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Diet quality of young people in southern Spain evaluated by a Mediterranean adaptation of the Diet Quality Index-International (DQI-I)

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The aim of this study was to assess whether the recently developed Diet Quality Index-International (DQI-I) was useful to evaluate the diet quality of a young Mediterranean population. A cross-sectional nutritional survey was carried out in southern Spain (Granada-Andalucia) from 2002 to 2005. Dietary information (24 h recall and FFQ) and socio-demographic and lifestyle data were collected from a representative sample of the population (*n* 288, 44·1 % females and 55·9 % males) aged 6–18 years (mean 12·88 (SD 2·78) years). DQI-I was designed according to the method of Kim *et al.* modified by Tur *et al.* for Mediterranean populations. It focused on four main characteristics of a high-quality diet (variety, adequacy, moderation and overall balance). This young population from southern Spain obtained 56·31 % of the total DQI-I score, indicating a poor-quality diet. A higher score was associated with a longer breakfast and greater physical activity. The DQI-I may require further modification for application in Mediterranean populations, differentiating between olive oil and saturated fats, among other changes. Further research is needed to develop a new diet quality index adapted to the Mediterranean diet.

Diet quality: Diet Quality Index-International (DQI-I): Young people's diet: southern Spain

The traditional diet in southern Spain corresponds to the typical Mediterranean dietary pattern (MDP)[1,2]. The MDP is characterized by: a high intake of vegetables, legumes, fruits and nuts, cereals (largely unrefined in the past); a high intake of olive oil but a low intake of saturated lipids; a moderately high intake of fish (depending on the proximity to the sea); a low-to-moderate intake of dairy products (mostly cheese or yoghurt); a low intake of meat and poultry; and a regular but moderate intake of wine, generally during meals[3–7]. The MDP has been associated with better health and a longer life[3–5,8–11] and has been promoted as a model for healthy eating[5,8,9,12,13]. However, there is wide epidemiological evidence of a rapid change in dietary patterns in Mediterranean countries, with a higher consumption of animal products and SFA to the detriment of vegetable foodstuffs[4,14–16]. This trend can be attributed to substantial socio-economic changes throughout Europe over the past 40 years. Departure from the MDP might be accompanied by loss of its protective effects on health, leading to a rise in diet-related diseases such as CVD and cancer[7,11,17,18].

A nutritional study in the Balearic Islands[19–22] examined secular changes in dietary patterns in relation to the traditional Mediterranean diet and evaluated compliance of the current diet with nutritional recommendations. In comparison with the prevalent dietary pattern at the beginning of the twentieth century, there was a higher fat and saturated fat content and a lower consumption of fruit and vegetables, reflecting loss of the MDP in the Balearic Islands[19]. By 2004, the mean percentage of adherence to the MDP in this population was 43·14 %, which was similar in all socio-demographic and lifestyle groups but with some differences in relation to age, sex and physical status. Thus, young people and the sedentary showed a lower adherence to the MDP[20]. Similar results were reported by other studies of dietary changes in Mediterranean countries and among their younger inhabitants[4,14–16,23,24]. The finding that MDP was independent of socio-economic level was also reported in a study of Spanish adults[2].

The objectives of the present study were to assess the diet quality of young people in Granada Province (southern Spain) by means of the Diet Quality Index-International (DQI-I)[25,26] and to relate socio-economic factors, habits and body composition to the index scores obtained. Diet quality indexes measure the overall diet quality based on food group consumption, intake of nutrients related to chronic disease and variety of the diet[27–32].

Subjects and methods

This population-based cross-sectional nutritional survey included 288 young individuals aged from 6 to 18 years old from Granada province (southern Spain). They were recruited between 2002 and 2005 from among young federated

Abbreviations: DQI-I, Diet Quality Index-International; MDP, Mediterranean dietary pattern.

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practising skiers at the High-Performance Centre, CAR-Sierra Nevada (*n* 88) or from among students at schools in the city of Granada (*n* 200). Age of 6–18 years was an inclusion criterion. Informed written consent was obtained from parents or tutors of under 18-year-olds and from 18-year-old participants, and the study was approved by the Ethics Committee of the University of Granada.

Questionnaires

Participants were administered with three questionnaires: questionnaire on socio-economic status, education level, lifestyle factors and health status; 24 h diet recall; and a validated quantitative FFQ[33–35]. The FFQ included ninety-seven food items classified by food group (i.e. nine dairy, seven cereals, three eggs, one pulse, twelve meat, five fish, five fats/oils, ten vegetables, twelve fruit, twelve desserts, three sweets/snacks, ten drinks/infusions, three nuts, five various). Data were gathered on the consumption or not of the item, the number of times it was consumed per week, and the amount consumed each time (in household measures). The 24 h recall studies were performed between February and May. FFQ were administered at the CAR or school or in the young person's home by a trained dietitian between Tuesday and Friday. The Novartis-Dietsource version 1.2 program was used to convert foods into nutrients[36].

Construction of modified Diet Quality Index-International

The DQI-I was modified to assess the Andalusia diet, following the Tur *et al.*[26] modification of the method developed by Kim *et al.*[25]. Notably, whereas Kim *et al.*[25] established a fat intake that was ≤20 % of total energy, Tur *et al.*[26] proposed a higher level (≤30 %) for the consumption of fats in the Mediterranean region. The present version of the index also included use of Spanish recommended daily intakes[37] and a change in the criterion for classifying 'empty-calorie foods'. The DQI-I focuses on four aspects of a high-quality diet (variety, adequacy, moderation and overall balance). Specific diet components are assessed under each category. These categories help users to identify aspects of their diet that may need improvement. The score for each category is the sum of the scores for each component in that category. The total DQI-I score (range 0–100 points) is the sum of the scores for the four categories (see Table 1).

Variety. Variety was evaluated both as overall variety and as variety of protein sources. The maximum overall variety score was achieved by intake of at least one serving per day from each of the five food groups (meat/poultry/fish/egg, dairy/beans, grains, fruit, and vegetables). The score for the variety of protein sources (meat, poultry, fish, dairy, beans and eggs) was based on intakes of more than half the serving size per day, using data gathered by the FFQ. Portions were based on portion-weight tables for each food group and household measures[38]. The scoring system is described in Table 2.

Adequacy. This category evaluates the adequacy of intake of those dietary elements that are required to protect against under-nutrition and deficiency disorders. The adequacy of fruit, vegetables, grain and fibre intake is dependent on the energy intake. Thus, for energy intakes of 7118 kJ (1700 kcal), 9211 kJ (2200 kcal) or 11 304 kJ (2700 kcal), the maximum score is assigned to a diet containing two, three or four portions of fruit and three, four or five portions of vegetables, respectively. Likewise, the highest score for grain and fibre categories was assigned to daily intakes of ≥6, ≥9 and ≥11 portions of grain and ≥20, ≥25 and ≥30 g fibre for the three energy intake levels, respectively. Protein intake was considered adequate when the proportion of total energy from protein was >10 %. Intakes defining the highest score for adequacy of iron, calcium and vitamin C were derived from the recommended daily intakes for Spanish people[37], which vary according to age and gender.

Moderation. This category evaluates the intake of food and nutrients related to chronic diseases, which may need restriction. To emphasize the importance of moderation in fat intake, total fat intake in the DQI-I is evaluated using more stringent cut-off values than those found in other dietary indexes. In our modification of the DQI-I, a score of 6 points was assigned when total fat was ≤30 % of total energy/d, 3 points when 30–35 % of total energy/d and 0 points when >35 % of total energy/d[26] (Table 2). The intake of saturated fats was also evaluated as the percentage of energy from saturated fat. Intake levels of cholesterol and sodium were also recorded (Table 2). The 'empty-calorie food' component assesses how much a person's energy supply is dependent on low-nutrient density foods, which provide energy alone and supply scant nutrients. The DQI-I states that table sugar, alcohol, oil and similar are empty calorie foods (if the sum of nutrient densities considered across nutrients in a food is <1, the food is considered an empty-calorie food). However, some of the foods classified as empty-calorie by Kim *et al.*[25] have nutritional value in the MDP and corresponding modifications were therefore made to the DQI-I. Thus, the following were only categorized in the MPD food pyramid as empty-calorie foods if their use was only 'occasional and moderate'[38]: cold meats, pâté, butter, vegetable margarine, bacon, sugar, industrial pastries, sweets,

Table 1. Diet Quality Index-International (DQI-I) scores and components

Component	Score ranges (points)	Mean	SD
DQI-I, total	0–100	56·31	9·48
Variety	0–20	18·18	2·86
Overall food group variety	0–15	13·72	2·36
Within-group variety for protein sources	0–5	4·46	0·95
Adequacy	0–40	26·36	4·40
Vegetable group	0–5	3·76	1·49
Fruit group	0–5	3·52	1·64
Grain group	0–5	2·09	1·17
Fibre	0–5	1·91	1·03
Protein	0–5	4·87	0·48
Iron	0–5	3·36	1·29
Calcium	0–5	3·15	1·38
Vitamin C	0–5	3·62	1·62
Moderation	0–30	10·07	6·12
Total fat	0–6	0·83	1·82
Saturated fat	0–6	0·71	1·54
Cholesterol	0–6	3·38	2·77
Sodium	0–6	4·43	2·15
'Empty calorie foods'	0–6	0·82	1·66
Overall balance	0–10	1·53	2·03
Macronutrient ratio	0–6	0·44	1·31
Fatty acid ratio	0–4	1·08	1·58

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Table 2. Components of the Diet Quality Index (DQI-I) and percentage of sample in component subcategories

Component	Full score	Scoring criteria		%
		Point	Criteria	
Variety	0–20			
Overall food group variety	0–15	15	≥1 serving from each food group/d	70·7
		12	Any 1 food group missing/d	16·6
		9	Any 2 food groups missing/d	8·6
		6	Any 3 food groups missing/d	3·8
		3	≥4 food groups missing/d	0·4
		0	None from any food group	0·0
Within-group variety from protein source	0–5	5	≥3 different sources/d	72·2
		3	2 different sources/d	26·3
		1	From 1 source/d	1·5
		0	None	0·0
Adequacy	0–40			
Vegetable group*	0–5	5	>100 % recommendations	55·3
		3	50–100 % recommendations	27·3
		1	<50 % recommendations	17·4
		0	0 % recommendations	0·0
Fruit group*	0–5	5	>100 % recommendations	48·8
		3	50–100 % recommendations	27·8
		1	<50 % recommendations	22·2
		0	0 % recommendations	1·2
Grain group*	0–5	5	>100 % recommendations	3·9
		3	50–100 % recommendations	40·5
		1	<50 % recommendations	55·0
		0	0 % recommendations	0·6
Fibre*	0–5	5	>100 % recommendations	1·1
		3	50–100 % recommendations	44·7
		1	<50 % recommendations	53·8
		0	0 % recommendations	0·4
Protein	0–5	5	>100 % recommendations	95·4
		3	50–100 % recommendations	4·6
		1	<50 % recommendations	0·0
		0	0 % recommendations	0·0
Iron†	0–5	5	>100 % recommendations	30·4
		3	50–100 % recommendations	55·6
		1	<50 % recommendations	14·0
		0	0 % recommendations	0·0
Calcium†	0–5	5	>100 % recommendations	25·3
		3	50–100 % recommendations	53·1
		1	<50 % recommendations	21·5
		0	0 % recommendations	0·0
Vitamin C†	0–5	5	>100 % recommendations	50·1
		3	50–100 % recommendations	26·1
		1	<50 % recommendations	23·6
		0	0 % recommendations	0·1
Moderation	0–30			
Total fat	0–6	6	≤30 % of total energy/d	5·0
		3	>30–35 % of total energy/d	9·7
		0	>35 % of total energy/d	85·2
Saturated fat	0–6	6	≤7 % of total energy/d	4·1
		3	>7–10 % of total energy/d	16·5
		0	>10 % of total energy/d	79·4
Cholesterol	0–6	6	≤300 mg/d	48·8
		3	>300–400 mg/d	15·7
		0	>400 mg/d	35·5
Sodium	0–6	6	≤2400 mg/d	59·6
		3	>2400–3400 mg/d	25·2
		0	>3400 mg/d	15·2
'Empty calorie food'	0–6	6	<5 times/week	4·7
		3	>5–10 times/week	18·2
		0	>10 times/week	77·1
Overall balance	0–10			
Macronutrient ratio (carbohydrate:protein:fat)	0–6	6	55–65:10–15:15–30	2·6
		4	65–68:9–16:13–32	3·1
		2	50–70:8–17:12–35	5·5
		0	Otherwise	88·8
Fatty acid ratio (PUFA + MUFA/SFA)	0–4	4	>2	20·1
		2	1·7–2	22·3
		0	<1·7	57·6

* Based on 7118 kJ (1700 kcal)/9211kJ (2200 kcal)/11 304 kJ (2700 kcal).
† Based on the recommended daily intakes for Spanish people[37].

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chewing gum, snacks, soda pop and alcoholic drinks. The scoring of empty-calorie foods was also modified, assigning a score of 6 for consumption <5 times per week, 3 points for 5–10 times per week, and 0 points for consumption >10 times per week (Table 2).

Overall balance. This category examines the overall balance of diet in terms of proportions of energy sources and fatty acid composition. Detailed cut-off values and corresponding scores as proposed by Tur *et al.*[26] are described in Table 2.

Socio-demographic variables

Qualitative variables. Sex (male/female) and physical activity (active/sedentary) were considered as dichotomous variables. Physical activity was assessed from the following dichotomous variable in the questionnaire[35]: 'Practice sports about 2 days per week (yes/no)'. The following qualitative socio-demographic variables were also studied: who they live with (domestic situation), educational level of parents, work schedule of parents, who cooks, where they normally eat, time devoted to breakfast, lunch and evening meal, and the importance they assign to breakfast.

Quantitative variables. Age was categorized according to the Schofield classification for estimation of the BMR[39]. BMI was calculated from weight and height measurements, and obesity grade was based on the classification of Cole and co-workers[40,41] and Kuczmarski *et al.*[42,43]. The results were tested by using the Harris–Bennedict formula to calculate %fat values, finding a correlation between BMI and %fat of R 0·735 ($P<0·0001$)[35]. Cut-off points for normal BMI values in study populations were based on the mean ± 2 SD (Z value). The significance level was 95 %. Subjects were classified as underweight (4 %), normal weight (73·3 %) or overweight (22·7 %).

Statistical analysis

Analyses were performed with SPSS version 12.0 (SPSS Inc., Chicago, IL, USA). Scores of the modified DQI-I and its four main categories were expressed as the mean and standard deviation score obtained for each component of the DQI-I, and the percentage of the population for each component subcategory was calculated. Student's t test, one-way ANOVA, and univariate and multivariate linear regression analyses were used to study the association between modified DQI-I scores and values of socio-economic, habit and body composition variables (significance of $P\leq 0·05$).

Results

The study sample comprised 288 young people, 44·1 % females and 55·9 % males. The sex distribution of the sample did not significantly differ from the current sex distribution in the population of southern Spain[44]. The mean age was 12·88 (SD 2·78) years (range 6–18 years).

The mean total modified DQI-I score was approximately 57 % of the possible score (100 %). The highest score was for adequacy, followed by variety and moderation. The lowest score was for overall balance (Table 1). Regarding the adequacy, a large proportion of the population reported an intake of proteins, vitamin C, calcium, fruit, iron and vegetables that were 50 % higher than recommendations (Table 2). However, most of the young people consumed less than 50 % of the recommended intake of fibre and failed to meet recommended intakes of grain groups. Regarding the variety, 70·7 % daily consumed at least one serving from each food group or missed only one food group, and 72·2 % daily consumed three or more different sources of protein (Table 2). In the moderation category, only 5·0 and 4·1 % of the sample were within the limits set for fat and saturated fat, respectively. Cholesterol intake was ≤ 300 mg/d in 48·8 % of the population and >400 mg/d in 35·5 %. Around 60 % met the goal for sodium intake. Only 4·7 % of the population consumed empty-calorie foods less than five times a week. A very poor balance was found for energy-yielding nutrients and fatty acids.

Comparative analyses (Student's t test and ANOVA) of socio-economic, habit and body composition, with the modified DQI score as dependent variable, showed a significant relationship between score and: age ($P=0·009$), with younger children obtaining a better mean DQI score; physical activity ($P=0·036$), with better mean score for active than sedentary individuals; domestic situation ($P=0·025$), with best score for those living with parents and siblings; education level of mothers ($P=0·029$), with best scores for children of women with a university education; lunch location ($P=0·041$), with significantly better scores for those eating at school versus other places; and breakfast ($P=0·025$) and lunch ($P=0·049$) duration, with better scores for those dedicating more time to these meals (Table 3). In a subsequent univariate linear regression analysis of socio-demographic variables, age ($P=0·007$), physical activity ($P=0·036$) and breakfast duration ($P=0·003$) continued to show a significant relationship with DQI score. A multivariate analysis of these three variables was then performed, in pairs and in combination, in order to test for confounding factors. The duration of breakfast was again significantly associated with the DQI score ($P=0·029$), whereas the association with physical activity was close to significance ($P=0·065$) and there was no significant relationship with age ($P=0·084$).

Discussion

A modified DQI-I was used to evaluate the diet quality of a representative sample of young people in southern Spain.

The mean score of the study population was 56·31 % of the full score, lower than mean DQI-I scores reported in the USA and China and higher than mean scores observed in the Balearic Islands[26]. According to the criteria of Kim *et al.*[25], scores below 60 % indicate a poor-quality diet, but it is arguable whether DQI-I criteria for high-quality diets are wholly applicable to Mediterranean-type diets.

The highest scores in the present group were for adequacy and variety, as also found in the Balearic population[22]. However, the DQI-I assumes that a diet including various protein sources is also a feature of a good varied diet, which may be questionable in cultures where animal foods are routinely consumed. Moreover, southern Spain is undergoing a change in dietary patterns and therefore in traditional protein sources, which may increase the score for their diet in this aspect of variety. Therefore, it may be more appropriate in this setting to select another food group for this measure of variability, such as vegetables, fruit or grain.

Table 3. Association between Diet Quality Index (DQI-I) and socio-demographic variables

		DQI		*t* test/ANOVA*		Univariate linear regression†		
		Mean	SD	*F*	*P*	β	(SEM β)	*P*
Sex	Male	56·1	9·0	−0·354	0·724	0·443	1·25	0·724
	Female	56·5	10·0					
Age	6–9 years	60·8	9·0	4·756	0·009	−4·090	1·50	0·007
	10–17 years	55·5	9·4					
	18 years	56·1	8·0					
BMI (kg/m^2)	<17·63	55·2	8·7	0·503	0·681	0·043	0·56	0·939
	17·63–19·90	57·3	9·8					
	19·90–22·67	56·3	8·9					
	>22·67	55·7	9·9					
Physical activity level	Active	57·1	9·6	2·104	0·036	−2·883	1·37	0·036
	Sedentary	54·2	8·6					
Obesity level	Underweight	56·5	7·9	0·310	0·733	0·854	1·33	0·524
	Normal weight	55·9	9·3					
	Overweight	57·1	9·3					
Living at home with	Parents and siblings	56·3	9·2	2·458	0·025	−0·046	0·39	0·907
	Father and mother	55·7	9·1					
	Mother	57·8	12·7					
	Mother and siblings	53·3	6·8					
	Father	78·0	6·2					
	Father and siblings	67·7	8·6					
	Other	52·6	10·4					
Education level of father	Low	56·5	11·4	0·735	0·480	0·580	0·87	0·506
	Medium	55·6	8·5					
	High	57·3	9·2					
Educational level of mother	Low	56·9	11·1	3·612	0·029	1·111	0·86	0·199
	Medium	54·5	8·5					
	High	58·2	9·3					
Location of lunch	Home	55·9	9·4	3·252	0·041	1·120	1·35	0·408
	School	59·3	9·6					
	Other	50·2	2·7					
Time spent on breakfast	<10 min	55·4	9·2	3·162	0·025	3·062	1·03	0·003
	10–20 min	58·1	10·0					
	>20 min	60·4	4·9					
Time spent on lunch	<15 min	53·4	9·8	2·419	0·049	1·161	1·03	0·263
	15–30 min	55·7	9·6					
	30–60 min	57·2	8·8					
	>60 min	69·0	9·4					
Time spent on dinner	<15 min	54·4	8·8	1·692	0·169	0·000	1·05	1·000
	15–30 min	56·6	9·8					
	>30 min	55·7	8·7					
Activity during lunch?	No distractions	57·9	9·3	0·719	0·488	−0·104	0·92	0·910
	Distractions	55·3	10·6					
	Talking	56·5	8·9					
Breakfast considered important	Yes	59·8	12·6	1·845	0·160	−4·697	2·51	0·063
	No	56·1	9·2					
	Don't know	50·1	9·0					

* Comparison of mean DQI scores among groups by ANOVA for polychotomous and Student's *t* test for dichotomous variables.
† Univariate linear regression analysis considering effect of single socio-demographic (independent) variable on DQI score (dependent variable).

Adequacy reflects compliance with prevailing recommendations to ensure a healthy diet. The diet of the present population was assigned a high score in this category for intake of protein, iron and calcium but a low score for intake of fruit, vegetables, grain and fibre.

According to scores obtained with this DQI-I, the Spanish diet lacks moderation and is highly unbalanced. Very poor scores were obtained for moderation in total fat and saturated fat consumption. The DQI-I sets strict standards, especially for fat intake, in line with US recommendations. However, although total fat intake in Mediterranean countries is similar to that in Northern Europe and North America, at around 38–40 %[19–22], the incidence of CVD and diet-related cancer is lower[29,45]. Importantly, olive oil is a central element of Mediterranean-type diets and makes a key contribution to its healthy properties. Moreover, studies in the Mediterranean area have demonstrated that the intake of vegetables is augmented by the consumption of olive oil[46,47]. Nevertheless, the large amounts of olive oil traditionally consumed by Mediterranean populations worsen their diet index score because it is considered an immoderate intake of fat. It appears reasonable to suggest that dietary evaluations and guidelines should take account of the quality rather than the quantity of fat, aimed at reducing intake of saturated fat but not of olive oil[8,9]. The DQI-I establishes moderate fat consumption as <30 % of total energy, lower than the percentage found in the Spanish diet. In fact, only 5 % of the young Spanish population in the present study had a fat intake below 30 % of

energy intake, even lower than the 14·5 % of the population in the Balearic Islands (14·5 %).

The original DQI-I categorizes olive oil and wine as empty-calorie foods with low nutrient density, but this is not appropriate to the Mediterranean diet. Olive oil contains a high proportion of MUFA, vitamin E and numerous antioxidant phenolic compounds[48–50]. Besides alcohol, wine also supplies antioxidant phenolic compounds[51–54]. Therefore, in the present adaptation of the DQI-I, these items of high energetic value were only classified as empty-calorie foods when their use was only occasional and moderate, as recommended in the food pyramid for the Spanish population[38]. Further research is warranted to establish the most appropriate criteria for moderation in the diet of Mediterranean populations.

The diet of the study population also obtained a very low score for its overall balance, i.e. the proportionality in energy sources and fatty acid composition. However, the macronutrient ratios used to evaluate energy sources require that the percentage of energy from fat be $\leq 30\,\%$ and, as explained earlier, very few individuals met this goal. In the present sample, the mean ratio of PUFA and MUFA to SFA was 1·08, similar to findings in the other Mediterranean population in the Balearic Islands[26]. The higher consumption of olive oil, the usual source of unsaturated fat in the Mediterranean setting, leads to a much higher intake of MUFA than PUFA. In fact, current Spanish Nutritional Objectives recommend 20 % of total energy from MUFA and 5 % from PUFA[8,9]. Further research is required to establish whether our adaptation of the DQI-I provides an accurate evaluation of the diet of young people in southern Spain or whether further adjustments are required.

The use of a single diet quality score for international comparisons is problematic. For dietary recommendations to be relevant and suitable for a given population, they should take account of prevailing food patterns in that population[8,9,14,15,26,29,55,56].

The present results suggest that age, physical activity, domestic situation, mother's educational level, the place where lunch is usually eaten, and the time taken to eat breakfast and lunch may be factors with an influence on the optimal diet[57]. In the multivariate analysis, physical activity level and breakfast duration emerged as independent factors. Sedentary young people not only consumed less energy but had a worse diet compared with active youngsters, and this combination clearly increases the risk of obesity and related diseases[58]. Interestingly, older children dedicated less time to breakfast, suggesting that age may be a confounding factor and that it is the time devoted to taking breakfast that has a positive effect on diet quality[14,15,57]. Children should be taught the value of breakfast at an early age in order to improve their diet in later years.

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