Public Health Nutrition: 4(6A), 1317–1323 DOI: 10.1079/PHN2001209

Vitamins in Spanish food patterns

Vitamins in Spanish food patterns: The eVe Study

Javier Aranceta[1,*], Lluís Serra-Majem[2,3], Carmen Pérez-Rodrigo[1], Juan Llopis[4], José Mataix[4], Lourdes Ribas[3], Rafael Tojo[5] and Josep A Tur[6]

[1]Community Nutrition Unit, Department of Public Health, Luis Briñas 18, 4th Floor, E-48013 Bilbao, Spain: [2]Department of Preventive Medicine and Public Health, University of Las Palmas, Las Palmas, Spain: [3]Research Group in Community Nutrition, Scientific Park of the University of Barcelona, Barcelona, Spain: [4]Institute for Nutrition, University of Granada, Granada, Spain: [5]Department of Paediatrics, University of Santiago de Compostela, Santiago de Compostela, Spain: [6]Department of Biology and Health Sciences, University of the Balearic Islands, Spain

Abstract

Objective: To describe vitamin intakes in Spanish food patterns, identify groups at risk for inadequacy and determine conditioning factors that may influence this situation.

Design: Pooled-analysis of eight cross-sectional regional nutrition surveys.

Subjects: Ten thousand two hundred and eight free-living subjects (4728 men, 5480 women) aged 25–60 years. Respondents of population nutritional surveys carried out in eight Spanish regions (Alicante, Andalucía, Balearic Islands, Canary Islands, Catalunya, Galicia, Madrid and Basque Country) from 1990 to 1998. The samples were pooled together and weighted to build a national random sample.

Methods: Dietary assessment by means of repeated 24-hour recall using photograph models to estimate portion size. Adjusted data for intra-individual variation were used to estimate the prevalence of inadequate intake. A Diet Quality Score (DQS) was computed considering the risk for inadequate intake for folate, vitamin C, vitamin A and vitamin E. DQS scores vary between 0 (good) and 4 (very poor). Influence of lifestyle (smoking, alcohol consumption and physical activity) was considered as well.

Results: Inadequate intakes (<2/3 Recommended Dietary Intake) were estimated in more than 10% of the sample for riboflavin (in men), folate (in women), vitamin C, vitamin A, vitamin D and vitamin E. More than 35% of the sample had diets classified as poor quality or very poor quality. Factors identified to have an influence on a poor-quality diet were old age, low education level and low socio-economical level. A sedentary lifestyle, smoking, usual consumption of alcohol and being overweight were conditioning factors for a poor-quality diet as well.

Conclusion: Results from The eVe Study suggest that a high proportion of the Spanish population has inadequate intakes for at least one nutrient and nearly 50% should adjust their usual food pattern towards a more nutrient-dense, healthier diet.

Keywords
Nutrition survey
Recommended Intakes
Inadequate intake
Food patterns
Cross-sectional studies
Diet quality

Vitamins must be supplied in adequate amounts via the diet in order to meet requirements. When usual vitamin intake cannot achieve this, functional, clinical and organic manifestations and symptoms appear progressively. Until recently vitamins were believed to play a regulatory role in metabolism or act as co-factors for key enzymatic systems. Nowadays their influence in the development of chronic diseases is highlighted as well. Scientists are interested in determining the optimal levels of intake for these micronutrients in order to achieve maximum health benefit and the best physical and mental performance[1].

However, the optimal biochemical level for each vitamin still remains unknown. Nevertheless, this parameter is related to dietary intake and bioavailability for each vitamin. New editions of Recommended Dietary Intakes include different reference levels for each nutrient depending on the criterion or functional outcome used to define adequacy.

In the public health and scientific arena, the debate about food fortification or recommendations for vitamin supplementation is open, as are updating and reviewing Recommended Dietary Intakes or Dietary Reference

**Corresponding author:* Email: bisaludpublica@jet.es

Values, particularly those for folate, B vitamins, vitamin C, vitamin E, beta-carotene and calcium[2,3].

The objective of this paper is to describe vitamin intakes in Spanish food patterns, identify groups at risk for inadequacy according to Spanish and European recommended intakes and determine conditioning factors that may influence this situation.

Methods

Sample

This study considers cross-sectional data from regional population nutrition surveys carried out between 1990 and 1998 in random samples of Alicante[4], Andalucía[5], the Balearic Islands[6], the Canary Islands[7], Catalunya[8], Galicia[9], Madrid[10] and the Basque Country[11]. All samples were drafted by multi-step stratified random sampling procedures by age, gender and habitat, proportional to population density. Valid response rates were in the range of 68.9% for Catalunya and 95.9% in Andalucía. Description of non-response has been dealt in elsewhere[8,10,11]. Adult people from each representative sample within the age range 25–60 years were included in the pooled analysis of this study. The pooled sample has been post-stratified by region, age group and gender following the procedures described by Hansen and Cochran[12]. In order to estimate the prevalence of diet inadequacy in Spain, a homogeneous distribution of the problem in every region has been assumed. The sample has been weighted according to the distribution of the Spanish population in the 1991 population census by age, gender and region. Sample design and weighting have been performed in collaboration with the Department of Statistics of the Institute Carlos III in Madrid.

Procedures and variables of the study

All interviewers followed a training period, standardisation of criteria and methodology before data collection in each regional survey. During this training, field workers learned and practised how to apply the study protocols regarding food consumption methodology, estimating portion sizes and coding procedures in order to improve accuracy. Education level and occupation were classified in all studies according to the scale suggested by the task force on the measurement of social class in health sciences of the Spanish Society of Epidemiology[13]. This classification reflects the qualification required for a particular job and corresponding salary, ranging from non-qualified manual workers to highly qualified business directors with responsibilities for other people's work. To analyse the influence of these factors in the prevalence of inadequacy, they were rearranged according to the following categories. For Education: low – primary school incomplete or illiterate (<6 years at school); medium – primary school completed, secondary school or further education (6–12 years of education); high – high school, college or university degree (>12 years of education). Socio-economical level was grouped based on occupation of the interviewee and household income as follows: low (≤100 000 ptas monthly), medium (>100 000 to <500 000 ptas monthly) or high (≥500 000 ptas monthly). Habitat was classified according to the locality population size: <10 000 inhabitants, between 10 000 and 100 000 inhabitants or >100 000 inhabitants. Geographical region was classified into north, north-east, north-west, centre, east and south+Canary Is.

Methodology for food consumption analysis

The nutritional surveys included in this study used a combination of methods for diet assessment. Repeated 24-hour recall was the method used in most studies. One study used a 3-day food diary. The information was completed by a food-frequency questionnaire in a number of studies. This pooled analysis has been performed based on the repeated 24-hour recall and food diary data[14]. Photographic models including local and regional dishes were used in all of the studies to estimate portion sizes. Results are based only in dietary intake data, excluding supplements.

Estimates for individual food consumption in each regional survey were pooled into a single database. In order to estimate intake of energy and nutrients, a tailor-made food composition database was built containing 1200 food items. Main sources used for that purpose were McCance & Widdowson's food composition tables (fifth edition)[15], Spanish food composition tables by Moreiras *et al.*[16] and those elaborated by Mataix *et al.*[17]. The database was completed with information supplied by food industries for frequently used products.

Diet quality

Diet quality was evaluated by comparison to Recommended Dietary Intakes (RDIs) for the Spanish population[18] and those suggested by the Scientific Committee for Food and Nutrition of the European Union[19]. The proportion of individuals with intakes below 2/3 of the RDI was the criterion used to estimate risk for inadequate intake. A Diet Quality Score (DQS) was computed considering the risk for inadequate intake for folate, vitamin C, vitamin A and vitamin E. DQS scores vary between 0 (good) and 4 (very poor).

Lifestyle

Information on smoking, alcohol consumption and physical activity was also considered. This information was collected by a means of questionnaires completed in a personal interview. Physical activity level (PAL) was estimated based on the time usually spent on daily sedentary, light, moderate or strong physical activity. Physical exercise, type, intensity and duration were considered as well, including work- and leisure-time activity. PAL was classified according to physical activity

Table 1 Estimated mean intake, selected percentiles and risk for inadequate intake of vitamins in Spanish men aged 25–60 years, The eVe Study

						RDI for the Spanish population		European RDI
Nutrient	Mean±SD	95% CI	P25	P50	P75	% RDI	% <2/3 RDI	% <2/3 RDI
Thiamin (mg)	1.78±0.77	1.68–1.88	1.29	1.67	2.13	162	2.8	2.3
Riboflavin (mg)	1.84±0.98	1.71–2.99	1.35	1.69	2.19	105	12.6	9.5
Niacin equivalents (mg)	40±15	36.4–43.7	28.9	39.2	48.6	222	0.4	0.2
Vitamin B_6 (mg)	2.27±0.87	2.12–2.41	1.64	2.13	2.75	125	0.1	2.1
Vitamin B_{12} (μg)	9.53±8.5	9.34–11.4	4.3	6.70	11.9	476	1	0.6
Folate (μg)	267±108	247–294	185	252	346	133	8.1	8.1
Biotin (μg)	30.6±15	29.6–31.5	20.6	27.9	36.6	204*	†	1.8
Pantothenic acid (mg)	5.33±1.98	4.96–5.70	4.03	5.1	6.46	177*	†	0.9
Vitamin C (mg)	123±85	117–135	62	105	168	205	13.9	8.7
Retinol (μg)	293±260	253–413	140	236	376	†	†	‡
Carotene (μg)	1774±1526	1721–2092	673	1404	2495	†	†	‡
Vitamin A (retinol equivalents)	686±524	642–855	359	565	868	67	60.5	38.6
Vitamin E (mg)	9.10±6.14	8.63–9.66	4.83	7.36	11.6	76	50	15
Vitamin D (μg)	2.42±2.63	2.36–3.01	0.64	1.64	3.4	57.9	73.9	–

$n = 4728$.
P25 – 25th percentile; P50 – P50th percentile; P75 – 75th percentile.
* Proportion of the European RDI satisfied by mean intake.
† There are no RDIs for biotin, pantothenic acid, retinol and carotene in the Spanish recommendations to date.
‡ There are no RDIs for retinol and carotene in the European recommendations to date.

ratio (PAR) as a multiple of basal metabolic rate (BMR) for each activity[20].

Consumption of alcohol was assessed in the context of food and beverage consumption. For the purpose of this study, men having alcohol intakes above 24 g day^{-1} and women with intakes above 16 g day^{-1} were considered 'alcohol consumers'.

Data analysis

Statistical analysis was performed using SPSS[21] and EPIINFO 6.0[22] (CSAMPLE module). EPIINFO allows calculations for standard errors of the estimators for complex sample designs and weighting. Descriptive statistics and 95% confidence intervals (95% CIs) have been estimated for stratified samples. Percentile distributions were calculated as well.

Student *t*-tests and one-way analysis of variance were used to test differences in group means according to age, gender, education, socio-economical level, rural–urban condition and geographical region. Whenever required, log transformations of the variables were previously computed to improve normality as tested by the Kolmogorov–Smirnov normality test. Level of significance for acceptance was *P*-value <0.05. Vitamin intakes were adjusted for intra-individual variability[23]. Underreporters were excluded from the analysis for estimating inadequate intakes[24].

Results

The pooled sample consisted of 10 208 individuals aged 25 to 60 years, 4728 men and 5480 women. Estimated energy intake in the sample was 2409 ± 753 kcal (median: 2290 kcal) for men and 1909 ± 567 kcal (median: 1802 kcal) for women. Energy intake was distributed as follows: 17% from protein; 38% from fat in the male group, 40% in the female group; and 44% from carbohydrates. Alcohol intake accounted for 5% of calorie intake among men and for 1.5% in the female group. Mean age of the sample was 41 ± 11 years. Mean and standard deviation (SD) for vitamin intakes by gender, as well as percentage of RDI, are described in Tables 1 and 2.

Mean intakes for vitamins A, E and D were below RDI both in men and women. Prevalence of inadequate intakes (<2/3 RDI) was 10% or more for riboflavin (in men), folate (in women), vitamin C, vitamin A, vitamin D and vitamin E, considering Spanish RDI as the criterion. Prevalence of inadequate intake was 8.7% for men and 6.9% for women when the European RDIs were used as cut-off points.

More than 35% of the sample was classified as having either poor or very poor Diet Quality Score. The proportion was higher among older women. Table 3 shows the distribution of DQS according to sociodemographic characteristics and lifestyles in men and women. The proportion of poor and very poor quality diets was higher among low educated people ($P < 0.01$) compared with higher education level groups, those from a low socio-economic background ($P < 0.01$) or living in rural areas ($P < 0.01$). Middle-aged and older men and women, either widow/widower or living alone, showed higher rates too. The proportion of poor-quality diets was higher in the south of the country.

Regarding lifestyle, people following a sedentary lifestyle showed a higher proportion of poor and very poor DQS in comparison to more active people ($P < 0.01$). Also, the rate for smokers was higher than that for non-smokers ($P < 0.01$) and usual consumers of alcohol had

Table 2 Estimated mean intake, selected percentiles and risk for inadequate intake of vitamins in Spanish women aged 25–60 years, The eVe Study

Nutrients	Mean±SD	95% CI	P25	P50	P75	RDI for the Spanish population		European RDI
						% RDI	% <2/3 RDI	% <2/3 RDI
Thiamin (mg)	1.49±0.55	1.41–1.56	1.11	1.39	1.77	165	1.1	0.9
Riboflavin (mg)	1.65±0.84	1.55–2.32	1.21	1.5	1.9	126	5.7	5.4
Niacin equivalents (mg)	32.7±12.9	29.6–35.8	23.3	32	40.0	233	0.6	0.6
Vitamin B_6 (mg)	1.97±0.8	1.82–2.11	1.4	1.83	2.39	122	8.6	1.4
Vitamin B_{12} (μg)	7.10±7.1	6.73–7.78	3.3	4.8	7.6	355	2.7	1.4
Folate (μg)	252±103	234–277	175	238	317	126	10	10
Biotin (μg)	25.9±11.33	25.3–26.4	18.6	24.2	31	173*	†	2.8
Pantothenic acid (mg)	4.68±1.62	4.42–4.93	3.53	4.48	5.6	155*	†	1.9
Vitamin C (mg)	136±88	125–152	69.6	121	184	226	10.9	6.9
Retinol (μg)	276±253	238–357	145	231	338	†	†	‡
Carotene (μg)	2023±1756	1981–2335	756	1582	2843	†	†	‡
Vitamin A (retinol equivalents)	665±523	618–753	361	548	815	83	48.5	30
Vitamin E (mg)	8.28±5.16	7.71–8.98	4.56	6.91	10.7	69	55.4	17.3
Vitamin D (μg)	1.96±2.25	1.97–2.33	0.57	1.3	2.54	48	82.4	–

$n = 5480$.
P25 – 25th percentile; P50 – P50th percentile; P75 – 75th percentile.
* Proportion of the European RDI satisfied by mean intake.
† There are no RDIs for biotin, pantothenic acid, retinol and carotene in the Spanish recommendations to date.
‡ There are no RDIs for retinol and carotene in the European recommendations to date.

poorer DQS compared with non-usual alcohol drinkers. Obese people (body mass index (BMI) ≥30 kg m^{-2}) had a higher proportion of poor and very poor DQS compared with non-obese subjects ($P < 0.01$). Dietary patterns in people with a good diet score showed higher consumption of fruit ($P < 0.01$), vegetables ($P < 0.01$), fish ($P < 0.01$), dairy products ($P < 0.01$), eggs ($P < 0.01$) and nuts ($P < 0.01$). The higher the consumption of fruit and vegetables, the lower the proportion of poor-quality diets.

Discussion

Data from household budgetary surveys in Spain[25] reported fair or poor average supply for vitamin B_6, folate, beta-carotene and vitamin D. The latest report from the panel of the Ministry of Agriculture, Fisheries and Food[26] suggested inadequate supply for niacin and riboflavin. The eVe Study was based on a pooled analysis of existing, random population, cross-sectional nutrition surveys carried out in different Spanish regions, and thus reports food consumption data at the country level for the first time. Despite the time interval (1990–1998), all studies used similar methodology for food consumption assessment and were performed on regional random population samples, with adequate response rates (68.9–95.9%).

Underreporting is a limiting factor in food consumption surveys. In order to avoid interference, underreporters (4% of the sample) were excluded from the pooled analysis in The eVe Study and energy intake was included as a covariate in the analysis.

Unfortunately, not all of these studies included biochemical markers in the protocol. However, other studies carried out in Spain, such as the Spanish cohorts in the multi-centre EURAMIC study[27] or the SENECA study[28], and biochemical nutrition assessment of the Bilbao population aged 60 years or older, provided useful information in this respect. The eVe Study highlighted inadequate intakes in significant proportions of the population for riboflavine, folate, vitamin C, vitamin E, vitamin A and vitamin D. In fact, different reference values provided different prevalence rates for inadequate intakes: when using the European recommendations as the criterion to evaluate adequacy the proportion of inadequate intakes was considerably lower, despite referring to the same nutrient distribution.

Consumption of supplements was not considered in every survey; thus the results in The eVe Study are based only on dietary intake, excluding supplements. However, data available in the country suggest some 8–10% of the population either usually or occasionally consume vitamin and mineral supplements. Similar figures have been reported in other Mediterranean countries such as Italy (10%) and France (18%), but the proportion is considerably lower than in other European countries like the UK (31%), Nordic countries (33%) or Central Europe (21%)[29].

Results from regional studies reported sub-optimal biochemical values for vitamins B_1 and B_2[5,8] in proportions between 3 and 6%; and higher proportions for vitamin B_6 (6–11%) and B_{12} (2–7%). Prevalence of sub-optimal red cell folate values in the EINUT-I survey in the Basque Country was higher for people classified in the upper quintile for alcohol intake and those classified in the lower quintile for fruit and vegetable consumption[11]. Other regional surveys reported sub-optimal red cell folate values in 13% of young women[5,8]; 5.4% of the sample in the Catalonian survey showed inadequate levels for plasma tocoferol[8]; a similar proportion was

Table 3 Distribution of Diet Quality Score by sociodemographic and lifestyle characteristics

	Men ($n = 4728$)			Women ($n = 5480$)		
Characteristic	*n*	Good quality (%)	Inadequate intake* (%)	*n*	Good quality (%)	Inadequate intake* (%)
Age						
25–34 years	1627	50.1	49.9	1705	56.6	43.4
35–44 years	1300	53.8	46.2	1575	58.0	42.0
45–54 years	1040	53.1	46.9	1322	59.6	40.4
55–60 years	761	50.1	49.9	878	50.1	49.4
Education						
Low	407	52.1	47.9	690	57.0	43.0
Medium	1518	53.0	47.0	1960	59.8	40.2
High	2803	52.6	47.4	2830	60.6	39.4
Socio-economic level						
Low	983	50.4	49.6	1222	59.3	40.7
Medium	2109	60.4	39.6	1842	66.8	33.2
High	1636	58.4	41.6	2416	68.6	31.4
Rural–urban						
<10 000 inhabitants	903	48.1	51.9	1019	54.0	46.0
10 000–100 000 inhabitants	1754	50.2	49.8	1943	63.1	36.9
≥100 000 inhabitants	2071	57.0	43.0	2518	64.7	35.3
Region						
North	827	58	42	981	70	30
North-west	670	48	52	750	41	59
Centre	870	50	50	1049	68	32
North-east	879	56	44	1095	59	41
East	651	55	45	789	41	59
South+Canary Islands	831	42	58	820	53	47
Marital status						
Single	1172	60.6	39.4	970	60.6	39.4
Married	3451	63.3	36.7	4126	68.8	31.2
Divorced	62	73.6	26.4	194	62.1	37.9
Widow/widower	43	26.0	74.0	192	54.8	45.2
Alcohol consumption						
No	3399	50.6	49.4	5014	56.9	43.8
Yes	1329	49.8	50.2	466	49.3	50.7
Smoking						
Non smoker	1943	55.8	44.2	3578	57.4	42.6
Past-smoker	425	48.0	52.0	301	64.4	35.6
Smoker	2360	48.0	52.0	1601	55.8	44.2
Physical activity						
Very low	870	50.6	49.4	1945	60.0	40.0
Low	1253	53.4	46.6	904	68.0	32.0
Medium	1305	59.6	40.4	1886	67.0	33.0
High	1016	54.4	45.6	592	68.0	31.0
Very high	284	49.1	51.0	153	73.0	27.0
Sports						
No	3139	49.4	50.6	4258	55.1	44.9
Yes	1589	54.2	45.8	1222	64.4	35.6
Obesity†						
No	4184	51.1	48.9	4647	58.2	41.8
Yes	544	56.8	43.2	833	48.1	51.9

* Intake <2/3 RDI at least for one of the nutrients considered in the DQS.
† Obesity defined as BMI≥30 kg m^{-2}.

reported in elderly people in Bilbao[30], although these levels are lower than those observed in the UK (15%)[31].

Studies analysing the influence of food consumption patterns (high consumption of fruit and vegetables) and lifestyles (alcohol and smoking) on biochemical levels of folate and vitamin C have reported a positive influence of high consumption of fruit and vegetables; conversely, smoking and usual alcohol consumption showed a negative association[28]. These results are in line with the findings in The eVe Study looking into factors influencing the DQS.

The eVe Study has contributed to the analysis of food typologies and determining risk factors. Identification of population subgroups at risk is a prerequisite to plan adequate intervention strategies.

In conclusion, results from The eVe Study suggest that a high proportion of the Spanish population has inadequate intakes for at least one nutrient and nearly 50% should adjust their usual food pattern towards a more nutrient-dense, healthier diet. In the context of public health nutrition, encouraging healthy dietary patterns should be the prior strategy to achieve adequate nutrient intakes.

Acknowledgements

The support of Roche Vitamins SA and Roche Consumer Health Spain is gratefully acknowledged.

The authors also acknowledge the contribution of the following research groups and institutions who provided their data to the pooled database: Municipality of Alicante; General Directorate of Public Health; Regional Government of Andalucía; School of Public Health of Andalucía; Institute of Nutrition and Food Technology, University of Granada; Balearic Authority for Health and Welfare, Balearic Council; Department of Biology, University of the Balearic Islands; Health Service of the Canary Islands; Department of Preventive Medicine, University of Las Palmas; General Directorate for Public Health, Regional Government of Catalunya; Department of Health, Regional Government of Galicia; Department of Paediatrics, University of Santiago de Compostela; General Directorate for Health Promotion and Disease Prevention, Regional Government of Madrid; Department of Statistics, Carlos III Institutes for Health; Directorate for Public Health, Department of Health, Regional Government of the Basque Country.

In addition, the authors thank the following individuals: E Alvarez, C Amela, I Aranceta, P Aranda Ramírez, A Armas, I Domínguez, I Egileor, P Enríquez, M Espada, A Farrán Codina, R García Closas, R García Herrera, A Gerekiz, J Gondra, L González de Galdeano, P Laínez, R LeisTrabazo, G Lloveras, M López Frias, F López Blanco, E Martínez de Vitoria, I Marzana, J Medrano, MA Montellano Delgado, E Moreno, MC Navarro, G Nicola, J Orduna, MS Puig, JM Ramón Torrell, J Sáenz de Buruaga, G Salvador Castell, L Salleras, A Sierra and A Urrutia.

References

1 Yates AA, Schlicker SA, Suitor CW. Dietary reference intakes: the new basis for recommendations for calcium and related nutrients, B vitamins, and choline. *J. Am. Diet. Assoc.* 1998; **98**: 699–706.

2 Food and Nutrition Board, Institute of Medicine. *Dietary Reference Intakes for Thiamine, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Panthothenic Acid, Biotin and Choline*. Washington, DC: National Academy Press, 1998.

3 Monsen ER. Dietary reference intakes for antioxidant nutrients: vitamin C, vitamin E, selenium and carotenoids. *J. Am. Diet. Assoc.* 2000; **100**: 637–40.

4 Medrano Heredia J, Mataix Verdú J, Aranceta Bartrina J, eds. *La Dieta Mediterránea y Alicante*, Alicante: Secretariado de Publicaciones, Universidad de Alicante, 1994.

5 Mataix Verdú J, Llopis González J, Martínez de Victoria E, Montellano Delgado MA, López Frias M, Aranda Ramírez P. *Valoración del Estado Nutricional de la Comunidad Autónoma de Andalucía*. Granada: Dirección General de Salud Pública y Participación de la Junta de Andalucía, Instituto de Nutrición y Tecnología de Alimentos de la Universidad de Granada, Escuela Andaluza de Salud Pública, 1999.

6 Tur JA, Puig MS, Nicola G. *Encuesta de Nutrición de las Islas Baleares*. Palma de Malorca: Departamento de Biología Fundamental, Universitat de les Illes Balears, 2000.

7 Serra Majem Ll (Director). *Encuesta Nutricional de Canarias, ENCA, 1997–1998. Vols. 1–5*. Santa Cruz de Tenerife: Servicio Canario de Salud, 2000.

8 Serra Majem L, Ribas Barba L, García Closas R, *et al. Avaluació de l'Estat Nutricional de la Població Catalana (1992–93). Avalauació dels Hàbits Alimentaris, el Consum d'Aliments, Energia i Nutrients, i de l'Estat Nutricional Mitjançant Indicadors Bioquímics i Antropomêtrics*. Barcelona: Generalitat de Catalunya, Departament de Sanitat i Seguretat Social, 1996.

9 Tojo Sierra R, Leis Trabazo R. *Estudio Galinut*. Santiago de Compostela: Conselleria de Sanidad – Departamento de Pediatría, 1999.

10 Aranceta J, Pérez C, Amela C, García Herrera R. *Encuesta de Nutrición de la Comunidad de Madrid*. Madrid: Consejería de Salud de la Comunidad de Madrid, 1994.

11 Aranceta J, Pérez C, Marzana I, Egileor I, González de Galdeano L, Sáenz de Buruaga J. *Encuesta de Nutrición de la Comunidad Autónoma Vasca. Tendencias de Consumo Alimentario, Indicadores Bioquímicos y Estado Nutricional de la Población Adulta*. Vitoria: Servicio de Publicaciones Gobierno Vasco, 1995.

12 Cited by: Kish L. *Survey Sampling*. New York: John Wiley & Sons, 1995; 90–2.

13 Alvarez Dardet C, Alonso J, Domingo A, Regidor E. *La Medición de la Clase Social en Ciencias de la Salud*. Barcelona: SG – Sociedad Española de Epidemiología, 1995.

14 Friedenreich Ch. Methodologic issues for pooling dietary data. *Am. J. Clin. Nutr.* 1994; **59**(Suppl.): 251S–2S.

15 Holland B, Welch AA, Unwin ID, Buss DH, Paul AA, Southgate DAT. *McCance & Widdowson's The Composition of Foods*, 5th revised and extended ed. Cambridge, UK: Royal Society of Chemistry, 1991.

16 Moreiras O, Carbajal A, Cabrera L. *Tablas de Composición de Alimentos*, 2nd ed. Madrid: Ediciones Pirámide, 1996.

17 Mataix Verdú J, Mañas Almendros M, eds. *Tabla de Composición de Alimentos Españoles*, 3rd ed., Corregida y aumentada. Granada: Universidad de Granada, 1998.

18 CSIC. *Tablas de Ingestas Recomendadas en Energía y Nutrientes para la Población Española*. Madrid: Instituto de Nutrición, Universidad Complutense de Madrid, 1994.

19 Scientific Committee for Food. Proposed nutrient and energy intakes for the European Community: report of the Scientific Committee for Food of the European Community. *Nutr. Rev.* 1993; **51**: 209–12.

20 Panel on Dietary Reference Values of the Committee on Medical Aspects of Food Policy. *Dietary Reference Values for Food Energy and Nutrients for the United Kingdom*. London: HMSO, 1991; 23–5.

21 Norusis MJ. *SPSS Professional Statistics 10.0*. Chicago, IL: SPSS, 2000.

22 Sullivan K, Kalsbeek W, Chen M, Frerichs R. CSAMPLE: analyzing data from complex survey samples. In: Dean AG, Dean JA, Coulombier D, Brendel KA, Smith DC, Burton AH, Dicker RC, Sullivan K, Fagan RF, Arner TG, eds. *Epi Info, Version 6: A Word Processing, Database, and Statistics Program for Epidemiology on Microcomputers*. Atlanta, GA: Center for Disease Control and Prevention, 1994.

23 Liu K, Stamler J, Dyer A, McKeever J, Mckeever P. Statistical methods to assess and minimize the role of intra-individual variability in obscuring the relationship between dietary lipids and serum cholesterol. *J. Chronic. Dis.* 1978; **31**(6–7): 399–418.

24 Stallone DD, Brunner EJ, Bingham SA, Marmot MG. Dietary assessment in Whitehall II: the influence of reporting on apparent socioeconomic variation in nutrient intakes. *Eur. J. Clin. Nutr.* 1997; **51**: 815–25.

25 Varela G, Moreiras O, Carbajal A, Campo M. *Encuesta de Presupuestos Familiares 1990–91. Estudio Nacional de Nutrición y Alimentación 1991. Vol. I.* Madrid: INE, 1995.
26 Ministerio de Agricultura, Pesca y Alimentación. *La Alimentación en España 1999.* Madrid: MAPA, 2000.
27 Kardinaal AF, Aro A, Kark JD, Riemersma RA, vant'Veer P, Gomez Aracena J, Kohlmeier L, Ringstad J, Martin BC, Mazaev VP, *et al*. The EURAMIC Study. European study on antioxidants, myocardial infarction and breast cancer. *Arterioescler. Thromb. Vasc. Biol.* 1995; **15**: 726–32.
28 Haller J, Löwik MRH, Ferry M, Ferro-Luzzi A. Euronut SENECA Study on Nutrition and the Elderly. Nutritional status: blood vitamins A, E, B6, B12, folic acid and carotene. *Eur. J. Clin. Nutr.* 1991; **45**(Suppl. 3): 63–82.
29 Gassin AL. Fortification and the European consumer: consumer awareness and attitudes to food fortification. *Scand. J. Nutr.* 1999; **43**(Suppl. 35): 122S–4S.
30 Aranceta Bartrina J, Pérez Rodrigo C, Marzana Sanz I, Eguileor Gurtubai I, Gondra Rezola J, González de Galdeano L, Saenz de Buruaga J. Estado nutricional vitamínico en ancianos. *Rev. Esp. Nutr. Comunitaria* 1997; **3**: 87–94.
31 Gregory J, Foster K, Tyler H, Wiseman M. (Office of Population Censuses and Surveys). *The Dietary and Nutritional Survey of British Adults*. London: HMSO, 1990.