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Compliance of nutritional recommendations of Spanish pregnant women according to sociodemographic and lifestyle characteristics: a cohort study

María Villar Vidal[1], Pilar Amiano[1,2,3] , Clara Rodríguez Bernal[4], Loreto Santa Marina[1,2,3], Imanol Mozo[3,5], Jesús Vioque[3,6], Eva María Navarrete-Muñoz[6], Dora Romaguera[7,8,9], Damaskini Valvi[8], Ana Fernández Samoano[10], Adonina Tardón[10] and Jesús Ibarluzea[1,2,3]

[1]Biodonostia Health Institute, San Sebastián, Spain. [2]Public Health Department of Gipuzkoa, San Sebastian, Spain. [3]CIBER de Epidemiología y Salud Pública (CIBERESP), Spain. [4]Centro Superior de Investigación en Salud Pública, Valencia, Spain. [5]Departamento de Matemáticas Universidad del País Vasco, Spain. [6]Departamento de Salud Pública Universidad Miguel Hernandez, Alicante, Spain. [7]Research Unit, University Hospital Son Espases, Palma de Mallorca, Spain. [8]Center for Research in Environmental Epidemiology (CREAL), Barcelona, Spain. [9]School of Public Health, Imperial College London, UK. [10]Universidad de Oviedo, Spain.

Abstract

Objective: **To assess nutrient intakes and compliance with nutritional recommendations in pregnant women according to selected sociodemographic characteristics and lifestyles.**

Methods: Cross-sectional study based on data from Spanish INMA cohort which recruited 2,585 pregnant women between 2003 and 2008 from four different regions of Spain. Sociodemographic information and anthropometry was collected and dietary intake was assessed through Food Frequency Questionnaires. The adequacy of food group intake was assessed considering current recommendations and from the Spanish Society of Nutrition. Moreover, intake of vitamin A, vitamin C and vitamin E, were compared with the Dietary Reference Intakes of the US Institute of Medicine.

Results: Percentage of women that did not fulfil the recommendations for cereals and legumes (3-4 servings/day) was 70.0%, for fruit intake (2-3 servings/day) it was 39.2%, for vegetables (2-4 servings/day) 47.3% and for dairy (3-4 servings/day) it was 51.6%. Intake of fruit and vegetables increased with age, educational degree and with physical activity (p<0.05). Also non-Spanish achieved better the recommendations. Percentage of pregnant women that did not fulfil the requirements (DRI) of vitamins A and C was 13.2 % and 16.2 respectively. More than 65% of the women did not met the recommended diary intake of vitamin E of 19 mg/day during the lactation period.

Conclusions: Maternal age, education, having healthy habits, as well as country of origin are factors strongly

Correspondence: María Villar Vidal.
Biodonostia Health Institute.
Av. de Navarra 4.
20013 Donostia-San Sebastián. Spain.
E-mail: maria.villar@ehu.es

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CUMPLIMIENTO DE LAS RECOMENDACIONES NUTRICIONALES DE MUJERES EMBARAZADAS EN ESPAÑA EN RELACIÓN A SUS CARACTERÍSTICAS SOCIODEMOGRÁFICAS: ESTUDIO DE UNA COHORTE

Resumen

Objetivo: **Estudiar las ingesta dietética y cumplimiento de las recomendaciones nutricionales de una población de mujeres embarazadas, de acuerdo a sus características sociodemográficas y hábitos de vida.**

Métodos: se trata de un estudio prospectivo basado en datos de la cohorte española INMA (Infancia y Medioambiente). Se han reclutado 2.585 mujeres embarazadas entre los años 2003 y 2008 en cuatro regiones diferentes de España. La ingesta dietética ha sido recogida mediante Cuestionarios de Frecuencia Alimentaria (CFA) y la información antropométrica, sociodemográfica y de estilos de vida a través de cuestionarios generales. La ingesta de grupos de alimentos y de vitaminas A, C y E y carotenoides fueron comparadas con las ingestas dietéticas de referencia de las guías Española y Americana.

Resultados: El porcentaje de mujeres embarazadas que no cumplían las recomendaciones de cereales y legumbres (3-4 raciones /día) fue del 70 %, de frutas (2-3 raciones /día) el 39,2%, de verduras (2-4 raciones /día) fue del 47,3% y de lácteos (3-4 raciones /día) el 51,6%.

La ingesta de frutas y verduras fue mayor en mujeres extranjeras y aumento con la edad, con el nivel de estudios y en mujeres con mayor actividad física (p<0.05).

El porcentaje de mujeres embarazadas que no cumplieron los requerimientos (CDR) de vitaminas A y C fueron el 13,2% 16, 2% respectivamente. Mas del 65% de las mujeres no cumplieron el mínimo de ingesta de vitamina E (19 mg/día) recomendado para mujeres embarazadas y en periodo de lactancia.

Conclusiones: **En este estudio se ha observado que factores como la edad, educación, tener hábitos de vida**

associated with the composition of the diet. Sedentary women and those with a low education are at risk for low vitamin and antioxidant intake and non-optimal food choices during pregnancy.

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saludables así como el país de origen están fuertemente asociados a la composición de la dieta en las mujeres embarazadas. Mujeres sedentarias y con bajo nivel educativo tienen ingesta más bajas de vitaminas y antioxidantes procedentes de las frutas y verduras y por lo tanto más riesgo de llevar una dieta poco adecuada durante el embarazo.

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Palabras clave: *Dieta. Embarazo. Incumplimiento Guías nutricionales. Características sociodemográficas. Antioxidantes.*

Introduction

Maternal diet during pregnancy can influence the child's health[1,2] and the risk of diseases later in life for both mother and child. In pregnant women, micronutrient deficiencies in folate, iron and calcium are well recognized to have an influence on prenatal development and their dietary intake is usually supplemented. The importance of analysing antioxidant intake during this vital period is, however, less well documented.

Due to their biochemical characteristics, it is accepted that antioxidants are important components of a healthy diet and their intake may prevent certain diseases[3], as well as having a notable influence on a child's first years[4] and helping combat oxidative stress in pregnancy[5]. Thus, nutritional surveillance assessing the intake of antioxidant rich-foods such as fruits, vegetables and nuts would make a valuable contribution to dietary assessment for epidemiological studies. Exploring the patterns of lifestyle and intake of food groups and nutrients would characterise the dietary habits of pregnant women and help to identify prevention strategies.

In this context, a previous study of pregnant women in a Spanish Mediterranean area analysed compliance with food-based dietary guidelines and reported lack of compliance for certain food groups as well as inadequate intakes of micronutrients[6]. Following this observation and to provide a broader overview of the situation, in the present study, we assessed food intakes during the first trimester of pregnancy in a large sample of women living in four different coastal areas of Spain: two in the north, on the Cantabrian coast and two in the south, on the Mediterranean coast. The data presented describes the situation in the early stages of pregnancy and complements previously published information concerning dietary habits of pregnant women from the on-going INMA research project[7].

The aims of the study are i) to explore compliance with nutritional recommendations in pregnant women as a function of sociodemographic and lifestyle characteristics[8], and ii) to describe the dietary intake of antioxidant nutrients, namely, total vitamin A, vitamin C and vitamin E as well as specific carotenoids (α-carotene, β-carotene, lycopene, lutein/zeaxanthin and cryptoxanthin) during the first trimester of pregnancy.

Materials and methods

Population and study design

The INMA (from INfancia y Medio Ambiente, the Spanish for Childhood and the Environment) project is a multicentre cohort study that aims to investigate the effect of environmental exposures and diet during pregnancy on foetal and child development. The project follows up four cohorts of pregnant women, two near the Cantabrian coast, in the regions of Asturias and Gipuzkoa, and two near the Mediterranean coast, in Valencia and the city of Sabadell. Women were identified during hospital admission and were invited to join the study. They were at least 16 years old, had a singleton pregnancy, had not followed any programme of assisted reproduction for the current pregnancy, had no communication difficulties and planned to deliver at the referral hospital. Recruitment for the four cohorts ran from 2003 to 2008. All participants signed an informed consent form and the all the corresponding local Ethics Committees approved the research protocol.

Data collection

Information on usual daily food intake during the first trimester of pregnancy (10-13 weeks) was collected using a food frequency questionnaire (FFQ) with 101 food items. It was an adapted version of Willett's questionnaire[9] developed and validated for use among pregnant women from the INMA study in Valencia, Spain[10]. Standard units and serving sizes were specified for each food item. The questionnaire offered nine response options to describe the frequency of intake, ranging from 'never or less than once per month' to 'six or more times per day'. The response for each food item was converted to an average daily intake for each participant. Nutrient values and recommended energy intakes were obtained from the US Department of Agriculture Food Composition Tables[11]. Total nutrient intakes of each nutrient for each woman were then calculated by multiplying the frequency of consumption of each food item by the nutritional composition of the portion size specified on the FFQ and then summing across all foods.

The adequacy of food group intake was assessed considering current recommendations and guidelines obtained from the Spanish Society of Nutrition (SENC)[12]. The SENC provides recommendations for pregnant and lactating women on number of servings of vegetables, fruits, cereal and legume products, dairy foods, and meat, fish, poultry, and eggs, as well as additional oils and beverages. Lack of compliance with these food-based dietary guidelines was ascertained by calculating the proportion of women not reaching the minimum recommended daily number of servings of each food group (servings/day, sv/d). The cut-off values used were the lowest values of the following recommended ranges: 4-5 servings/d of cereals and legumes; 2-4 servings/d of vegetables; 2-3 servings/d of fruits; 3-4 servings/d of dairy products; 2 servings/d of protein-rich foods (meat, poultry, fish, eggs); and 4-8 glasses/d of non-alcoholic drinks (water, herbal teas, soft drinks).

In addition, an estimate was made of the percentage of women whose intake was below the recommended values for vitamins. In this case, inadequacy was calculated using two different sets of Dietary Reference Intakes (DRIs) as cut-off points: those established by the SENC[12], which are 700 µg for total vitamin A, 80 mg for vitamin C, and 15 mg for vitamin E, and those established by the US Institute of Medicine, which are 550 µg for total vitamin A, 70 mg for vitamin C and 12 mg for vitamin E[13;14].

Various different self-reported questionnaires were also administrated. Socioeconomic status (SES) was assessed with two indicators based on education and occupation. The first considered the total years of education completed by the women, creating three categories: infant and primary education (<11 years of education), secondary education (12-15 years), and tertiary education (>16 years). The second categorized the population as having a history of manual (low SES) or non-manual (high SES) work[15].

Further, data were collected to characterise the women's lifestyle in terms of the following variables: physical activity during the first trimester of pregnancy, classified into three categories by hours per week (h/w) (sedentary: almost always sitting or lying with no sports or other physical activity, for <1 h/w; moderately active: housework, light sport, etc. for 1-3 h/w; and active: jobs or other activities involving walking, intense sport, etc. for >4 h/w); mean alcohol intake (0 <1 g/d and > 1 g/d) and smoking habit (yes/no); as well as change in smoking status during pregnancy (smoker at the beginning of pregnancy and smoker in week 12). Lastly, self-care was assessed in terms of: pre-pregnancy body mass index (BMI) (underweight: <18.5 kg/m^2, normal weight: 18.5–24.9 kg/m^2, overweight: 25.0–29.9 kg/ m^2 and obese:> 30.0 kg/ m^2).

Statistical analysis

To understand the sample as a whole, compliance of the pregnant women with dietary recommendations was explored in a large cohort/region-adjusted model considering sociodemographic and lifestyle characteristics as possible explanatory factors of their dietary habits. Maternal characteristics and dietary variables are described with medians and interquartile ranges and means of percentages.

Differences in the intake of food groups as a function of sociodemographic and lifestyle characteristics were assessed using the non-parametric Kruskal-Wallis test. When significant differences were found, Tukey's post hoc test was performed in order to identify paired differences between groups. ANOVA was carried out in order to assess small deviations from normality.

Intakes of vitamins and carotenoids were adjusted for total energy intake using the Willet's residual method[16]. The distribution of intake was right-skewed for most of the nutrients (vitamins and carotenoids); therefore, these data were transformed by the natural logarithm to bring the distribution closer to normality. Nutrients values are expressed as geometric means and standard deviations.

Differences in intake and inadequacy of vitamin intakes between subgroups were assessed using a chi-square test. For all tests, $p<0.05$ was considered statistically significant. Statistical analysis was carried out using IBM SPSS version 19.0.

Results

Complete dietary data was collected for 2,585 women. Their mean age was 30.6 years, with 39.9% of the sample being <30 years old, and it was their first pregnancy in 56.3% of cases. Overall, 66.4% of the women had completed at least secondary education and 91% were born in Spain. Almost 63% were classified as sedentary and 26.8% were overweight or obese before pregnancy (Table I).

Food groups

Table II shows the median intake of food groups (in servings per day) and percentage of women not meeting recommendations. Median intakes for the whole study population were within the range of recommendations for the majority of food groups, the exceptions being cereals and legumes and, in most cases, dairy.

Lack of compliance was very high for cereals and legumes (70.9%), followed by dairy (51.6%), vegetables (47.1%) and fruit (39.2%). Interestingly, foreign-born women had significantly lower percentages of inadequacy for three of these food groups: cereals and legumes ($p<0.05$), vegetables ($p<0.05$) and fruits

Table I
Sociodemographic and lifestyle characteristics of pregnant women of the INMA cohort

		N	%
Northern coastal region	Asturias	482	
	Gipuzkoa	467	
Southern coastal region	Sabadell	654	
	Valencia	822	
Maternal age (years)	<25	198	7.7
	25-29	832	32.2
	30-34	1079	41.7
	≥35	476	18.4
Country of birth	Spain	2360	91.5
	Other	218	8.5
Parity	0	1453	56.3
	1	950	36.8
	≥2	179	6.9
Education	Primary	648	25.1
	Secondary	1066	41.3
	University	867	33.6
Occupational social class	Manual	1368	52.9
	Non manual	1216	47.1
Pre-pregnancy BMI	Underweight	177	4.5
	Normal weight	1774	68.7
	Overweight	488	18.9
	Obese	203	7.9
Physical activity	<1 h week	1624	63.0
	1-3 h week	656	25.5
	>4 h week	296	11.5
Smoking	Never smoked	1096	45.1
	Smoker at the beginning of pregnancy	770	31.6
	Smoker in week 12	442	18.1
Alcohol	None	1792	69.5
	<1 g/d	600	23.3
	>1 g/d	188	7.2

($p<0.05$). The results by food groups can be summarised as follows.

C*ereals and legumes:* none of the women met the recommendations for servings (4-5) and the percentage of inadequate intakes of cereals and legumes ranged from 57.3% in underweight to 76.5% obese women ($p<0.05$). Older women with higher levels of education and physical activity had better rates of compliance than those who were younger with lower levels of education and physical activity ($p<0.05$).

Fruits and vegetables: Across the subgroups analysed, fruit and vegetable intake inadequacies were in the ranges 24.3-49.5% and 36.7-53.0% respectively. The same trend with social profile was observed for these food groups, women who were Spanish ($p<0.05$), younger ($p<0.05$), with one child ($p<0.05$), and a sedentary lifestyle ($p<0.05$) being those that were most likely not to meet dietary guidelines.

Dairy: Manual workers as well as women with a low educational level had intakes that just met the mi-

Table II
Median intake of food groups in servings per day (Serv/d) and IQ a and percentage (%) b of women not meeting recommendations Ψ for food intake during the first trimester of pregnancy

Food groups		*Cereals and legumes*		*Vegetables*		*Fruits*		*Dairy*		*Meat, poultry, fish and eggs §*		*Drinks¥*	
(Recommended servings/d)		*(4-5)*		*(2-4)*		*(2-3)*		*(3-4)*		*2*		*(4-8)*	
Median Serv/d (IQ)	*% Inadequacy*	*Serv/d (IQ)*	*%*	*Serv/d (IQ)*	*%*	*Serv/d (IQ)*	*%*	*Serv/d (IQ)*	*%*	*Serv/d (IQ)*	*%*	*Serv/d (IQ)*	*%*
All women		3.2(1.8)	70.9	2.1 (1.5)	47.1	2.4 (2.0)	39.2	2.9(2.0)	51.6	2.3(0.9)	33.0	7.1(2.9)	9.6
Country of birth	Spain	3.2(1.8)	71.6	2.0(1.5)	48.3	2.4(2.0)	40.00	2.9(2.0)	51.9	2.7(0.9)	32.8	7.1(2.9)	9.7
	Other	3.2(2.1)	63.8*	2.3(1.4)	36.7*	2.9(2.4)	28.9*	3.0(2.1)	49.2	2.3(1.1)	35.8	7.4(3.0)	7.8
Age (years)	<25	3.5(1.8)	64.1	1.6(1.8)	60.6	2.0(2.2)	49.5	2.9(2.2)	51.5	2.3(0.9)	28.3	7.1(2.6)	7.1
	25-29	3.2(1.9)	69.7	2.0(1.5)	50.7*	2.2(1.9)	43.4*	2.8(2.0)	53.2	2.2(0.9)	33.5	7.2(2.2)	8.3
	30-34	3.2(1.7)	72.2	2.1(1.3)	44.6*	2.4(1.9)	37.7*	3.0(2.0)	49.8	2.3(0.8)	32.8	7.1(2.9)	10.1
	≥35	3.1(1.7)	73.1	2.3(1.5)	41.6*	2.6(2.1)	30.9*	2.8(2.0)	53.6	2.3(1.0)	34.5	6.8(2.8)	12.0
Parity	0	3.2(1.7)	71.8	2.0(1.5)	50.0	2.3(2.0)	38.5	2.9(2.0)	52.3	2.2(0.9)	36.4*	7.1(2.8)	12.0
	1	3.2(1.8)	71.6*	2.1(1.5)	44.9	2.5(2.0)	41.9*	2.9(2.0)	50.9	2.3(0.9)	28.9	6.9(2.9)	11.3
	≥2	3.5(2.0)	62.3*	2.3(1.4)	37.4*	2.5(2.1)	30.7*	2.9(1.9)	51.4	2.4(0.9)	26.3	7.4(2.9)	8.9
Education	Primary	3.4(1.8)	66.8*	2.1(1.6)	46.6	2.3(2.2)	42.3	3.1(2.1)	47.4*	2.3(0.9)	29.6*	7.4(2.8)	8.8
	Secondary	3.2(1.8)	70.6*	2.1(1.5)	47.2	2.3(1.9)	40.4	2.8(1.9)	53.7*	2.3(0.9)	29.5*	7.1(2.9)	8.8
	University	3.1(1.7)	74.4*	2.1(1.3)	47.6	2.5(1.9)	35.2*	2.8(2.0)	52.6	2.1(0.8)	39.7	7.1(2.8)	11.2
Occupational social class	Manual	3.3(1.8)	67.8*	2.0(1.5)	48.8	2.3(2.0)	40.9	3.0(1.9)	48.8*	2.3(0.9)	29.8*	7.1(2.8)	9.2
	Non-manual	3.1(1.7)	75.1	2.1(1.4)	45.6	2.4(2.0)	37.3	2.6(2.0)	55.1	2.2(0.8)	36.6	7.1(2.9)	10.1
Pre-pregnancy BMI	Underweight	3.6(2.3)	57.3*	1.8(1.6)	53.0	2.4(2.1)	44.4	2.7(2.2)	58.1	2.4(0.9)	29.1	6.7(2.9)	12.8
	Normal weight	3.3(1.8)	70.3	2.1(1.5)	48.3	2.4(1.9)	38.8	2.9(2.0)	50.8	2.2(0.8)	33.4	6.9(2.6)	10.6
	Overweight	3.1(1.7)	76.5*	2.2(1.4)	43.6	2.5(2.2)	35.9*	2.6(2.1)	55.5	2.2(1.0)	35.2	7.5(3.0)	7.6*
	Obese	2.9(1.9)	75.9*	2.2(1.5)	43.3	2.1(2.0)	47.3*	3.1(1.8)	46.8*	2.3(0.8)	26.6*	7.6(2.6)	4.4*
Physical activity	<1 h week	3.3(1.8)	69.2*	2.0(1.4)	50.0*	2.3(2.0)	42.5*	2.9(2.0)	51.2	2.3(0.9)	33.0	7.1(2.9)	10.2
	1-3 h week	3.1(1.7)	73.6*	2.2(1.6)	43.0*	2.4(1.9)	37.5*	2.9(2.0)	52.6	2.3(0.9)	30.3	7.1(2.6)	8.7
	>4 h week	3.1(1.6)	74.3	2.3(1.4)	40.8	3.0(2.2)	24.3	2.7(2.2)	52.7	2.1(0.8)	38.2	7.3(2.8)	8.4

* p<0.05. IQ, interquartile range (25th–75th percentile). (a) P values obtained using the Kruskal–Wallis test. (b) P values for percentages obtained the Chi-square test. Ψ Food-based dietary guidelines of the Spanish Society of Community Nutrition. § Corresponding to protein- rich foods, ¥ corresponding to low-sugar, non-alcoholic drinks.

nimum of 3 servings/d for dairy products ($p<0.05$). Obese women also met the requirements for this food group, while underweight women had the highest percentage of inadequacy (58.1%) of all the subgroups considered.

Meat, poultry, fish, and eggs: Requirements for this food group were met by all the pregnant women. Percentages of inadequacy were between 26.3 and 39.7%, Spanish women with two or more children and who were underweight were those that had the highest intake.

Drinks: Requirements were met by all the women. Significant differences were found in drink intake between overweight, obese and normal-weight women ($p<0.05$).

Vitamins and carotenoids

Dietary intakes of total vitamin A, C and E and specific carotenoids are compiled in table III. In relation to differences in mean intakes by selected maternal characteristics, it was found that foreign-born women had higher intakes for vitamin A (total), vitamin C, for α-carotene, β-carotene and cryptoxanthin ($p<0.05$). Total vitamin A intake increased with age, parity, education and level of physical activity ($p<0.05$), vitamin C intake was higher in more active women and those from a higher occupational social class, and intake of vitamin E was higher among women with university education ($p<0.05$) and who were more active and had non-manual jobs.

Carotenoid intake (α and β) showed the same trend to be higher in more educated, older, overweight (but not obese), and physically active women. On the other hand, we only found differences in lycopene intake by BMI, with obese and overweight women having higher intakes ($p<0.05$).

Table IV shows percentages of inadequacies in vitamin intake. Based upon the SENC recommendations for pregnant women, more than 80% did not reach the DRI for vitamin E. The rates of inadequacy for vitamin A were 6.5 and 18.9% in sedentary and young women respectively ($p<0.05$). The same pattern was observed for vitamin C intake, ranging from 9.5 to 20.6% ($p<0.05$), and significant differences were also found by educational level ($p<0.05$). Spanish women, once again, had a higher proportion of inadequacy of the three vitamins, but women's country of origin was only a statistically significant variable for vitamin E ($p<0.05$).

Discussion

In this study, we aimed to identify dietary patterns by exploring compliance with nutritional recommendations in order to identify which lifestyle and sociodemographic-related variables are determinants of healthier diet choices during pregnancy.

Trends in inadequacies have been found in the intake of cereals and legumes, fruits and vegetables as a function of the selected characteristics, namely, country of origin, age, education, pre-pregnancy weight and physical activity. Our observations are similar to the previous description in the study of pregnant women in a Mediterranean region[6], though inadequacies were also found in dairy food intakes. Country of origin was found to be related to fruit and vegetable intake and differences in dietary habits, in agreement with the tendency found in other European studies where the main immigrant populations consumed more fruits and vegetables[17].

Our findings also concur with others that associate maternal age and education with the composition of the diet[18] and corroborate the observation that women with two or more children consume more fruits and vegetables[19]. Women who are overweight or obese consumed lower quantities of cereals and legumes and more non-alcoholic drinks than normal-weight women and the observed associations between non-alcoholic drinks, especially soft drinks, and lifestyle factors are similar to those found in another cohort study where lower social status, a low level of physical activity and unhealthy BMI were associated with increased intakes of all types of soft drinks[20].

Older women had higher intakes of fruits and vegetables, though we did not find significant differences in the adequacy of intakes for this food group, while their intakes of cereals and legumes, and milk and other dairy products were below the recommendations. These data also agree with the findings of other authors in studies performed in pregnant women in Spanish Mediterranean areas[6,21]. In addition, our data suggest that older and more educated women tend to have higher intakes of most antioxidants from fruits and vegetables as previously reported[8].

We also found differences by educational level for fruits, cereals and protein-rich foods but not for vegetable intake. Interestingly, there is evidence that in Southern European countries, a relatively high level of fruit and vegetable consumption is common for cultural and economic reasons and is not determined by occupation or education[22]. In this context, it is notable that women living in the northern regions showed a higher intake of fruits and vegetables (characteristic of a Mediterranean diet) than those in the southern regions (data not shown), differing from the data obtained in a recent Spanish study[23]. Although they have their own culinary traditions, our data supports the idea that regions in the north of Spain are in harmony with current dietary habits in Mediterranean countries. Similar conclusions were drawn from a previous Spanish study[24] and a health survey published in 2007[25]. However, variation in food group intake as well as antioxidant intakes could be partly attributable to differences in the population selected or the dietary assessment method, as well as to the use of different food composition databases.

Table III
Intake of vitamins and selected carotenoids ¥ during the first trimester of pregnancy in women of the INMA-Cohort. Geometric Means (Standard deviation) concentrations of vitamins and carotenoids

	Total Vitamin A		*Retinol§.*		*Carotenoids§.*		*Vitamin C*		*Vitamin E*		*α Carotene*		*β Carotene*		*Cryptoxanthin*		*Lutein + zeaxanthin*		*Lycopene*	
Geometric mean in µg (SD)	*µg/d*	*SD*	*µg/d*	*SD*	*µg/d*	*SD*	*mg/d*	*SD*	*mg/d*	*SD*	*µg/d*	*SD*	*µg/d*	*SD*	*µg/d*	*SD*	*µg/d*		*µg/d*	*SD*
All women	1197.9	(1.7)	520.7	(2.0)	688.3	(1.7)	137.7	(1.7)	10.7	(1.3)	426.0	(2.5)	4123.4	(1.7)	326.0	(2.0)	2415.5	(2.0)	3658.3	(2.1)
Country of birth																				
Spain	1181.7	(1.5)	514.4	(2.0)	683.4	(1.7)	136.0	(1.6)	10.7	(1.3)	419.2	(2.5)	4094.2	(1.7)	319.9	(2.0)	2411.6	(2.0)	3633.1	(2.1)
Other	1391.2*	(1.6)	596.0*	(2.3)	744.4*	(1.7)	156.8*	(1.7)	10.5	(1.3)	508.7*	(2.5)	4459.0*	(1.7)	400.6*	(2.2)	2458.9	(2.0)	3948.0*	(1.8)
Age (years)																				
<25	1018.4*	(1.7)	470.9	(2.2)	517.1*	(2.0)	113.0*	(1.7)	9.9*	(1.3)	288.6*	(3.0)	3095.0*	(2.0)	265.7*	(2.5)	1739.9*	(2.3)	3418.8	(2.1)
25-29	1165.4*	(1.6)	516.0	(2.1)	648.5*	(1.8)	132.9*	(1.8)	10.5*	(1.3)	387.0*	(2.7)	3884.4*	(1.8)	310.2*	(2.2)	2269.2*	(2.0)	3696.5	(2.1)
30-34	1232.5	(1.5)	533.7	(1.9)	723.7	(1.6)	140.3*	(1.6)	10.9	(1.3)	458.2	(2.3)	4336.2	(1.6)	334.8	(1.8)	2590.7	(2.0)	3673.8	(2.0)
≥35	1253.2	(1.5)	516.8	(1.9)	762.7	(1.6)	151.3	(1.6)	10.9	(1.3)	496.6	(2.4)	4570.8	(1.6)	363.4	(1.9)	2629.6	(1.9)	3643.0	(2.0)
Parity																				
0	1178.5*	(1.6)	523.8	(2.0)	669.3*	(1.7)	142.2	(1.7)	10.7	(1.3)	405.4*	(2.6)	4009.2*	(1.7)	335.2	(2.0)	2355.0	(2.0)	3614.2	(2.0)
1	1213.4	(1.5)	520.1	(2.0)	703.6*	(1.7)	130.8	(1.7)	10.7	(1.3)	446.8	(2.4)	4215.8*	(1.7)	308.8*	(2.0)	2479.6	(2.0)	3642.6	(2.2)
>2	1273.3	(1.6)	489.1	(2.1)	771.5	(1.6)	138.9	(1.6)	10.8	(1.3)	500.0	(2.3)	4622.4	(1.6)	347.2	(1.9)	2644.3	(1.9)	4054.8	(1.8)
Education																				
Primary	1154.3	(1.6)	504.6*	(2.1)	646.4*	(1.8)	130.0*	(1.7)	10.3*	(1.3)	372.2*	(2.7)	3872.1*	(1.8)	308.8	(2.1)	2270.6*	(2.0)	3590.2	(2.0)
Secondary	1192.5	(1.6)	508.9*	(2.0)	686.0	(1.7)	135.5	(1.7)	10.7	(1.3)	423.3	(2.6)	4109.8	(1.7)	318.4	(2.1)	2422.5	(2.1)	3643.3	(2.1)
University	1236.5*	(1.5)	545.5	(1.9)	723.6	(1.6)	146.4	(1.6)	11.0	(1.3)	473.7	(2.3)	4335.6	(1.6)	349.6*	(1.8)	2526.7	(1.9)	3722.0	(2.1)
Occupational social class																				
Manual	1178.5*	(1.6)	520.2	(2.1)	661.7*	(1.8)	133.1*	(1.7)	10.5*	(1.3)	403.2*	(2.6)	3963.6*	(1.8)	316.5	(2.1)	2301.4*	(2.1)	3647.5	(2.1)
Non manual	1218.7	(1.5)	519.8	(1.9)	718.9	(1.6)	142.8	(1.6)	10.9	(1.3)	452.1	(2.4)	4307.3	(1.6)	337.0	(1.9)	2553.8	(1.9)	3665.3	(2.1)
Pre-pregnancy BMI																				
Underweight	1066.3*	(1.6)	422.6*	(1.9)	639.8	(1.8)	122.3*	(1.8)	10.6	(1.3)	392.4	(2.8)	3832.8	(1.7)	310.1	(2.0)	2194.4	(2.0)	3468.8	(2.1)
Normal weight	1194.2	(1.5)	523.9	(2.0)	681.3	(1.7)	135.8	(1.6)	10.7	(1.3)	428.0	(2.5)	4081.4	(1.7)	318.7	(2.0)	2399.8	(2.0)	3572.8	(2.1)

Table III (cont.)
Intake of vitamins and selected carotenoids ¥ during the first trimester of pregnancy in women of the INMA-Cohort. Geometric Means (Standard deviation) concentrations of vitamins and carotenoids

	Total Vitamin A		*Retinol§.*		*Carotenoids§.*		*Vitamin C*		*Vitamin E*		*α Carotene*		*β Carotene*		*Cryptoxanthin*		*Lutein + zeaxanthin*		*Lycopene*	
Geometric mean in µg (SD)	*µg/d*	*SD*	*µg/d*	*SD*	*µg/d*	*SD*	*mg/d*	*SD*	*mg/d*	*SD*	*µg/d*	*SD*	*µg/d*	*SD*	*µg/d*	*SD*	*µg/d*		*µg/d*	*SD*
Overweight	1231.9	(1.6)	516.7	(2.1)	728.0*	(1.7)	151.2*	(1.7)	10.7	(1.3)	458.9*	(2.4)	4362.3*	(1.7)	367.1*	(1.9)	2527.2*	(2.0)	3809.4*	(2.0)
Obese	1218.8	(1.6)	553.1	(2.0)	685.9	(1.8)	132.5	(1.7)	10.8	(1.3)	357.8*	(3.02)	4109.3	(1.8)	309.5	(2.1)	2445.7	(2.2)	4188.2*	(1.8)
Physical activity																				
<1 h week	1156.8*	(1.6)	508.7	(2.0)	654.2*	1.733	131.1*	(1.7)	10.5*	(1.3)	396.6	(2.6)	3918.7*	(1.7)	307.0*	(2.1)	2261.4*	(2.0)	3590.1	(2.2)
1-3 h week	1242.1	(1.5)	543.2	(1.9)	724.6*	1.676	142.7*	(1.6)	10.8*	(1.3)	461.7	(2.4)	4341.1	(1.7)	346.4*	(1.8)	2633.7*	(2.0)	3658.7	(1.9)
>4h week	1335.3	(1.4)	532.5	(1.9)	814.0	1.613	167.3	(1.6)	11.6	(1.3)	530.3	(2.3)	4878.1	(1.6)	399.6	(1.8)	2900.9	(1.9)	4071.7	(1.9)

a Variables were transformed by the natural logarithm before analysis. Geometric means and geometric standard deviations are presented. P values obtained using ANOVA unless otherwise stated.*Mean values were significantly different using Tukey's post hoc ($p<0.05$).
¥ Dietary vitamin and carotenoid intakes were adjusted for total energy intake using the residual method. §.Retinol and carotenoids calculated from Total vitamin A. Retinol is preformed vitamin A.

A comparison of food consumption among the ten European countries of the EPIC study showed that intakes of leafy and fruiting vegetables and of citrus fruits were higher, and intakes of root vegetables were lower in Spain than in northern European countries[19]. The results of our study are consistent with previous studies where vegetables and fruits are the main sources of α-carotene, β-carotene, cryptoxanthin and lutzeaxanthin intake; nevertheless, non-alcoholic beverages seem to be an important source of cryptoxanthin as these drinks provide a considerable amount and variety of carotenoids[26]. We detected (data not shown) that overweight and obese women have higher intakes of most carotenoids although their fruit and vegetable inadequacies are noteworthy. This supports the idea that these beverages are an important source of carotenoids and are related to less healthy food choices[20]. Moreover, previous studies in Spanish cohorts also describe a higher intake of soft drinks, and fruit juices in southern than in northern coastal regions which could explain the differences[23] as these drinks are a non-negligible source of antioxidants.

Rates of vitamin intake inadequacies are found to be higher considering Spanish than the American guidelines for vitamins, the latter having lower limits. Overall, a high percentage of women reached the DRIs for vitamin A and C, while younger women, with a low level of physical activity and only primary education were more likely to have inadequate intakes. The rates of nutrient inadequacies were high, the percentage of women that did not fulfil the requirements for vitamin E being particularly notable, around 80% considering Spanish guidelines[12] and 60% even considering American[13,14] guidelines.

Other studies in Mediterranean areas have also found high rates of inadequacy for vitamin E[27;28] and these results make it evident that there is a need to promote a greater consumption of vitamin-E-rich foods, beyond olive oil and nuts. Indeed, the present situation (mean intake of 10.7 mg/d) may be regarded as alarming given that the Spanish Society of Nutrition recommends a diary intake of vitamin E of 19 mg/day during the lactation period[12]. A higher consumption of fruits and vegetables, as well as nuts, might improve the quality of the diet, correcting the low intakes of vitamin E.

Consumption at population level depends not only on food supply but also on the existence and implementation of public policies[29]. The levels of compliance for main food group and for the vitamin and carotenoid intakes extend our knowledge of dietary inadequacies in a region where diet is supposed to be healthier than in many Western countries. With this study, we have complemented previously published information concerning dietary habits of pregnant women from the on-going INMA research project. As the next phase of the project, we will continue analysing nutrition at specific stages of pregnancy and its

Table VI
Percentage of intake inadequacy a.b for vitamins A, C and E from food during the first trimester of pregnancy

	Spanish guidelines a			USA guidelines b		
(Dietary Reference Intakes)	Vitamin A§. (700 µg/d) %	Vitamin C (80 mg/d) %	Vitamin E (15 mg/d) %	Vitamin A§ (550 µg/d) %	Vitamin C (70 mg/d) %	Vitamin E (12 mg/d) %
All women	13.2	16.2	86.3	5.2	11.4	65
Country of birth						
Spain	13.6	16.3	87.1*	5.3	11.5	65.2
Other	9.0	14.4	78.1	4.5	10.5	62.7
Age (years)						
<25	18.9*	26.9*	81.1	10.3*	20.6*	61.1
25-29	16.0*	17.9	86.4	7.5*	13.5*	67.8
30-34	11.1	14.5	87.9	3.2	9.3*	64.8
≥35	11.0	12.8	84.5	3.8	8.7	62.2
Parity						
0	14.6*	15.3	88.2*	5.9	10.7	67.9*
1	12.2	18.3*	84.5	4.7	13.0*	61.9*
>2	7.2	12.6	80.8	2.4	8.4	58.7
Education						
Primary	13.1	20.6*	76.6*	4.7	20.6	55.1*
Secondary	12.4	16.2	86.2	4.5	16.2	64.2*
University	14.8	13.7	88.9	6.8	13.7	69.2
Occupational social class						
Manual	13.9	17.5	83.0*	6.3	17.3	61.9
Non manual	15.8	19.5	86.8	7.9	19.5	67.9
Pre-pregnancy BMI						
Underweight	13.6	15.3	86.9	5.1	15.3	65.4
Normal weight	12.2	16.3	88.2	4.6	16.3	66.8
Overweight	12.4	15.9	88.3*	4.5	10.8	66.7*
Obese	13.9	16.5	84.5	5.8	11.9	63.4
Physical activity						
<1 h week	14.9*	17.9*	86.5	5.9*	12.7*	64.8
1-3 h week	12.0*	14.5	86.0	4.6*	10.3*	65.1
>4 h week	6.5	9.7	85.9	2.5	6.5	66.1

a Values of intake inadequacy are expressed as the percentage of women whose intake is below the Dietary Reference Intakes established by the SENC (12).
b Values of intake inadequacy are expressed as the percentage of women whose intake is below the Dietary Reference Intake established for each micronutrient by the US Institute of Medicine (13,14) .
§. Total vitamin A.

relation to outcomes in the child's health. Further, findings from this research may lead us to question the effectiveness of public health programmes providing information to help women make healthy food choices during their pregnancy.

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