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Proposal of a Mediterranean diet index for pregnant women

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Numerous studies have addressed the nutritional needs of pregnant women. The nutritional status of the woman before and during gestation affects the growth of the fetus and the course of the pregnancy and influences the risk of obesity for mother and infant. The aim of this study was to propose a diet quality index for pregnancy based on a Mediterranean-type diet (MDS-P), evaluating the diet of a group of pregnant women by applying the Mediterranean Diet Score (MDS) and evaluating their intake of micronutrients required in optimal amounts during pregnancy, such as Fe, folic acid and Ca. The data used to construct this index (MDS-P) were gathered by means of a FFQ specifically designed for pregnant women. The mean MDS of this group, was 4·31 (SD 1·32), considered to represent satisfactory compliance with the Mediterranean diet (range 0–8). The mean MDS-P (range 0–11), which also takes account of dietary intake or supplements of folic acid, Fe and Ca was 7·53 (SD 1·44), indicating a compliance of around 70 %. The present study findings suggest that the MDS-P, which evaluates the adequacy of folic acid, Fe and Ca as well as compliance with the Mediterranean diet, may represent a valid tool for the specific assessment of the diet of pregnant women living in countries in the Mediterranean area. Further studies are required to complete the validation process.

Mediterranean diet quality: Pregnant women: Nutrition

Numerous studies have addressed the nutritional needs of pregnant women[1,2]. It has also been pointed out that environmental and lifestyle factors must be considered in order to maintain an adequate nutritional balance during pregnancy[3–5]. The nutritional status of the woman before and during gestation affects the growth of the fetus and the course of the pregnancy and influences the risk of obesity for mother and infant[6–8]. Women who are overweight or obese can experience severe problems during pregnancy[9]. An excess of energy and macronutrients in the diet of these women can also lead to marginal deficiencies in some nutrients, e.g. low Fe intake, with associated anaemia[10], or low folate intake, associated with neural tube defects or preterm delivery[11,12]. Moreover, an unbalanced nutrient supply can increase the risk of gestational diabetes[13], a diet with a low glycaemic index can lead to low-weight deliveries, and a high-fat and low-carbohydrate diet has been described as doubling the risk of a small-for-gestational-age birth[14]. Therefore, an appropriate eating pattern is essential throughout childbearing years and during pregnancy to ensure a healthy pregnancy and baby[7,15]. A good diet should provide the amount and variety of nutrients to ensure optimal health for both mother and baby. Pregnant women require more energy and nutrients to meet the demands of the developing fetus[8]. An index rating system that provides a summary of diet quality in pregnant women would be useful as a composite measure of dietary intake for pregnant women and their healthcare providers. Recent proposals for a healthy diet have compared Northern European diets with a Mediterranean-type diet, which is considered to yield possible benefits, including the prevention of premature birth[16].

Several indices have been developed for assessing the diet quality of previously defined population groups. Since Kant[17] published the Dietary Diversity Score (range 0–5), based on the number of major food groups (dairy, meat, grain, fruit, and vegetable) consumed daily, several indices and modifications have been proposed. Drewnowski *et al.* [18] developed the Dietary Variety Score, a slight modification of the Dietary Diversity Score that considered the consumption of more (164) foods over a longer period (15 d). The first five components of the Healthy Eating Index[15,19] address the diet quality in comparison to the food guidelines provided by the Food Guide Pyramid, the second five components examine dietary moderation. Kim *et al.* [20] developed the Diet Quality Index-International, a score based on information from FFQ and a quantitative assessment of reference nutrients. A correction to this index was recently applied to evaluate adherence to the Mediterranean diet[21,22]. However, the endpoints for pregnant women are different, since the aim is to prevent low birth weight and birth defects and to support maternal nutrition without excessive weight gain[10,15]. Inadequate intakes of micronutrients are associated with poor pregnancy outcomes. A Diet Quality Index

Abbreviations: MDS, Mediterranean Diet Score; MDS-P, Mediterranean Diet Score–Pregnancy; RDI, recommended daily intake.

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for Pregnancy was developed by Bodnar & Siega-Riz[23] to reflect current nutritional recommendations for pregnancy and national dietary guidelines. Numerous authors have pointed out the importance of supplementing the diet of pregnant women with different micronutrients, especially Fe and folates[24–26], and some have even related supplementation with folic acid or folic acid plus Fe with a reduced risk of a low-weight birth[27] and a lesser incidence of Down's syndrome[12]. It is important to take account of the lifestyle and particularities of a given country or population in the evaluation of diet quality. Thus, besides addressing specific nutritional requirements, it is necessary to evaluate the foods consumed and the frequency with which they enter the daily diet of the target population. The population of interest in the present study is under the influence of the Mediterranean diet.

The aim of the present study was to propose a diet quality index for pregnancy based on a Mediterranean-type diet, evaluating the diet of a group of pregnant women by applying the Mediterranean Diet Score (MDS)[28] and evaluating their intake of micronutrients required in optimal amounts during pregnancy, such as Fe, folic acid and Ca.

Experimental methods

Study population

In 2000–2, a cohort of 318 mother–son pairs was established at the San Cecilio University Hospital of Granada in order to investigate chronic exposure to endocrine-disrupting chemicals. Inclusion criteria for mothers were the birth of a son at the hospital and the signing of informed consent to participate and complete a questionnaire. The investigation was approved by the Ethics Committee of San Cecilio University Hospital of Granada and all subject data were coded to maintain confidentiality.

Nutritional survey

The epidemiological questionnaire[29] is an adaptation of one prepared by the European Project QLK4-1999-01 422. Structured face-to-face interviews were conducted at the hospitals by trained interviewers before delivery in order to gather data on sociodemographic characteristics, reproductive history, diet, and tobacco and alcohol consumption. Questions were also included on medical recommendations received on nutritional supplements and any special diets. The frequency of consumption of foods was studied by means of a semi-quantitative questionnaire, classifying the frequency of consumption of foods as follows: never; one to three times/month; one to three times/week; four to six times/week; and (only for some foods) every day. Results were expressed as times/week or g/d. The questionnaire design took account of the eating habits of the Spanish population. The mean portions consumed by the study population were estimated using habitual domestic measurements: spoons, glasses, cups, etc.[2,30,31]. Intake of foods (in g/d) was calculated from the reported frequency and weight (in g) of each portion, as described by the women or in some cases according to the usual average portion in Spain[32].

We constructed a diet quality index based on the traditional Mediterranean diet[28] and on the specific need during pregnancy for Fe, Ca and folic acid[10]. The MDS was calculated by evaluating compliance with eight typical components of the Mediterranean diet: high consumption (>median intake) of vegetables, fruit and nuts, pulses, cereals, fish, high MUFA:SFA ratio and low consumption of meat and dairy products[28]. A moderate alcohol diet, also typical of the Mediterranean diet, was not considered for calculating the index in this group of women, who reported no alcohol consumption due to their pregnancy.

Table 1. Characteristics of the study population

Characteristics	Mean	SD	Range	Minimum	Maximum
Age (years)	31·91	5·35	28·00	18·00	46·00
Previous weight (kg)*	61·63	11·07	72·50	40·00	112·50
Current weight (kg)	74·52	11·16	68·00	52·00	120·00
Weight change (kg)	12·85	5·07	37·00	−10·00	27·00
Pre-pregnancy BMI (kg/m^2)*	23·32	3·98	23·30	16·56	39·86
Weeks of gestation	39·23	1·57	10·00	32·00	42·00
Birth weight (g)	3256·72	478·64	3140·00	1450·00	4590·00
Previous pregnancy	0·90	1·04	8·00	0·00	8·00
Season at delivery (%)					
Spring	32·10				
Summer	16·70				
Autumn	25·30				
Winter	25·90				
Receipt of medically recommended supplement (%)					
Folic acid	64·20				
Iron	51·00				
Calcium	15·80				
Residence (%)					
Rural	59·40				
Urban	40·60				
Educational level (%)					
Primary school	53·20				
Secondary school	35·70				
University	11·00				

* At start of pregnancy.

The dietary intakes of the selected micronutrients (folic acid, Fe and Ca) were scored in relation to the Spanish recommended daily intake (RDI)[32], considering two-thirds of the RDI for pregnancy as the cut-off point, in common with some other indexes[21,33,34]. The Novartis-Dietsource program version 1.2 was used to convert foods into nutrients[35].

SPSS-15 statistical software (SPSS Inc., Chicago, IL, USA) was used for all analyses. Standard descriptive statistics (mean, median and standard deviation) and ANOVA test were used.

Results

Anthropometric and sociological characteristics of the study population are summarized in Table 1. Median food intake values (Table 3) were used to calculate the MDS (score range 0–8). Three points are added in the proposed version for pregnant women, corresponding to the three micronutrients, scoring 1 point if the intake of the micronutrient is greater or equal to two-thirds of the RDI or if the woman is receiving a medically prescribed nutrient supplement and 0 points if the intake is below this cut-off value. Hence, the proposed Mediterranean Diet Score–Pregnancy (MDS-P) ranges from 0 to 11 points. Table 2 shows nutrient intake as a percentage of Spanish RDI.

Folic acid supplementation was received by 64·2 % of the study population, 42·0 % during the first 3 months and only 17·8 % throughout the pregnancy. Fe supplementation was received by 51·0 %, but by only 19·0 % throughout the pregnancy, and Ca supplementation was received by 15·8 %, but by only 9·2 % throughout the pregnancy.

The mean MDS in this population was 4·31 (SD 1·32), ranging from 1 to 7, and the mean MDS-P value was 7·53 (SD 1·44), ranging from 4 to 11. Table 3 shows the median intake (in g/d) of each food group used to calculate the MDS-P and the distribution of the group in accordance with their score, considering an MDS-P of ≤ 4 as poor compliance, MDS-P of 5–8 as adequate compliance, and MDS-P ≥ 9 as high compliance. A significant relationship was observed between lower score and higher BMI of the mother at the start of the pregnancy and between higher score and lower weight at the end of the pregnancy. There was also a tendency to an association between lower MDS-P and shorter gestation period ($P=0{\cdot}16$; Table 4).

Discussion

Different populations can have distinct nutritional needs according to their age, lifestyle or specific physiologic/pathologic situations, among other factors. The availability of instruments to assess the diet of specific populations is of great interest. An index has been proposed to evaluate the diet quality of pregnant women in the USA[10], and the present study aimed to develop a similar instrument that also takes account of the specific nutritional requirements during pregnancy but is adapted to the specific lifestyle and eating habits of our setting, considering the Mediterranean diet as a nutritional model[22,28,36,37].

The data used to construct this index (MDS-P) were gathered by means of a FFQ specifically designed for pregnant women in Europe (QLK4-1999-01 422). It is based on the eating habits of the Mediterranean population as previously established by using the MDS[28]. It considers the consumption of different food groups in g/d. Besides including characteristic foods of the Mediterranean diet, the MDS-P takes

Table 2. Energy and nutrient intakes as percentage of Spanish recommendations*
(Minimum, maximum and mean values and standard deviations)

		%RDI†			
Nutrient intake		Minimum	Maximum	Mean	SD
Energy (MJ/d)	10·67	54·82	183·39	109·38	20·12
Proteins (g/d)	56·00	81·87	451·78	182·06	44·16
Proteins (% energy)	10	8·41	31·71	14·68	2·51
Carbohydrates (% energy)	60	33·74	88·32	55·95	7·75
Lipids (% energy)	30	10·84	58·07	30·69	7·88
SFA (% energy)	<7	2·92	12·64	5·25	1·41
MUFA (% energy)	>17	8·56	29·55	14·57	2·95
PUFA (% energy)	3–6	3·09	10·23	5·45	1·12
Ca (mg/d)	1400·00	26·11	163·47	93·76	26·07
Fe (mg/d)	18·00	25·24	128·13	71·20	17·04
Zn (mg/d)	20·00	7·50	142·50	57·45	28·42
Se (μg/d)	65·00	68·76	596·15	260·35	78·56
Iodine (μg/d)	135·00	9·72	25·39	17·10	2·84
Vitamin B_1 (mg/d)	1·00	96·00	315·00	185·00	41·00
Vitamin B_2 (mg/d)	1·60	46·65	192·37	114·74	31·27
Niacin (mg/d)	17·00	42·94	488·24	149·96	59·05
Vitamin C (mg/d)	80·00	8·75	696·25	144·77	109·23
Vitamin A (μg/d)	800·00	7·25	596·10	108·12	72·23
Vitamin D (μg/d)	10·00	1·00	502·00	30·95	63·05
Vitamin E (mg/d)	15·00	3·92	176·29	49·87	30·94
Folic acid (μg/d)	600·00	92·50	348·14	220·71	52·43

RDI, recommended daily intake.
* For details of subjects and procedures, see Experimental methods.
† Recommendations for Spanish pregnant women[32].

Table 3. Intake of food groups to calculate the Mediterranean Diet Score–Pregnancy (MDS-P) and daily diet intake of food groups: % of study population in each tertile of the MDS-P*

(Maximum, median and mean values and standard deviations)

						% in MDS-P tertile		
Food groups	Maximum	Mean	SD	Median		≤4·0	5·0–8·0	≥9·0
Dairy products (g/d)	346·43	293·03	43·89	300·71	<Median	0·0	64·4	35·6
					≥Median	2·7	81·8	15·5
Eggs (g/d)	53·57	23·42	10·82	21·43	<Median	0·0	50·0	50·0
					≥Median	1·6	75·5	22·9
Pulses (g/d)	14·29	10·64	4·36	14·38	<Median	3·7	86·6	9·8
					≥Median	0·0	65·3	34·7
Vegetables (g/d)	250·00	199·67	46·30	217·85	<Median	2·1	86·3	11·6
					≥Median	1·0	62·9	36·2
Soft drinks (ml/d)	600·00	216·22	122·12	200·00	<Median	3·0	71·7	25·3
					≥Median	0·0	76·2	23·8
Fruits and nuts (g/d)	117·14	105·43	22·49	108·92	<Median	5·5	81·8	12·7
					≥Median	0·0	71·0	29·0
Meat (g/d)	71·43	32·68	15·26	28·60	<Median	0·0	63·0	37·0
					≥Median	1·7	75·7	22·5
Fish (g/d)	85·71	37·25	19·74	34·60	<Median	0·0	100·0	0·0
					≥Median	1·8	69·4	28·8
Cereals (g/d)	637·13	356·70	108·47	353·92	<Median	3·0	87·0	10·0
					≥Median	0·0	61·0	39·0
SFA (g/d)	22·62	15·79	3·15	15·23	<Median	0·0	63·5	36·5
					≥Median	2·9	83·7	13·5
MUFA (g/d)	53·08	43·62	3·21	43·38	<Median	1·1	69·5	29·5
					≥Median	1·9	78·1	20·0
PUFA (g/d)	20·82	16·31	1·37	16·22	<Median	1·0	70·8	28·1
					≥Median	1·9	76·9	21·2
MUFA:SFA ratio	4·29	2·85	0·45	2·82	<Median	3·2	86·2	10·6
					≥Median	0·0	63·2	36·8
Energy intake (MJ/d)	19·55	11·66	2·14	11·63	<Median	3·0	79·8	17·2
					≥Median	0·0	68·3	31·7
Iron (mg/d)	23·06	12·82	3·07	12·23	<Median	0·0	84·1	15·9
					≥Median	1·9	71·2	26·9
Calcium (mg/d)	2288·54	1312·67	364·97	1294·40	<Median	5·3	84·2	10·5
					≥Median	1·1	72·9	26·0
Folic acid (μg/d)	385·86	281·87	49·52	230·58	<Median	1·3	81·3	17·3
					≥Median	1·6	69·6	28·8

* For details of subjects and procedures, see Experimental methods.

into account three important micronutrients during pregnancy, following the Diet Quality Index for Pregnancy proposed by Laraia *et al.* [10] but using recommendations proposed for the Spanish population[32].

The dietary intake of micronutrients revealed by the FFQ was below recommendations[32]. However, as part of the health service follow-up of pregnancy, folic acid supplementation is generally prescribed, and Fe and Ca supplementation can also be offered. The mean MDS of this group was 4·31 (SD 1·32), which is considered to represent satisfactory compliance with the Mediterranean diet according to the review by Bach *et al.* in 2006[34]. The mean MDS-P, which also takes account of dietary intake or supplements of folic acid, Fe and Ca was 7·53 (SD 1·44), indicating a compliance of around 70·0 %.

A validation study of the FFQ used is in progress, and the absence of these data for the present paper is a study limitation.

The present finding of a relationship between lower MDS-P and higher BMI and weight of these mothers, although not significant, supports previous data indicating the protective effect of the Mediterranean diet against obesity-related conditions[38–43]. The relationship found between lower score and shorter gestation period supports recent findings on the benefits of the Mediterranean diet in the prevention of premature deliveries[16] and on the importance of an adequate supply of folates and Fe, among other micronutrients, for the adequate development of the fetus[12,25–27]. The present study findings suggest that the MDS-P, which evaluates the adequacy of folic acid, Fe and Ca as well as compliance with the Mediterranean diet, may represent a valid tool for the specific assessment of the diet of pregnant women living in countries in the Mediterranean area. Further studies are required to complete the validation process.

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Table 4. Maternal characteristics and newborn weight†
(Minimum, maximum and mean values and standard deviations)

Characteristics	MDS-P tertile	Mean	SD	Minimum	Maximum	*F*‡	*P*‡
Age (years)§	≤4·0	34·33	3·05	31·00	37·00	1·049	0·352
	5·0–8·0	32·40	6·33	18·00	46·00		
	≥9·0	33·75	4·44	25·00	45·00		
Height (m)	≤4·0	1·65	0·02	1·63	1·67	0·358	0·699
	5·0–8·0	1·62	0·06	1·45	1·79		
	≥9·0	1·63	0·06	1·51	1·78		
Weight (kg)	≤4·0	71·00	3·46	67·00	73·00	1·276	0·281
	5·0–8·0	61·71	11·06	40·00	112·50		
	≥9·0	60·77	10·36	48·00	89·00		
BMI (kg/m^2)§	≤4·0	25·85	5·92	22·10	32·69	0·799	0·045*
	5·0–8·0	23·16	3·68	16·90	38·97		
	≥9·0	23·57	4·89	17·72	39·86		
Current weight (kg)	≤4·0	81·83	4·07	79·00	87·00	0·701	0·049*
	5·0–8·0	74·37	11·06	53·00	120·00		
	≥9·0	74·08	11·19	58·00	104·00		
Weight change (kg)	≤4·0	10·83	3·40	7·00	14·00	0·177	0·838
	5·0–8·0	12·89	8·13	−10·00	83·00		
	≥9·0	13·30	5·38	0·00	28·00		
Weeks of gestation	≤4·0	37·00	2·64	35·00	40·00	1·852	0·160
	5·0–8·00	38·91	1·94	32·00	42·00		
	≥9·0	39·12	1·35	36·00	41·00		
Newborn weight (g)	≤4·0	3433·33	438·22	3070·00	3920·00	0·183	0·833
	5·0–8·0	3296·84	478·72	2000·00	4420·00		
	≥9·0	3271·27	472·12	1800·00	4300·00		

MDS-P, Mediterranean Diet Score–Pregnancy.
*$P<0·05$.
† For details of subjects and procedures, see Experimental methods.
‡ ANOVA test.
§ At start of pregnancy.

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