitment. The questionnaire accounted for food frequency and portion sizes, but also occasional intakes, seasonal differences and variations between working days and weekends. More than 600 food items were introduced in the nutrient database software developed specifically for the EPIC study (ENDB). Energy and nutrients intake and their food sources were in this manner analyzed.[20] Other baseline examinations comprised anthropometric measurements and a questionnaire guided interview about lifestyle factors.[16]

Nutritional evaluation

To evaluate inadequate nutrient intakes, the Spanish RI values published by the Spanish National Research Council and Complutense University of Madrid (1994) were used.[9] Similarly, the energy and nutrients intake has been compared to the NO set in 1995 for the Spanish population.[12] In order to make more reliable comparisons, we used the standards and guidelines that were applicable at time of recruitment. The updated ones are based on the dietary changes that are taking place in the Spanish population and are not as indicative of the dietary habits present in the early 1990s.[13] The percent contribution of food groups to intakes of nutrients has also been assessed.

Statiscal analysis

Differences in energy and nutrients mean intakes by age and sex were analyzed. Age groups were defined according to the ones set by the dietary recommendations (20-39, 40-49, 50-59 and 60-69 years). The relative contribution of macronutrients to the diet was obtained by setting the percentage of energy intake from fat, carbohydrates and proteins. For this purpose, the following conversion factors were applied: 4 kcal/g for proteins and carbohydrates, 9 kcal/g for fat and 7 kcal/g for alcohol. Nutrient inadequacy by age groups and sex was assessed by calculating the percentage of the population with intakes ≤ 1/3 RI (high risk), ≤ 2/3 RI-> 1/3 RI (moderate risk), ≤ RI-> 2/3 RI, or > RI.[21]

Differences between means of two groups were analyzed by the Student's t-test. Two-way ANOVA between age groups within each sex group and post-hoc analysis by Tukey's or Dunnet's test were also performed.

Additionally, under-reporters of energy intake were identified as those with the energy intake: basal metabolic rate ratio below 1.14.[22] Intakes and levels of inadequacy were also compared by body mass index (BMI) (normal weight, ≤ 25; overweight > 25 < 30, and obese, ≥ 30 kg/m^2), and smoking status (never vs ever smokers).

Statistical significance was set at $p < 0.05$. STATA statistical software (release 8.0; College Station, TX: Stata Corp LP, 2005) has been used for this data analysis.

Results

Compliance with the NO

Mean daily energy and macronutrient intake is presented and compared to the NO in table I. Energy intake changed slightly among the age groups, being energy consumption the highest at 40-49 years. The relative contribution of the macronutrients to the energy intake did not meet the NO, as intake of proteins (19.4%) and lipids (35.7%) were far beyond the range of reference values, comprising a low intake of carbohydrates. These percentages were in general higher in women than in men, and at younger ages.

Protein consumption was lowest in older adults, due to a lower intake of proteins of animal origin. Proteins of plant origin changed comparatively only slightly between the age groups, decreasing the percentage of energy provided by protein in the same extent (from 19.5% at 20-39 years to 19.3% at 60-69 years). Compared to the NO, protein intake exceeded largely the reference value.

Carbohydrates contributed to the total energy intake by 43.3% on average; hence the NO were not fulfilled. Consumption was significantly higher in men (227.6 g) compared to women (183.0 g) and was kept high up to the oldest age group (220.7 g in men and 177.3 g in women). A similar pattern was observed for dietary fibre, for which intake was closer to the NO in men. An increase towards higher consumption in the 40 to 59 age group was observed in men, whereas in women consumption levels remained similar until older ages where the amount of fibre consumption diminished.

Intake of lipids, expressed as percentage of energy intake, fitted better the NO in the oldest age group (34.2% in men and 33.5% in women). The gradual decline with age was due to a reduction in intake of fat of animal origin, while the intake of fat of plant origin did not materially change. This was even more notable in women (lowest lipid intake at 60-69 years, $p < 0.05$). Regarding the fatty acid profile, MUFA (monounsaturated fatty acids) and PUFA (polyunsaturated acids) agreed with the NO, while SFA (saturated fatty acids) not. Women exhibited a lower fatty acid mean intake (16.3% MUFA and 5.1% PUFA) compared to men (16.6% MUFA and 5.2% PUFA), except for SFA (11.3% in women and 10.7% in men), which was significantly higher at 20-59 years ($p < 0.05$). Therefore, as observed for the total fat intake, older participants had a better lipid profile, especially women. This can be also inferred from the PUFA/SFA and PUFA + MUFA/SFA indexes. Cholesterol varied depending on the age group and sex.

Compliance with the RI

The RI were met for almost all the nutrients, except for magnesium, iron, vitamin A, D and E (table II). Higher mean intakes of magnesium were observed among men aged 40-49 years, compared to 60-69 years ($p < 0.05$). Among women, intake was lower at older ages, though intake was under the RI in all age groups. Insufficient intake was even more manifest for iron: median intake did not cover the RI in women aged 20-

Table I

Daily energy and macronutrient intake (Mean and Standard Error, SE) in the Granada EPIC cohort (n = 7,723) compared to the NO (Aranceta, 1995), by age groups and sex

Nutrients	20-39 years						40-49 years						50-59 years						60-69 years					
	Men (n = 92)		Women (n = 1,080)		Total (n = 1,172)		Men (n = 696)		Women (n = 2,193)		Total (n = 2,289)		Men (n = 598)		Women (n = 1,831)		Total (n = 2,429)		Men (n = 349)		Women (n = 884)		Total (n = 1,233)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Energy (kcal)	2,301	57.3	1,748	15.2	1,792*	15.3	2,343	22.3	1,712	10.1	1,864*	10.6	2,235	24.1	1,634§	10.4	1,781*	11.1	2,133	32.7	1,533§	14.7	1,703*	16.0
Proteins (g)	108.4	2.6	84.1	0.7	85.9*	0.7	111.5	1.1	82.3	0.5	89.3*	0.5	105.9	1.1	78.5§	0.5	85.3*	0.5	99.4§	1.6	73.6§	0.7	80.9*	0.8
% Energy (NO < 13%)	19.1	0.3	19.5	0.1	19.5	0.1	19.1	0.1	19.5	0.1	19.4	0.1	19.2	0.1	19.5	0.1	19.4	0.1	18.9	0.2	19.4	0.1	19.3	0.1
Animal origin (g)	69.6	2.0	53.8	0.5	55.1	0.5	70.6	0.9	52.4	0.4	56.8	0.4	66.9	0.9	50.3	0.4	54.3	0.4	62.2	1.2	46.5	0.6	50.9	0.6
Plant origin (g)	33.9	1.2	25.9	0.3	26.6	0.3	36.5	0.4	25.7	0.2	28.3	0.2	35.1	0.5	24.5	0.2	27.1	0.2	33.4	0.6	23.7	0.3	26.4	0.3
Carbohydrates (g)	226.0	6.8	187.1	1.8	190.2*	1.8	233.2	2.4	184.1	1.2	195.9*	1.1	225.2	2.6	182.1	1.2	192.7*	1.2	220.7	3.4	177.3	1.7	189.6*	1.7
% Energy (NO 55-60%)	39.5	0.7	42.8	0.2	42.6	0.2	40.2	0.3	43.1	0.1	42.4	0.1	40.8	0.3	44.8	0.1	43.8	0.1	42.1	0.4	46.5	0.2	45.3	0.2
Fibre (g) (NO > 25 g)	24.4	0.8	20.2	0.2	20.5*	0.2	26.3	0.3	20.5	0.1	21.9*	0.1	25.5	0.3	20.2	0.1	21.5*	0.1	24.2	0.4	19.3§	0.2	20.7*	0.2
Lipids (g)	95.5	3.1	71.9	0.8	73.8*	0.8	95.1	1.2	70.2	0.5	76.2*	0.5	87.9	1.2	64.5§	0.5	70.2*	0.5	82.6	1.8	57.9§	0.8	64.9*	0.8
% Energy (NO 30-35%)	36.9	0.6	36.8	0.2	36.8	0.2	36.2	0.2	36.6	0.1	36.5	0.1	35.1	0.2	35.2	0.1	35.1	0.1	34.2	0.3	33.5	0.2	33.7	0.2
Animal origin (g)	39.6	1.7	28.3	0.4	29.1	0.4	38.8	0.6	27.6	0.3	30.3	0.3	35.6	0.6	25.6	0.3	28.1	0.3	33.5	0.9	22.6	0.5	25.1	0.4
Plant origin (g)	44.8	2.0	33.9	0.4	34.7	0.4	47.5	0.8	33.6	0.3	36.9	0.3	44.6	0.9	31.1	0.3	34.4	0.3	41.9	1.2	28.9	0.4	32.6	0.5
MUFA (g)	43.9	1.5	32.8	0.4	33.7*	0.4	44.8	0.6	32.0	0.2	35.1*	0.2	41.5	0.6	29.4§	0.3	32.3*	0.3	38.8	0.9	26.4§	0.4	29.9*	0.4
% Energy (NO 15-20%)	17	0.3	16.8	0.1	16.8	0.1	17.1	0.1	16.7	0.1	16.8	0.1	16.5	0.1	16.0	0.1	16.1	0.1	15.9	0.2	15.3	0.1	15.5	0.1
SFA (g)	29.3	1.1	22.9	0.3	23.4*	0.3	28.7	0.4	22.4	0.2	23.9*	0.2	26.2	0.4	20.6	0.2	22.0*	0.2	25.1	0.6	18.6§	0.3	20.4*	0.3
% Energy (NO < 10%)	11.4	0.3	11.5	0.1	11.5	0.1	10.9	0.1	11.6	0.1	11.4	0.05	10.5	0.1	11.2	0.1	11.0	0.1	10.4	0.2	10.7	0.1	10.6	0.1
PUFA (g)	14.7	0.7	10.4	0.1	10.7*	0.1	13.9	0.2	9.9	0.1	10.9*	0.1	13.1	0.2	9.0§	0.1	10.0*	0.1	11.9§	0.3	7.9§	0.1	9.0	0.1
% Energy (NO <10%)	5.6	0.2	5.3	0.05	5.4	0.1	5.3	0.05	5.2	0.04	5.2	0.03	5.2	0.1	4.9	0.04	5.0	0.03	4.9	0.1	4.6	0.05	4.7	0.05
PUFA/SFA	0.5	0.02	0.5	0.01	0.5	0.01	0.5	0.01	0.5	0.01	0.5		0.5	0.01	0.5	0.01	0.5	0.01	0.5	0.01	0.5	0.01	0.5	0.01
PUFA+MUFA/SFA	16.2	0.7	11.9	0.1	12.3	0.1	15.6	0.2	11.5	0.1	12.5	0.1	14.8	0.3	10.5	0.1	11.6	0.1	13.5	0.3	9.4	0.1	10.6	0.1
COL (mg/1,000 kcal) (NO < 100)	171.9	4.7	182.3	1.5	181.4	1.4	166.1	1.7	175.9	1.1	173.5	0.9	164.2	2.1	164.8	1.2	164.7	1.0	155.7	2.8	155.6	1.9	155.6	1.6
Alcohol (g)	14.7	1.7	2.2	0.1	3.2	0.2	15.5	0.7	2.1	0.1	5.3	0.2	16.9	0.9	1.4	0.1	5.2	0.3	15.6	1.1	1.0	0.1	5.2	0.4
% Energy	4.5	0.5	0.9	0.06	1.1	0.1	4.5	0.2	0.8	0.04	1.7	0.1	4.9	0.2	0.6	0.04	1.6	0.8	4.8	0.3	0.4	0.05	1.7	0.1

SFA: Saturated fatty acids; MUFA: Monounsaturated fatty acids; PUFA: Polyunsaturated fatty acids. COL: Cholesterol. *Significant differences between sex in each age group (p < 0,05). §Significant differences between all age groups within each sex group (p < 0,05).

Table II
Daily energy and macronutrient intake (Mean and Standard Error, SE) in the Granada EPIC cohort (n = 7,723) compared to the RI (CSIC, 1994), by age groups and sex

Nutrients	20-39 years					40-49 years					50-59 years					60-69 years				
	Men (n = 92)		Women (n = 1,080)		RI Men/Women	Men (n = 696)		Women (n = 2,193)		RI Men/Women	Men (n = 598)		Women (n = 1,831)		RI Men/Women	Men (n = 349)		Women (n = 884)		RI Men/Women
	Mean	SE	Mean	SE		Mean	SE	Mean	SE		Mean	SE	Mean	SE		Mean	SE	Mean	SE	
Energy (kcal)	2,301	57.3	1,748	15.3	3,000/2,300*	2,343	22.3	1,712	10.1	2,850/2,185*	2,235	24.1	1,634[§]	10.4	2,700/2,075*	2,133	32.7	1,533[§]	14.7	2,400/1,875*
Proteins (g)	108.4	2.6	84.1	0.7	54/41*	111.5	1.1	82.3	0.5	54/41*	105.0	1.1	78.5[§]	0.5	54/41*	99.4[§]	1.6	73.6[§]	0.7	54/41*
Magnesium (mg)	368.6	10.1	281.7	2.5	350/330 *	379.5	4.4	280.6	1.8	350/330*	364.4	4.6	272.2[§]	1.9	350/300*	350.1	6.4	262.3[§]	2.8	350/300*
Calcium (mg)	903.0	29.9	778.8	9.9	800/800	923.0	14.4	805.9	7.7	800/800	871.5	14.2	815.6	9.5	800/800	899.1	19.9	841.0	17.9	800/800
Iron (mg)	15.6	0.4	12.3	0.1	10/18	16.9	0.2	12.1	0.1	10/18	16.6	0.2	11.6	0.1	10/10	15.5	0.3	10.8	0.1	10/10
Potassium (mg)	3,826.3	89.6	3,132.4	24.8	–*	3,931.7	37.6	3,099.9	17.4	–*	3,798.8	40.0	2,999.3[§]	18.9	–*	3,570.4	53.8	2,841.2[§]	29.1	–*
Phosphorus (mg)	1,578.9	38.9	1,253.9	11.0	–*	1,615.6	17.2	1,244.4	8.0	–*	1,526.3	16.7	1,207.5	9.2	–*	1,463.3	23.3	1,170.1	15.7	–*
Vitamin B1 (mg)	1.8	0.05	1.4	0.01	1.2/0.9*	1.8	0.02	1.3	0.01	1.1/0.9*	1.7	0.02	1.2[§]	0.01	1.1/0.8*	1.6[§]	0.03	1.2[§]	0.01	1/0.8*
Vitamin B2 (mg)	1.9	0.05	1.5	0.02	1.8/1.4	1.8	0.02	1.5	0.01	1.7/1.3	1.7	0.02	1.5	0.01	1.6/1.2	1.7	0.03	1.4	0.02	1.4/1.1
Vitamin B6 (mg)	2.2	0.1	1.8	0.01	1.8/1.6*	2.3	0.02	1.7	0.01	1.8/1.6*	2.2	0.02	1.6[§]	0.01	1.8/1.6*	2.0[§]	0.03	1.5[§]	0.01	1.8/1.6*
Vitamin B12 (μg)	8.6	0.6	5.6	0.1	2/2*	8.3	0.2	5.2	0.1	2/2*	7.8	0.2	4.6[§]	0.1	2/2*	6.9	0.3	3.9[§]	0.1	2/2*
Vitamin C (mg)	157.6	8.5	138.7	2.1	60/60*	157.5	2.8	143.0	1.4	60/60*	152.6	3.0	142.9	1.6	60/60*	142.3	3.5	132.4	2.2	60/60*
Vitamin A																				
Total (RE μg)	901.2	64.8	743.4	14.9	1,000/800*	808.3	17.2	714.4	9.6	1,000/800*	707.3	13.4	623.1[§]	8.9	1,000/800 *	664.8	18.2	558.7[§]	10.7	1,000/800*
Retinoids (μg)	473.7	62.6	333.2	12.8	–*	353.4	13.7	314.2	7.5	–*	394.0	9.2	256.1[§]	6.8	–*	282.7	12.8	225.0[§]	7.4	–*
Carotenoids (μg)	2,564.8	135.1	2,461.6	42.3	–	2,729.5	60.2	2,401.3	31.8	–*	2,479.6	57.9	2,201.7[§]	31.6	–	2,292.3	76.3	2,002.3[§]	43.6	–*
Vitamin D (μg)	4.3	0.3	3.2	0.1	5/5*	4.4	0.1	3.1	0.04	5/5*	4.3	0.1	2.9	0.05	5/5	3.8	0.1	2.6[§]	0.06	5/5*
Vitamin E (mg)	14.0	0.6	10.6	0.1	12/12*	13.9	0.2	10.5	0.1	12/12*	13.2	0.3	9.6[§]	0.1	12/12*	12.1	0.4	8.7[§]	0.1	12/12*

*Significant differences between sexes in each age group ($p < 0,05$). [§]Significant differences between all age groups within each sex group ($p < 0,05$).

49 years, but reached adequate intakes at older ages, at which iron requirements are lower. Differences between men and women were of diverse magnitude and conditioned on the age group. Regarding vitamins, intakes of total vitamin A were lower at older ages. Men and women aged 20-49 years showed the highest intakes compared to the older age groups ($p < 0.05$). Small variations for vitamin C mean intakes were observed, although intakes covered the RI. A marked reduction in mean nutrient intake was observed for vitamin D and vitamin E, the latter one diminishing in a higher extent and below RI in women older than 50 years, compared to younger women ($p < 0.05$). The average intake of vitamin D in the sample did also not compliance with the RI.

Mean intake of food groups is displayed in table III. Dairy products were the most consumed, above all among older women compared to younger women ($p < 0.05$). This food group is the main source of proteins, calcium, vitamin A, D, B2, and B6, SFA and magnesium. Intake of legumes, potatoes & tubers, meat and fat were higher in men than in women ($p < 0.05$). In general, those foods assumed to be healthier (cereals, legumes, potatoes and fish) were more consumed from younger ages onwards, contrary to those related to detrimental effects (eggs, meat and fat). Cereals and legumes are important sources of carbohydrates, vegetable protein and fibre; potatoes are the main contributors of carbohydrates, and fish to iron, vitamin D and PUFA.

Other healthy foods, namely vegetables and fruits, were consumed in high levels among men (263.7 g/day and 331.9 g/day, respectively) and women (231.0 g/day and 300.5 g/day, respectively). Consumption of fruits augmented at older ages, and contributed to intake of fibre, vitamin C and vitamin A. In contrast, vegetables were less consumed from age 50 onwards in men and women; as a result, women had the lowest intake at 60-69 years compared to younger age groups ($p < 0.05$). Consumption of cakes and biscuits were similar in men and women and turned to lower intakes at older ages ($p < 0.05$). Older participants also reported a lower consumption of sugar and confectionary, and of non-alcoholic and alcoholic beverages, compared to younger participants ($p < 0.05$).

Table IV shows the risk of inadequate nutrient intakes. The percentage of the sample that laid over the RI of protein intake was higher than 95% in all age groups, and about 10%-20% exceeded the RI for energy intake.

In general, the RI were met for most of the nutrients, such as vitamin C and vitamin B1, B12, and iron in men. In all, 50-78% of the sample had intakes above the RI for vitamin B2 and vitamin B6 and only a small proportion showed a moderate risk of nutrient inadequacy (7% for vitamin B2; 3% of men and 13% of women for vitamin B6). For the rest of the nutrients, we observed a considerably high percentage of the sample with intakes under the RI: intakes < 1/3 RI (high risk of nutrient inadequacy) were observed for vitamin E (0-5%), D (12-36%) and A (3-8%), more notably in women and even more severe in the oldest age group. For these nutrients, the percentage with intakes ≤ 2/3 RI- > 1/3 RI was of major concern (up to a 40%), thus about 20-30% of the sample met the RI. 20% of women had intakes < 2/3 RI-> 1/3 RI of magnesium, and iron intake was also under this border in about 55% of women between 20-49 years.

The analysis on the sample including only acceptable reporters of energy intake resulted in higher energy and nutrient intakes. Comparisons by BMI showed minor differences in intakes between the subgroups, although obese participants presented the lowest energy (1,733 kcal) and nutrient intakes, and a better lipid profile (SFA = 21.6 g). However, after excluding under-reporters this pattern reversed, with percentages of proteins (18.8%), carbohydrates (42.9%) and lipids (36.5%) of the same magnitude in all subgroups (data not shown). Ever smokers showed a stronger noncompliance to the NO because carbohydrate intake was higher (40%) (data not shown). Exclusion of under-reporters had, however, a varying effect on compliance to the RI (fig. 1). The percentage of the sample with intakes ≤ RI was remarkable for the nutrients mentioned above (magnesium, iron, vitamins D and and the degree to which it affected inadequacy depended on the age group and nutrient (ranging from 3 points for iron to 10 points for magnesium in women younger than 50 years).

Discussion

Nutritional data derived from the Granada EPIC cohort, made up of 7.789 subjects recruited in 1992-1996, is compared to the NO and RI. The results of this analysis indicate that there are certain sex and age differences in the intake of energy and nutrients, which account for differences in the compliance with the NO and with the RI.

Nutrient intake in terms of the caloric and lipid profile did not meet the NO: lipids (mainly SFA and cholesterol) and proteins exceeded these recommendations, whereas carbohydrates and fiber were under the reference values. This was on the whole common to both sexes and to all age groups, although age group 60-69 years achieved best the NO. Foods consumed in the cohort may explain these findings: higher consumption of cereals, legumes and potatoes at older ages augmented the total carbohydrate intake; fruits, vegetables, cereals and legumes incremented the fiber intake; a lower consumption of meat, eggs, fat, and cakes and confectionary reduced the lipid (SFA and cholesterol) and protein content of the dietary intake. However, this dietary pattern still proved to be inadequate to reach the NO. These changing dietary habits might be attributed to age or generation-dependent behaviors, but also to dietary adaptations that take

Table III

Food sources (Mean daily intake g/day. Standard Error of the mean, SE; and percentage, % of the total contribution to the diet) of energy and nutrients in the Granada EPIC by age groups and sex

Nutrients	20-39 years								40-49 years							
	Men (n = 92)			Women (n = 1,080)			Total (n = 1,172)		Men (n = 696)			Women (n = 2,193)			Total (n = 2,289)	
	Mean	SE	%[a]	Mean	SE	%[a]	Mean	SE	Mean	SE	%[a]	Mean	SE	%[a]	Mean	SE
Dairy Products	308.6	15.8	14.9	303.3	5.4	17.9	303.7	5.2	296.2	7.5	14.1	309.6	3.6	18.8	306.3	3.3
Cereals & Products	238.3	9.3	11.3	188.4	2.5	11.5	192.3	2.4	259.0	3.7	12.5	183.5	1.8	11.4	201.7	1.7
Legumes	44.9	3.0	2.1	35.7	0.7	2.2	36.4*	0.7	51.7	1.2	2.5	35.1	0.5	2.2	39.1*	0.5
Potatoes & Tubers	64.0	4.2	3.0	54.5	0.9	3.3	55.2*	0.9	67.6	1.7	3.3	50.8	0.6	3.2	54.9*	0.7
Fish & Shellfish	68.5	3.7	3.3	53.3	1.1	3.2	54.5	1.0	77.9	1.9	3.7	52.0	0.8	3.2	58.2	0.8
Meats & Products	143.9	5.3	6.9	97.3[§]	1.4	5.9	100.9*	1.4	138.6	2.4	6.7	90.5[§]	1.0	5.6	102.1*	1.0
Egg & Products	24.0	1.9	1.2	20.2	0.4	1.2	20.5	0.4	22.6	0.7	1.1	19.1	0.3	1.2	19.9	0.3
Fat	28.9	1.2	1.4	25.8	0.3	1.6	26.1*	0.3	30.4	0.5	1.5	25.9	0.2	1.6	27.0*	0.2
Cakes & Biscuits	30.8	4.1	1.4	31.9	1.4	1.9	31.8	1.3	29.6	1.6	1.4	30.9	0.9	1.9	30.6	0.8
Sugar & Sweets	28.8	2.9	1.4	22.2[§]	0.6	1.3	22.7*	0.6	23.5	0.8	1.1	18.8[§]	0.4	1.1	19.9*	0.4
Fruits, Nuts & Seeds	302.7	21.4	13.9	264.3[§]	5.6	15.3	267.3	5.4	328.3	7.8	15.4	294.7	4.0	17.5	302.8*	3.6
Vegetables	265.0	14.6	12.5	251.9	4.0	14.9	252.9	3.9	279.0	5.9	13.1	248.2	2.8	14.9	255.6*	2.6
Alcoholic beverages	265.8	29.1	11.8	46.0	3.2	2.5	63.2	4.1	249.1	10.6	10.8	40.8	2.1	2.2	91.0	3.4
Non-Alcoholic beverages	244.2	22.3	10.9	219.6[§]	5.9	12.7	221.6	5.7	192.1	7.0	8.8	191.4[§]	3.8	11.1	191.5	3.3

Nutrients	50-59 years								60-69 years							
	Men (n = 598)			Women (n = 1,831)			Total (n = 2,429)		Men (n = 349)			Women (n = 884)			Total (n = 1,233)	
	Mean	SE	%[a]	Mean	SE	%[a]	Mean	SE	Mean	SE	%[a]	Mean	SE	%[a]	Mean	SE
Dairy Products	272.4	7.3	13.5	322.0	4.1	20.4	309.8	3.6	313.0	11.2	16.3	333.6	6.3	22.4	327.8	5.5
Cereals & Products	244.8	4.0	12.2	177.7	1.8	11.5	194.3	1.8	237.4	5.1	12.6	175.4	2.5	12.1	192.9	2.4
Legumes	51.9	1.3	2.6	35.0	0.5	2.3	39.2*	0.5	48.7	1.7	2.6	32.7	0.8	2.3	37.2*	0.8
Potatoes & Tubers	69.3	1.8	3.5	51.7	0.7	3.3	56.0*	0.7	67.9	2.4	3.6	48.0	1.0	3.3	53.6*	1.0
Fish & Shellfish	77.3	2.1	3.7	48.9	0.8	3.1	55.9	0.8	64.9	2.4	3.3	43.2	1.0	2.9	49.4	1.0
Meats & Products	124.8[§]	2.4	6.2	81.2[§]	1.0	5.2	92.0*	1.1	109.5[§]	3.3	5.7	68.6[§]	1.3	4.7	80.2*	1.4
Egg & Products	22.5	0.7	1.1	16.5	0.3	1.0	17.9	0.3	19.8	1.0	1.0	15.0	0.4	1.0	16.4	0.4
Fat	28.2	0.6	1.4	24.3[§]	0.3	1.5	25.3*	0.2	26.4	0.7	1.4	22.9[§]	0.4	1.6	23.9*	0.3
Cakes & Biscuits	28.2	1.7	1.4	29.5	1.0	1.8	29.2	0.8	30.1	2.7	1.6	25.1[§]	1.2	1.7	26.5	1.2
Sugar & Sweets	20.0	0.8	1.0	16.3	0.5	1.0	17.2*	0.4	18.9	1.1	1.0	15.1	0.6	1.0	16.2*	0.5
Fruits, Nuts & Seeds	342.6	8.8	16.4	326.6	4.6	20.0	330.5	4.1	328.5	11.1	16.8	304.9	6.1	20.0	311.6	5.4
Vegetables	263.3	6.3	12.9	216.6[§]	2.8	13.5	228.1	2.7	233.4	7.6	12.1	192.9[§]	4.0	12.7	204.4*	3.6
Alcoholic beverages	238.3	12.1	10.6	22.8	1.6	1.3	75.8	3.7	193.8	14.1	8.9	17.0	2.0	1.0	67.1	4.8
Non-Alcoholic beverages	178.8	8.3	8.4	157.8[§]	3.8	9.4	163.0*	3.5	161.1	10.2	7.9	134.2[§]	5.4	8.4	141.8*	4.8

*Significant differences between sexes in each age group ($p < 0.05$). [§]Significant differences between age groups within each sex group ($p < 0.05$). [a]Percent contribution to diet.

Percent contribution to main nutrients: *Dairy products* (proteins = 18.3; carbohydrates = 9.2; lipids = 18.0; MUFA = 11.8; SFA = 32.8; PUFA = 4.9; cholesterol = 16.4; magnesium = 17.4; calcium = 56.2; vitamin B1 = 9.8; vitamin B2 = 39.0; vitamin B6 = 10.6; vitamin B12 = 27.5; vitamin A = 20.2; vitamin D = 8.2). *Cereals & Products* (proteins = 17.0; carbohydrates = 40.4; fiber = 26.9; magnesium = 16.7; calcium = 10.6; iron = 20.8; vitamin B1 = 22.0; vitamin B2 = 8.5; vitamin B6 = 9.7). *Legumes* (fiber = 15.2; magnesium = 6.0; iron = 9.5). *Potatoes & Tubers* (carbohydrates = 6.1; fiber = 5.2; vitamin B6 = 7.8; vitamin C = 6.8). *Fish & Shellfish* (proteins = 13.9; lipids = 2.9; PUFA = 6.0; cholesterol = 19.2; magnesium = 7.0; iron = 15.3; vitamin B2 = 6.5; vitamin B6 = 10.0; vitamin B12 = 42.6; vitamin D = 56.9). *Meats & Products* (proteins = 28.2; lipids = 15.6; MUFA = 15.1; SFA = 19.2; PUFA = 15.6; cholesterol = 27.6; magnesium = 9.0; iron = 13.1; vitamin B1 = 25.8; vitamin B2 = 16.1; vitamin B6 = 20.5; vitamin B12 = 20.4; vitamin D = 7.8). *Egg & Products* (lipids = 3.5; MUFA = 3.1; SFA = 3.3; PUFA = 3.8; cholesterol = 28.0; vitamin B12 = 7.0; vitamin A = 7.7; vitamin D = 16.3). *Fat* (lipids = 36.1; MUFA = 49.9; SFA = 20.0; PUFA = 34.3; vitamin A = 5.1; vitamin D = 5.5; vitamin E = 35.9). *Cakes & Biscuits* (carbohydrates = 11.2; lipids = 12.9; MUFA = 10.5; SFA = 19.3; PUFA = 7.2; cholesterol = 13.8; vitamin A = 8.2; vitamin D = 10.3). *Sugar & Sweets* (carbohydrates = 9.1). *Fruits, nuts & seeds* (carbohydrates = 16.7; fiber = 26.5; magnesium = 16.7; calcium = 9.7; iron = 9.5; vitamin B1 = 13.0; vitamin B2 = 8.5; vitamin B6 = 14.6; vitamin C = 47.4; vitamin A = 8.7; vitamin E = 23.5). *Vegetables* (fiber = 20.7; magnesium = 11.8; calcium = 8.6; iron = 13.0; vitamin B1 = 10.0; vitamin B2 = 8.4; vitamin B6 = 16.1; vitamin C = 36.0; vitamin A = 40.7; vitamin E = 15.9). *Non-Alcoholic beverages* (magnesium = 4.9).

Tabla IV

Inadequate nutrient intake in the Granada EPIC cohort. Percentage of the cohort with intakes ≤ 1/3 RI (high risk), ≤ 2/3 RI-> 1/3 RI (moderate risk), ≤ RI-> 2/3 RI, > RI by age groups and sex

	Energy (kcal)		Proteins (g)		Calcium (mg)		Iron (mg)		Magnesium (mg)		Vit B1 (mg)		Vit B2 (mg)		Vit B6 (mg)		Vit B12 (µg)		Vit C (mg)		Vit A (µg)		Vit D (µg)		Vit E (mg)	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
20-39 years																										
≤ 1/3 RI	0	0	0	0	0	0.8	0	1.0	0	0.2	0	0	0	0	0	0	0	0	0	0.4	1.1	2.8	13.0	22.1	0	1.1
≤ 2/3 RI-> 1/3 RI	25	36.8	0	0.1	5.4	19.1	1.1	52.6	6.5	22.4	2.2	1.0	4.3	7.1	2.2	4.2	0	0.6	2.2	1.7	38	28.2	34.8	39.8	13.0	27.1
≤ RI-> 2/3 RI	65.2	49.9	2.2	1.4	38.0	40.6	6.5	38.9	40.2	54.2	5.4	10.6	45.6	39.2	22.8	35.5	0	3.2	3.3	7.5	35.9	38.5	22.8	22.7	27.2	44.0
> RI	9.8	13.2	97.8	98.5	56.5	39.4	92.4	7.4	53.3	23.2	92.4	88.4	50.0	53.6	75.0	60.3	100	96.1	94.6	90.4	25	30.5	29.3	15.4	59.8	27.9
40-49 years																										
≤ 1/3 RI	0	0	0	0	0.1	0.9	0	1.2	0.6	0.1	0	0	0	0	0	0	0	0	0.3	0	3.2	2.6	12.8	22.9	0.4	1.3
≤ 2/3 RI-> 1/3 RI	25.4	30.3	0	0	8.6	14.5	0.1	53.9	5.9	21.7	0.1	1	5.7	4.5	0.6	4.7	0	0.9	1	1.7	41.5	32.6	31.0	40.2	13.2	28.3
≤ RI-> 2/3 RI	54.9	54.8	0.7	1.1	34.3	42	4.9	38.1	39.9	56.4	7.3	12.1	40.2	31.6	21.1	37.9	0.4	2.7	4.7	4.5	32.5	37.2	24.7	22.8	30.7	41.1
> RI	19.7	14.9	99.3	98.9	54.5	42.6	95	6.8	53.6	21.8	92.5	87	54	63.9	78.3	57.4	98.8	96.3	94	93.7	22.8	27.4	31.5	14	55.6	29.2
50-59 years																										
≤ 1/3 RI	0.5	0	0	0	0.7	0.8	0	0	0.8	0	0	0	0.3	0	0.2	0	0.2	0.2	0.3	0.2	5.3	4.5	12.0	27.1	0.3	1.8
≤ 2/3 RI-> 1/3 RI	23.4	31.1	0.2	0.2	11.4	15.4	0.5	5.1	7.5	16.6	1.7	0.5	7.5	3.7	1.8	7.6	0.5	0.7	0.7	1.5	49.2	43.1	31.9	40.4	18.2	37.6
≤ RI-> 2/3 RI	56.5	53.6	1.5	1.4	33.4	39.9	6.8	31.1	42.3	53.8	9.9	8.3	38.3	28.0	22.4	43.4	0.5	4.6	4.0	4.0	31.1	33.1	25.7	18.1	33.3	38.7
> RI	19.6	15.3	98.3	98.5	54.5	43.9	92.6	63.7	49.3	29.5	88.5	91.2	53.8	68.3	75.6	49.0	98.8	94.4	95.0	94.3	14.4	19.3	30.3	14.4	48.2	21.9
60-69 years																										
≤ 1/3 RI	0	0	0	0	0.6	1.2	0	0	0.8	0	0	0	0	0	0	0.1	0.3	0.1	0	0.2	7.4	8.4	18.9	36.0	0.6	4.7
≤ 2/3 RI-> 1/3 RI	18.9	28.5	0.3	0.2	11.5	15.3	0.6	7.5	8.6	21.6	0.3	1.6	4.6	4.5	2.9	13.2	0.3	3.2	0.6	2.8	53.9	47.3	31.8	37.8	28.1	43.2
≤ RI-> 2/3 RI	52.1	51.9	1.7	3.2	34.1	41.3	9.4	37.3	51.6	53.9	10.3	12.0	34.4	21.0	34.9	49.0	2.0	8.8	2.0	4.5	27.5	30.2	24.9	18.0	34.9	38.1
> RI	28.9	19.6	97.9	96.6	53.9	42.2	89.9	55.2	39.0	24.4	89.4	86.4	61.0	74.4	62.2	37.7	97.4	87.9	97.4	92.4	11.2	14.1	24.3	8.2	36.4	13.9

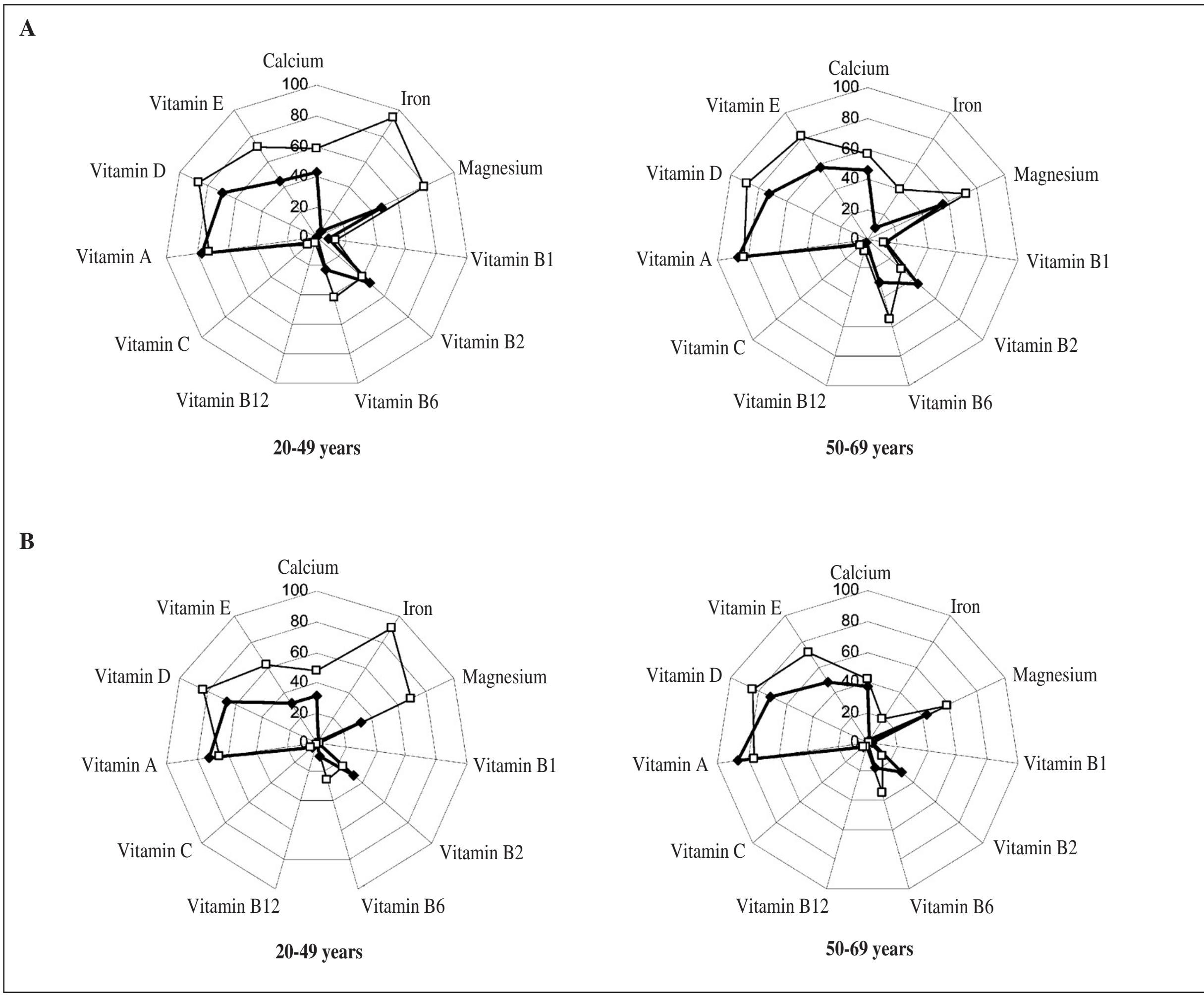

Fig. 1.—Percentage of the Granada EPIC cohort with intakes below nutrient recommended intakes (< RI overall), by age groups (20-49 years and 50-69 years). Total cohort (A) and (B) after excluding under-reporters of energy intake.

place in people of older ages in whom prevalence of chronic diseases demands a healthier lifestyle. Whatever the case may be, since this is a cross-sectional analysis we can not give indications of the sequence of these changes.

We took the NO developed in 1994 in Spain by the SENC[9] that accomplished the dietary habits that predominated at time of recruitment in the Granada EPIC-cohort. Of major concern when developing the NO was dietary fat, as a consequence of the high consumption of olive oil in Spain. Therefore the lipid profile was included in the NO establishing of the total caloric intake, MUFA should cover 15-20% and that SFA should be below 10%. In the Granada EPIC cohort saturated fat intake varied from 11.5% at younger ages to 10.5% at older ages, thus this objective was nearly complied. However, cholesterol and saturated fat raised the total fat intake up to 35.7% of the total energy intake, which was even higher in women than in men. This observation could be attributed to the contribution of alcohol intake to the energy intake in men. Subtracting alcohol from the caloric profile, however, resulted in similar percentages of caloric intake from lipids in both sexes.

Although the Granada EPIC cohort is not representative of the general population from which it was drawn, dietary intakes were similar to the ones observed in several nutritional surveys conducted in several regions of Spain: the mean intake of fat and SFA was approximately 39% and 12.5% of the total calories, respectively.[23,24] Indeed, in the region of Andalusia, where Granada is located, SFA intake represented a 13%.[25] Carbohydrate-rich diets were also preferred in Spain, but did not reach the recommended 50-55% of total calories due to the relatively higher percentage of lipids and proteins in the diet. The average percentage of carbohydrates to total energy in the sample was of 43.3%, as observed in the Spanish population (around 40% in Spain and 41% in Andalusia).[23-25] Of note is that in the Catalan Nutrition Survey it was found that people consuming smaller amounts of fiber presented the highest percentage of energy from fat and SFA.[26] We could not confirm this as those in the first tertile of fiber intake consumed fat and SFA (36% and 11,9% from total energy, respectively) in higher levels than those in the third tertile (35,4% and 10,5% from total energy, respectively).

These nutritional surveys also revealed inadequate intakes for some vitamins and minerals, such as iron, calcium, magnesium and vitamins B1, B2, D and retinol.[23-25] We observed similar inadequate intakes for iron, magnesium, vitamin D and A, but of lesser degree. The most relevant nutrient inadequacies were observed in women at ages 20-49 years were the most strength inadequacy (< 2/3 RI > 1/3 RI) refers to iron (55% of women), followed by vitamin A (30%), D (40%), E (28%), magnesium (22%) and calcium (15%). In men, inadequacies were found in a similar extent for vitamin A and to a much lesser degree for magnesium (5%), calcium (10%) vitamin D (30%) and E (15%). The inadequacy found for vitamin A and E, could be related to an underestimation of intake of added fats. However, this is unlikely since added fats were accounted for in the dietary interviews (fats and oils used for cooking), and intake was found to be relatively high, being vegetable oil the most frequently consumed fat.[27,28]

Regarding vitamin D, nutrient inadequacy could be disregarded since sun exposure and skin synthesis may cover partially the dietary requirements. However, some studies conducted in Spain on vitamin D status in different populations groups and regions have concluded that vitamin D deficiency is worthy of worrying.[29]

The food composition of the diet and the change of dietary habits with age and sex might have contributed to these observations, since some foods were of poor nutritional profile or not sufficiently consumed. This is somewhat uncertain since further revisions of the RI have not materially modified these recommendations, but some problems have been posed, especially for calcium, vitamin C and D, when compared to recommendations set recently in other countries.[30] Comparing nutrient intakes to these higher values may even raise the prevalence of nutrient inadequacy in our cohort.

It should be kept in mind that intake estimates below these recommendations do not express nutrient deficiencies in a very strict manner, since recommended intakes go largely beyond the mean requirement. However, the higher the nutrient intakes deviate from the recommendations, the higher the risk to develop deficiencies.[31,32] For this reason, we estimated risk of inadequate intakes and also analyzed food consumption from a nutritional point of view. Furthermore, adequacy of nutritional intake does not necessarily imply that diet is nutritionally balanced. As such, a nutritional deficiency has to be confirmed by analyzing biomarkers of nutrient intake.[32] Since we did not measure nutrient status, we can not confirm whether suboptimal levels of nutrients were supplied scarce by the diet.

Assessing the prevalence of inadequate intake requires comparing the long-term dietary nutrient intake to the dietary reference intakes.[33] This should be undertaken by country or region since nutrient recommendations have been established according to different nutrient references and adapted to a particular target population.[34] The EPIC cohort has yet not undergone such an examination as a whole or more appropriately, by country or region, although several studies about dietary intakes of foods and nutrients has been published for descriptive purposes.[15]

Exclusion of under-reporting of energy intake has shown to be determinant in nutritional evaluations.[35] However, considering the effect of under-reporting in our study yielded similar results and did not appreciably affect the prevalence of nutrient inadequacy. Intake of supplements may have led to underestimation of mean nutrient intakes. However, overall percentage of users in Spain was estimated to 6.6% in men and 13.4% in women.[15] The effect on nutrient intakes estimates may have been therefore negligible. It is also unlikely that nutrient levels were affected by consumption of fortified foods since they were introduced in Spain in the late 1990s. Regarding to the statistical analysis, it has to be declared that comparisons by contrast hypothesis were prone to result statiscally significant due to the huge sample size.

Besides, considering determinants such as socioeconomic status and physical activity, amongst others, would bring deeper insight into the determinants of nutritional status, allowing the identification of population groups at high risk of nutritional deficiencies or unbalanced intakes. These determinants, however, should not be influencing factors (almost 80% of the participants were sedentary during leisure time, 51% never completed primary school and 73.5% came from rural areas).[16,36] We considered other subgroups, defined by BMI and smoking status and found that smokers presented lower levels of agreement with the NO. However, compliance of mean energy and nutrient intakes to nutritional guidelines and recommended intakes should be estimated by accounting for all these variables and by identifying determinants of nutritional status in the population.

Conclusion

Nutritional adequacy of the Granada EPIC cohort was, in general, adequate. However, a higher risk of inadequate or deficient intakes was more prevalent at ages younger than 50 years, especially in women for iron, and to a lesser degree for magnesium. Intakes below 2/3 RI for Vitamins D, A, and E were also found. It may be important to take these results into account in interpreting specific diet-related outcomes.

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References

1. Willet WC. Diet and Health: what should we eat? *Science* 1994; 264: 532-537.
2. Willet WC. Nutritional Epidemiology, second edition. New York: 1998. Oxford University Press.
3. World Health Organización (WHO) Global health risks: mortality and burden of disease attributable to selected major risks. Geneva: 2009. WHO.
4. National Research Council. Recommended Dietary Allowances. 9th ed. Washington: 1989. National Academy Press.
5. Committee for food of the European Community. Proposed nutrient and energy intakes for the European Community: A report of the Scientific Committee for food of the European Community. *Nutr Rev* 1993; 51: 209-212.
6. Institute of Medicine. Food and Nutrition Board. Dietary Reference Intakes for calcium, phosphorus, magnesium, vitamin D and fluoride. Washington: 1997. National Academy Press.
7. Institute of Medicine. Food and Nutrition Board. Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline. Washington: 1998. National Academy Press.
8. World Health Organization. Report of a WHO Study Group. Diet, nutrition, and the prevention of chronic diseases. WHO Technical Report Series no. 916. Geneva: 2003. WHO.
9. Consejo Superior de Investigaciones Científicas (CSIC). Tablas de Ingestas Recomendadas en Energía y Nutrientes para la población española. Madrid: 1994. Instituto de Nutrición, Universidad Complutense de Madrid.
10. Moreiras O, Carbajal A, Cabrera L. Tablas de composición de alimentos. Madrid: 1999. Pirámide, pp 127-131.
11. Food and Agriculture Organisation/World Health Organisation (FAO/WHO). Preparation and Use of Food-Based Dietary Guidelines. Report of a joint FAO/WHO consultation. Technical Report Series No 880. Geneva: 1998. WHO.
12. Aranceta J. Objetivos nutricionales para la población española. Propuesta de la SENC para la población española. In: Serra L, Aranceta J, Mataix J, et al. Documento de Consenso Guías Alimentarias para la Población Española. Barcelona: 1995. SG-Editores, pp. 127-162.
13. Serra-Majem L, Aranceta J and SENC working Group. Nutritional objectives for the Spanish Population. Consensus from the Spanish society of community nutrition. *Publ Health Nutr* 2001; 4(6A): 1409-1413.
14. Riboli E and the EPIC Collaborative Group. Nutrition and cancer: Background and rationale of the European Prospective Investigation into Cancer and Nutrition (EPIC). *Ann Oncol* 1992; 3: 783-791.
15. Slimani N, Margetts B. The EJCN special issue "Nutrient intakes and patterns in the EPIC cohorts from 10 European countries". *Eur J Clin Nutr* 2009; 63 (Suppl. 4): S1-S274.
16. González CA, Navarro C, Martínez C, Quiros JR, Dorronsoro M, Barricarte A, et al. El Estudio Prospectivo Europeo sobre Cáncer y Nutrición (EPIC). *Rev Esp Salud Pública* 2004; 78: 167-176.
17. Riboli E, Hunt KJ, Slimani N, Ferrari P. Norat T, Fahey M, et al. European Prospective Investigation into Cancer and Nutrition (EPIC): study populations and data collection. *Publ Health Nutr* 2002; 5 (6B): 1113-1124.
18. EPIC Group of Spain. Relative Validity and Reproducibility of a Diet History Questionnaire in Spain. I. Foods. *Int J Epidemiol* 1997a; 26 (Suppl. 1): S91-S99.
19. EPIC Group of Spain. Relative validity and reproducibility of a Diet History Questionnaire in Spain. II. Nutrients. *Int J Epidemiol* 1997b; 26 (Suppl. 1): S100-S109.
20. Slimani N, Deharveng G, Unwin I, Southgate DA, Vignat J, Skeie G et al. The EPIC nutrient database project (ENDB): a first attempt to standardize nutrient databases across the 10 European countries participating in the EPIC study. *Eur J Clin Nutr* 2007; 61 (9): 1037-1056.
21. Gibson RS. Nutritional Assessment. A Laboratory Manual. New Cork: 1998. Oxford University Press, pp. 425-444.
22. Goldberg GR, Black AE, Jebb SA, Cole TJ, Murgatroyd PR, Coward WA, et al. Critical evaluation of energy intake data using fundamental principles of energy physiology. 1. Derivation of cutt-off limits to identify under-reocording. *Eur J Clin Nutr* 1991; 45: 469-481.
23. Aranceta J, Pérez C, Amela C, Garcia Herrera R. Encuesta Nutricional de la Comunidad de Madrid (1992/1993). Madrid: 1994. Consejería de Salud de Madrid.
24. Serra Majem L, Ribas Barba L, García Closas R, Ramón JM, Salvador G, Ferran A. Llibre Blanc: Avaluació de l'estat nutricional de la població catalana (1992.1993). Barlona: 1998. Departamento de Sanitat i Seguretat Social, Generalitat de Catalunya.
25. Mataix J, Llopis J, Martínez de Victoria E, Montellano MA, Lopez M, Aranada P. Valoración del Estado Nutricional de la Comunidad Autónoma de Andalucía (1997). Consejería de Salud: 2000. Junta de Andalucía, Sevilla.
26. Serra-Majem L, Ribas L, Ramon JM. Compliance with dietary guidelines in the Spanish population. Results from the Catalan Nutrition. Survey. *Br J Nutr* 1999; 81 (Suppl. 2): S105-S112.
27. EPIC Group of Spain. Consumption patterns and the principal sources of lipids and fatty acids in the Spanish cohort of the European Prospective Investigation on Diet and Cancer (EPIC). The EPIC Group in Spain. *Med Clin (Barc)* 1999; 112 (4): 125-32.
28. García-Closas R, Berenguer A, Tormo MJ, Sánchez MJ, Quiros JR, Navarro C, et al. Dietary sources of vitamin C, vitamin E and specific carotenoids in Spain. *Br J Nutr* 2004; 91: 1005-1011.
29. Aranceta J, Serra LL, Ortega R. Las vitaminas en la alimentación de los españoles. Madrid: 2000. Médica Panamericana.
30. Joyanes M, González-Gross M, Marcos A. The need to review the Spanish recommended dietary energy and nutrient intakes. *Eur J Clin Nutr* 2002; 56 (9): 899-905.
31. Barr SI, Murphy SP, Poos MI. Interpreting and using the dietary references intakes in dietary assessment of individuals and groups. *J Am Diet Assoc* 2002; 102 (6): 780-788.
32. Foote JA, Murphy SP, Wilkens LR, Basiotis BP, Carlson A. Dietary variety increases the probability of nutrient adequacy among adults. *J Nutr* 2004; 134 (7): 1779-1785.
33. Murphy SP, Poos MI. Dietary Reference Intakes: summary of applications in dietary assessment. *Public Health Nutr* 2002; 5 (6A): 843-849.
34. Doets EL, Wit LS, Dhoukshe-Rutten RA, Cavelaars AE, Raats MM, Timotijevic L, et al. Current micronutrient recommendations in Europe: towards understanding their differences and similarities. *Eur J Nutr* 2008; 47 (Suppl. 1): S17-S40.
35. Ribas-Barba L, Serra-Majem L. Román-Viñas B, Ngo J, Garcia-Alvarez A. Effects of dietary assessment methods on assessing the risk of nutrient intake adequacy at the population level: from theory to practice. *Br J Nutr* 2009; 101 (Suppl. 2): S64-S72.
36. Tormo MJ, Navarro C, Chirlaque MD, Barber X, Argilaga S, Agudo A et al. Physical sports activity during leisure time and dietary intake of foods and nutrients in a large Spanish cohort. *Int J Sport Nutr Exerc Metab* 2003; 13 (1): 47-64.