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ORIGINAL COMMUNICATION

Nutrient adequacy and Mediterranean Diet in Spanish school children and adolescents

Ll Serra-Majem[1,2,3]*, L Ribas[2], A García[3], C Pérez-Rodrigo[4] and J Aranceta[4]

[1]*Department of Clinical Sciences, University of Las Palmas de Gran Canaria, Las Palmas de Gran Canaria, Spain;* [2]*Community Nutrition Research Centre, University of Barcelona, Science Park, Barcelona, Spain;* [3]*Foundation for the Advancement of the Mediterranean Diet, University of Barcelona, Science Park, Barcelona, Spain; and* [4]*Community Nutrition Unit, Ayuntamiento de Bilbao, Bilbao, Spain*

Objective: To evaluate dietary habits and nutritional status of Spanish school children and adolescents, and their relationship with the Mediterranean Diet.
Design: Cross-sectional study by face-to-face interview.
Setting: Free living children and adolescents of all Spanish regions.
Subjects: A random sample of 3166 people aged 6–24 y.
Methods: Home interviews conducted by a team of 43 dietitians included 24-h recalls (a second 24-h recall in 25% of the sample) and a short frequency questionnaire to determine the quality of the Mediterranean Diet (KIDMED).
Results: The participation rate was 68%. In general, the adequacy of the Mediterranean Diet rose with increased mean intakes of the majority of vitamins and minerals and decreased percentages of inadequate intakes ($<2/3$ of the RNI) for calcium, magnesium, vitamin B_6 and C in both sexes, and iron and vitamin A only in females.
Conclusions: This study demonstrates that the Mediterranean Diet contributes to nutritional quality, and also shows concomitant risks as the Mediterranean Diet deteriorates.
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Keywords: food consumption; nutrient intake; children; adolescent; nutrition survey; Mediterranean Diet; Spain

Introduction

The Mediterranean Diet is probably one of the healthiest dietary models known today, with only a few Asian diets, such as the Japanese, being comparable. The health benefits of the Mediterranean Diet have been demonstrated in numerous studies, the most outstanding being the 'Seven-Countries Study' conducted by Ancel Keys (1980). The Mediterranean Diet is comprised of the following foods: olive oil, bread, wheat products, vegetables and fruits, pulses and nuts, wine, cheese and yoghurt, fish and certain meats, combined with an active lifestyle conditioned by day-to-day work and commuting.

The Mediterranean Diet used to be highly caloric and rich in vitamins and minerals derived from vegetables and fruits, wholemeal cereals and virgin olive oil and fish, which made the risk of deficient micronutrient intakes quite infrequent. This explains why inadequate intakes of the B group vitamins (B_1, B_2, niacin, B_6, folates or B_{12}) were rare in the Mediterranean basin, where intakes of antioxidant vitamins (vitamins E and C) and carotenes were also high. However, the changes the Mediterranean Diet have undergone with regards to the reduction of calorie consumption and expenditure, the incorporation of low nutrient dense foods (such as soft drinks, sweets, bakery products), and the food processing methods (such as refinement of flour), have contributed to a increased risk of deficient intakes for some vitamins, especially folates, vitamins A and D, as well as

***Correspondence: L Serra-Majem, Department of Clinical Sciences, University of Las Palmas de Gran Canaria, PO Box 550, 35080 Las Palmas de Gran Canaria, Spain.**
E-mail: lserra@dcc.ulpgc.es
Guarantor: L Serra-Majem.
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inadequate intakes for the rest of the vitamins, in particular among certain population groups or collectives (Serra-Majem *et al*, 2001b, 2002).

The objective of this study was to evaluate the nutritional status of the Spanish population aged 6–24 years, with regard to compliance with the Mediterranean Diet.

Materials and methods

The methodology of the EnKid study has been described elsewhere (Serra-Majem *et al*, 2001a, 2002).

Sample

The target population consisted of all inhabitants living in Spain aged 2–24 y, and the sample population was derived from residents aged 2–24 y registered in the Spanish official population census. The theoretical sample size was set at 5500 individuals, taking into account an anticipated 70% participation rate, which would result in a sample of approximately 3850 individuals. Calculations were made, within a 95% CI, to ascertain the level of precision for estimates of parameters most likely to be compromised (micronutrients) in each stratum, as a function of the maximum sample size that the study permitted. For the purpose of this analysis, only the population aged 6–24 y was included.

Questionnaires

Dietary questionnaires and a global questionnaire incorporating questions related to socioeconomic status, education level and lifestyle factors. The dietary questionnaire used in this analysis was: one 24-h diet recall by subject; and a second 24-h diet recall in 25% of the sample. The 24-h recalls were administered throughout the year in order to avoid the influence of seasonal variations. The questionnaires were conducted in the participant's home. To avoid bias brought on by day-to-day intake variability, the questionnaires were administered homogeneously from Monday to Sunday. In order to estimate volumes and portion sizes, the household measures found in the subjects' own homes were used. The administration of two questionnaires in a subsample allowed us to adjust intakes for random intraindividual variation.

Also, a short (16-item) questionnaire was gathered in the entire sample in order to ascertain the compliance with a Mediterranean Diet model, also described elsewhere (Serra-Majem *et al*, in press). Based on the given answers, the test classified individuals according to the quality of the Mediterranean Diet categorised as: High, Medium or Poor. The questionnaire is shown in Table 1.

Table 1 KIDMED test to assess the Mediterranean Diet

KIDMED test	*Scoring*
Takes a fruit or fruit juice every day	+1
Has a second fruit every day	+1
Has fresh or cooked vegetables regularly once a day	+1
Has fresh or cooked vegetables more than once a day	+1
Consumes fish regularly (at least 2–3/week)	+1
Goes >1/ week to a fast food restaurant (hamburger)	−1
Likes pulses and eats them >1/week	+1
Consumes pasta or rice almost every day (5 or more per week)	+1
Has cereals or grains (bread, etc) for breakfast	+1
Consumes nuts regularly (at least 2–3/week)	+1
Uses olive oil at home	+1
Skips breakfast	−1
Has a dairy product for breakfast (yoghurt, milk, etc)	+1
Has commercially baked goods or pastries for breakfast	−1
Takes two yoghurts and/or some cheese (40 g) daily	+1
Takes sweets and candy several times every day	−1

KIDMED Index: poor ≤3; medium 4–7; high ≥8.

Fieldwork

Fieldwork was initiated on 1 May 1998 and ended on 30 April 2000. Prior to conducting the interviews, participants were sent a letter of introduction and invitation to collaborate by the study coordinators.

In total, 43 dietitians or nutritionists, who had undergone a rigorous selection, training and standardisation process, conducted home interviews. Survey data were entered by the same field staff into laptop computers, which had software specifically designed for the study. Completed interview data were periodically sent to the coordinating centres in Barcelona and Bilbao.

For children aged 6–13 y, the interviews were answered by the children themselves, with support from the caretaker responsible for his/her feeding. When it was necessary, additional information was obtained from school lunch menus, conducting telephone interviews with the food service director of the school.

Food composition table

The nutrient database software used for the study consisted of the Spanish database from Mataix *et al* (1998), completed with information from the French (Favier *et al*, 1995) and British (Holland *et al*, 1991) food composition tables.

Statistical analyses

Data were analysed using the statistical package SPSS for Windows version 10.0. Data from the 24-h recalls were adjusted for intraindividual variability in order to accurately estimate distribution of intakes and percentage of population groups above or below defined cutoff points (RNI) (Liu *et al*, 1978).

For the identification of under-reporting of food intake, we used the energy intake/basal metabolic rate (EI/BMR) ratio of less than 1.14 and classified the individual as under-reported (Goldberg *et al*, 1991). The Reference nutrient values utilised were those elaborated by Departamento de Nutrición (1994).

Results

A total of 3166 individuals participated in the study, which represented 68.2% of the sample. Of them, 1449 were men and 1717 women.

Table 2 shows the mean intakes of energy and nutrients by age and sex with respect to the level of compliance to the Mediterranean Diet Model (KIDMED Index). Energy intake did not change according to the KIDMED Index with the exception of male adolescents aged 15–24 y, who showed tendency towards increased levels. Consumption of fibre, calcium, iron, magnesium, potassium, phosphorus and practically all the vitamins with the exception of vitamin E, increased according to the KIDMED Index.

In Table 3 percentage of inadequate intakes are presented (less than two-thirds of the RNI) based on the KIDMED Index. These percentages showed declines with increasing index scores for calcium, iron (in females), magnesium, vitamin B_6 (excluding males aged 6–14 y), vitamin C and A (in females).

Discussion

The dietary patterns and nutritional profile derived from enkid data reflect the changes in feeding habits and nutritional status which have occurred in Spain. It is precisely within the child and adolescent cohorts, more

Table 2 Nutrient intake and adhesion to the Mediterranean Diet by age and sex

	KIDMED Index for (6–14 y)							*KIDMED Index for (15–24 y)*						
	Poor ≤3		*Medium 4–7*		*High ≥8*			*Poor ≤3*		*Medium 4–7*		*High ≥8*		
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	P	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	P
Men														
Energy (kj)	8822.8	1542.1	9007.4	1327.6	9258.0	1526.9	0.312	9588.5	1558.4	9823.8	1728.9	9994.1	1715.9	0.213
Energy (kcal)	2108.7	368.6	2152.8	317.3	2212.7	364.9	0.312	2291.7	372.5	2347.9	413.2	2388.6	410.1	0.213
Fibre (g)	15.2	2.6	15.8	3.0	16.7	3.5	0.013	15.9	2.6	17.4	3.3	18.4	3.7	<0.000
Calcium (mg)	936.3	141.6	950.7	171.5	1007.6	181.4	0.001	834.6	224.2	930.4	216.5	992.3	233.1	<0.000
Iron (mg)	13.2	2.5	14.2	2.1	14.6	2.4	0.027	15.5	2.6	15.5	2.7	15.8	2.5	0.143
Magnesium (mg)	268.6	42.0	281.8	43.8	292.0	51.2	0.022	279.2	40.7	299.2	45.5	312.7	50.5	<0.000
Sodium (mg)	2507.4	489.7	2465.7	570.3	2596.1	710.3	0.104	2863.9	583.8	2829.0	485.9	2882.4	512.8	0.476
Potassium (mg)	2568.7	326.0	2791.9	390.3	2945.9	465.3	<0.000	2873.4	408.1	3032.1	403.5	3128.4	395.9	<0.000
Phosphorus (mg)	1398.6	185.8	1449.0	201.4	1505.1	230.3	0.007	1478.3	210.1	1577.3	228.5	1625.1	236.0	<0.000
Vitamin B_6 (mg)	1.5	0.3	1.7	0.4	1.9	0.4	<0.000	1.8	0.2	1.9	0.2	1.9	0.2	<0.000
Vitamin E (mg)	6.9	2.4	6.8	1.5	6.9	1.2	0.379	8.1	1.8	7.9	1.7	8.1	1.7	0.379
Thiamin (mg)	1.3	0.3	1.4	0.3	1.5	0.3	<0.000	1.4	0.2	1.5	0.2	1.5	0.2	0.048
Riboflavin (mg)	1.7	0.3	1.8	0.4	1.9	0.4	<0.000	1.6	0.4	1.8	0.3	1.8	0.3	<0.000
Niacin (mg)	21.5	3.9	22.8	3.7	23.8	4.0	0.005	25.4	2.6	26.1	2.5	26.7	2.4	<0.000
Folate (μg)	134.6	37.2	149.6	36.8	160.5	36.4	<0.000	159.7	38.6	171.2	43.8	182.9	41.8	<0.000
Vitamin B_{12} (μg)	8.1	1.6	7.9	1.4	8.1	1.4	0.252	8.6	1.4	8.9	1.5	9.1	1.3	0.017
Vitamin C (mg)	44.4	19.3	66.9	33.3	77.0	30.2	<0.000	61.1	31.5	75.5	30.6	86.8	32.9	<0.000
Vitamin A (μg)	477.6	124.3	502.5	101.5	523.5	101.3	0.089	498.0	125.3	521.1	124.9	545.9	113.1	0.001
Vitamin D (μg)	2.0	0.5	2.1	0.5	2.1	0.5	0.373	2.1	0.4	2.3	0.5	2.3	0.6	0.108
Women														
Energy (kJ)	7537.1	1234.2	7756.6	1014.5	7854.0	1138.9	0.530	7160.6	1366.4	7489.0	1374.6	7723.8	1342.6	0.004
Energy (kcal)	1801.4	295.0	1853.9	242.5	1877.2	272.2	0.530	1711.4	326.6	1789.9	328.5	1846.0	320.9	0.004
Fibre (g)	13.7	1.9	13.5	1.8	14.0	2.0	0.047	13.7	2.9	14.2	3.1	15.5	3.3	<0.000
Calcium (mg)	763.9	149.7	816.4	137.8	863.8	148.5	0.001	735.0	130.7	787.9	145.2	843.6	153.1	<0.000
Iron (mg)	11.8	1.5	11.9	1.3	12.3	1.5	0.070	11.6	1.7	12.1	1.9	12.7	2.1	<0.000
Magnesium (mg)	240.2	23.3	247.7	28.7	252.5	29.4	0.031	236.5	32.8	249.3	36.2	266.3	40.0	<0.000
Sodium (mg)	2114.7	537.0	2100.5	364.3	2129.7	436.4	0.988	2057.5	437.5	2042.2	420.4	2056.2	488.4	0.917
Potassium (mg)	2277.7	355.4	2453.2	306.0	2534.6	346.4	0.002	2221.6	377.2	2480.9	421.2	2678.5	472.5	<0.000
Phosphorus (mg)	1226.8	161.7	1261.6	146.3	1294.0	146.0	0.052	1183.1	160.6	1268.7	171.5	1334.8	185.5	<0.000
Vitamin B_6 (mg)	1.3	0.2	1.4	0.2	1.5	0.2	<0.000	1.4	0.2	1.5	0.3	1.6	0.3	<0.000
Vitamin E (mg)	5.9	2.3	6.4	2.1	6.5	2.3	0.825	6.1	1.5	6.4	1.7	6.8	1.6	<0.000
Thiamin (mg)	1.1	0.2	1.2	0.2	1.3	0.2	0.001	1.1	0.2	1.2	0.2	1.2	0.2	<0.000
Riboflavin (mg)	1.4	0.3	1.5	0.2	1.6	0.2	<0.000	1.4	0.3	1.5	0.3	1.6	0.3	<0.000
Niacin (mg)	19.1	2.7	19.3	3.0	20.1	2.9	0.002	20.0	3.1	21.1	3.3	22.4	3.5	<0.000
Folate (μg)	128.5	19.0	134.3	24.1	142.1	23.3	<0.000	140.6	23.8	155.0	28.7	168.4	31.2	<0.000
Vitamin B_{12} (μg)	6.7	0.9	6.4	1.0	6.5	1.0	0.174	6.9	1.2	7.2	1.0	7.3	1.0	0.045
Vitamin C (mg)	50.5	15.6	65.9	29.8	73.9	24.6	<0.000	59.4	27.0	75.6	29.6	89.4	32.6	<0.000
Vitamin A (μg)	340.1	148.0	434.9	83.2	455.3	86.6	<0.000	414.4	75.2	450.8	100.5	479.4	105.5	<0.000
Vitamin D (μg)	1.3	0.5	1.6	0.4	1.7	0.5	0.012	1.5	0.4	1.6	0.6	1.7	0.6	0.114

Table 3 Percentage of inadequate intakes (<2/3 RNI*) according to Mediterranean Diet adhesion by age and sex

	KIDMED Index for 6–14 y				*KIDMED Index for 15–24 y*			
	Poor ≤3 (%)	*Medium 4–7 (%)*	*High ≥8 (%)*	*P trend*	*Poor ≤3 (%)*	*Medium 4–7 (%)*	*High ≥8 (%)*	*P trend*
Men								
Energy	4.8	1.9	1.3	0.303	23.4	17.0	14.5	0.129
Protein	0.0	0.0	0.0	—	0.0	0.0	0.0	—
Calcium	4.8	2.6	0.4	0.027	12.8	3.0	1.5	0.001
Iron	0.0	0.8	0.0	0.300	0.0	0.5	0.0	0.382
Magnesium	19.0	9.8	4.6	0.004	29.8	12.2	10.0	0.003
Thiamin	0.0	0.4	0.0	0.464	0.0	0.3	0.0	0.537
Riboflavin	0.0	1.1	0.4	0.559	17.0	4.3	1.5	<0.000
Niacin	0.0	0.4	0.0	0.464	0.0	0.3	0.0	0.537
Vitamin B_6	0.0	3.0	2.9	0.724	2.1	0.3	0.0	0.039
Folate	14.3	9.8	5.0	0.021	25.5	19.2	12.1	0.002
Vitamin B_{12}	0.0	0.0	0.0	—	0.0	0.0	0.0	—
Vitamin C	47.6	18.0	5.4	<0.000	19.1	8.6	5.1	0.002
Vitamin A	57.1	63.9	59.6	0.523	87.2	91.1	90.0	0.969
Vitamin D	100.0	95.9	95.8	0.618	100.0	94.4	94.3	0.289
Vitamin E	28.6	43.2	36.3	0.394	55.3	59.2	52.0	0.122
Women								
Energy	13.3	6.9	6.3	0.467	27.7	21.7	14.9	0.002
Protein	0.0	0.0	0.0	—	0.0	0.0	0.0	—
Calcium	26.7	10.4	4.2	<0.000	14.9	13.4	5.3	<0.000
Iron	33.3	23.8	15.4	0.008	66.0	48.8	38.9	<0.000
Magnesium	0.0	4.2	2.9	0.707	31.9	18.8	9.5	<0.000
Thiamin	0.0	0.4	0.4	0.871	0.0	0.0	0.0	—
Riboflavin	0.0	1.2	0.8	0.881	2.1	1.4	0.6	0.182
Niacin	0.0	0.4	0.4	0.871	0.0	0.0	0.0	—
Vitamin B_6	33.3	10.8	5.0	<0.000	17.0	8.1	2.7	<0.000
Folate	46.7	32.3	23.8	0.010	100.0	99.4	99.4	0.711
Vitamin B_{12}	0.0	0.0	0.0	—	0.0	0.0	0.0	—
Vitamin C	13.3	15.4	4.6	<0.000	23.4	9.7	4.2	<0.000
Vitamin A	80.0	61.5	54.2	0.024	97.9	82.2	75.2	<0.000
Vitamin D	100.0	99.6	97.1	0.024	100.0	99.4	98.7	0.185
Vitamin E	66.7	60.8	57.1	0.310	85.1	83.9	80.7	0.164

than any other age group, where the characteristics of the Mediterranean Diet are unravelling (Gorgojo *et al*, 1999; Ortega *et al*, 2001; Serra-Majem, 2000; Serra-Majem *et al*, 2001a; Sánchez Villegas *et al*, 2002).

This study demonstrates the high nutritional quality of the Mediterranean Diet, which contributes to the health benefits ascribed to this dietary model. For this reason, apart from better dietary fat quality and the increased quantity of antioxidants (Visioli & Galli, 2001; Su *et al*, 2002; Barzi *et al*, 2003), we should also add the factor of enhanced nutritional adequacy. The health advantages of a diet devoid of risks for inadequate intakes *vs* a deficient diet have been demonstrated in multiple studies (Fairfield & Fletcher, 2002; Fletcher & Fairfield, 2002; Barringer *et al*, 2003). However, the presence of suboptimal levels does not necessarily mean that biochemical levels or nutrient-related functions are altered. For this reason, the inclusion of biochemical indicators should be included as part of the study design. In general, the influence of intake on biochemical indicators would be important only if differences found between groups were, apart from being significant, also found to be clinically relevant (Olmedilla & Granado, 2000).

Faced with the risk of inadequate vitamin and mineral intakes, the use of fortified foods or supplements is often recommended, if nutrition education is found to be ineffective or not possible (Darnton-Hill & Nalubola, 2002; Roberfroid, 2002). This study demonstrates that when the level of adhesion to a Mediterranean Diet model is optimal, there is a reduced risk of inadequate intakes, thus making fortification and supplementation unnecessary for almost all vitamins and minerals. Health promotion strategies should be prioritised to promote the Mediterranean Diet instead of alternatives such as fortification of supplementation (Bemelmans *et al*, 2000; Siero *et al*, 2000).

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