International Journal of Obesity (2008) 32, S35–S41
 0307-0565/08 $32.00
www.nature.com/ijo

ORIGINAL ARTICLE

Food and nutrient intake, nutritional knowledge and diet-related attitudes in European adolescents

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Background and objective: To provide an overview of methods used to assess food and nutrient intake, nutritional knowledge and diet-related attitudes in the Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-Sectional Study (HELENA-CSS), with selected results from the feasibility study.
Material and Methods: To assess food intake in 13- to 16-year-old adolescents, a previously developed computer-assisted and self-administered 24-h recall was adapted for international use. Food consumption data were linked to national food composition databases to calculate energy and nutrient intakes. To assess nutritional knowledge in pupils not having any special (trained) education concerning 'nutrition', a 23-item validated multiple choice questionnaire was adapted. To assess eating attitudes, behaviour and/or putative problems with body weight in adolescents, a validated inventory covering 60 questions or statements was adapted for the study. In a feasibility study, instruments, data collection and processing were tested in one school class in each of the 10 participating European cities.
Results and Conclusions: The feasibility study provided plausible results, quite consistent between countries. Against this background and for the first time, standardized and uniform methodology was made available for the main study to assess and characterize dietary intake, nutritional knowledge and eating attitudes.
International Journal of Obesity (2008) **32,** S35–S41; doi:10.1038/ijo.2008.181

Keywords: diet; nutritional knowledge; eating attitudes; adolescents

Background and objectives

It is obvious from the literature that there is a need for harmonization and standardization of diet and nutrition methods for nutrition surveys in Europe to overcome the present uncertainties over the true nutritional quality of the diets of European children and adolescents.[1] Therefore, one of the particular objectives of the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) Study was to develop, validate and establish an innovative, standardized instrument and procedures for the assessment of dietary habits of adolescents across Europe to allow a comprehensive characterization of nutrient intakes, food consumption and meal patterns, as well as nutritional knowledge and eating behaviour and attitudes.[2] Before the start of the final data collection, a pilot study was conducted and organized on a small scale in each country to check the feasibility in respect of procedures, methods and data processing.[3]

Here, we report on selected assessments regarding the background and justification of methods used in the HELENA Study including:

- food intake assessment;
- nutrient intake assessment;
- assessment of eating behaviour and weight problems and
- assessment of nutritional knowledge.

In addition, we present selected results from the feasibility study that was conducted between February and May 2006.

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[11]See Appendix at the end of the supplement on page S82.

Food consumption

The EU project 'European Food Consumption Survey Method' considered the 24-h recall method as the best method to get population mean intakes and distributions for participants aged 10 years and above in different European countries. Furthermore, it was suggested that usual intake should be estimated by statistical modelling techniques using two non-consecutive 24-h recalls.[4]

Following these recommendations and regarding the challenges to measure food consumption in adolescents, a computer-assisted self-administered tool, attractive for adolescents, was adapted for dietary assessment in the HELENA Study.[5]

Energy and nutrient intake

To calculate energy and nutrient intakes, food intake information has to be linked to food composition databases (FCDBs). At present, most of the European countries do have more or less extended FCDBs, and sometimes, several different databases can be found in one country (for example, in Germany: BLS,[6] Souci/Fachmann/Kraut[7] and LEBTAB[8]). Many of these databases developed from classical nutrient tables in printed form to electronically stored and managed data sets. For international epidemiological studies on nutrition and disease, harmonized FCDBs, as well as standardized calculation procedures, are required to assess nutrient intake across countries.[9,10] To achieve this, different approaches have been taken in recent years in Europe. The International Agency for Research on Cancer, together with compilers of national FCDBs, researchers in international studies (EURope ALIMentation, EURALIM; Survey Europe on Nutrition in the Elderly: a Concerted Action, SENECA) and industry, has developed a standardized nutrient database for the 10 countries involved in the European Prospective Investigation into Cancer and Nutrition (EPIC) Study. This European nutrient database will contain values for approximately 100 nutrients for 1000 foods per country, mainly derived from EPIC consumption data in adults.[11] A most recent approach starting in 2005 is the European food information resource network project (EuroFIR)[12] a partnership between 46 universities, research institutes and small to medium-sized enterprises from 25 European countries. EuroFIR will provide the first comprehensive pan-European food information resource, using state-of-the-art database linking, to allow effective management, updating, extending and comparability.[13] For the HELENA Study, it was decided to use official national FCDBs from the participating countries in cooperation with EuroFIR.

Dietary quality

Dietary quality is a sum of several dietary parameters reflecting health-related dietary properties. Two general options are available to assess dietary quality: (a) based on amounts and frequencies of food consumed (for example, dietary diversity score (DDS), five-a-day) or (b) based on nutrient intake compared with references (for example, mean adequacy ratio, MAR). Food intake is especially of interest to characterize the quality of diet under preventive aspects.[14] Food patterns are influenced by cultural and socioeconomic backgrounds and may differ even between neighbouring countries. Therefore, one of the aims of dietary evaluation in HELENA is the description of food patterns across European countries. To reduce the broad range of information from dietary surveys, different types of scores have been developed.[15] Food-based scores were used to analyse and summarize the consumption of food items in terms of food groups, some considering the amount eaten as well. To test the feasibility of food-based scores for use in the HELENA Study, the DDS was used to evaluate data from the pilot study. This score is not only easy to calculate and efficient[16] but was also successfully used to predict biomarkers of dietary intake, obesity, cardiovascular disease and diabetes,[17,18] as well as being a promising measurement tool.[19]

Nutritional knowledge

The aim of nutrition education is to communicate sufficient knowledge of a 'healthy diet', although it has been shown that sufficient knowledge does not need to be associated with sensible dietary behaviour.[20–23] The best possibility of measuring abilities and knowledge is the use of multiple choice tests when all items show the same number of alternatives and only one of the answers to choose from is correct.[24] To allow cross-cultural comparisons in nutritional knowledge and to link the data to food habits, a validated multiple choice questionnaire designed for children and adolescents was considered the best option to assess nutritional knowledge within the HELENA Study.[25]

Diet-related attitudes

Eating attitudes, behaviour and/or (putative) problems with body weight influence food, nutrient and energy intake and are major public issues because of their physical and psychological consequences. Most questionnaires examining nutritional and weight-dependent attitudes and behaviours in children and adolescents, such as the Three Factor Eating Questionnaire and the Dutch Eating Behaviour Questionnaire, rely on the language ability of adults. For children, an inventory of eating behaviour and weight problems was introduced, which can be applied to young adolescents. The validated so-called eating attitudes and weight problems inventory (EWI) designed for adolescents examines the extent to which the measured nutritional and weight-dependent attitudes and habits of the respondents show gender- and age-dependent differences as well as the way in which they are related to body weight and social class.[26] This inventory was used within HELENA to allow cross-cultural comparisons in dietary attitudes and behaviour and to link the data to food habits.

Methods

Assessing food consumption

The instrument Young Adolescents' Nutrition Assessment on Computer, adapted for the HELENA Study, is a single 24-h recall assessment tool based on six meal occasions referring to the day before the interview.[5] The food item database (basic version) of the pilot study included approximately 800 food items, hierarchically organized in 25 food groups, that can be selected by the respondent for each meal. Each country developed its own EXCEL database file adapted to the respective local language and food culture (that is, special dishes, food items, beverages, food amounts and picture links). The programme saves the participants' recorded data (for example, identification number of participant, ticked food items and amounts and a country-specific food code). Later, the country-specific food codes are used to assign food composition data (recipes, ingredients and nutrients) from the respective national FCDB to calculate energy and nutrient intake. A typical recall takes approximately 30 min for the first run and 20 min for the second run.

Assessing energy and nutrient intake

At the start of the HELENA Study, a questionnaire was circulated that asked for general descriptors of the national FCDBs planned to be used within HELENA, a list of the nutrients covered and the nutrient contents of a few common food items to check differences between the FCDBs.

To link FCDBs and food consumption data, specific software programs were used. Owing to the different properties of the national FCDBs and local experience, every participating centre was responsible for the proper management of the necessary calculations.

Assessing the dietary quality

To evaluate food patterns, the DDS was used.[16,27] To calculate the score, a recalled consumption of at least one item from each of five food groups (dairy, meat, grain, fruit and vegetables) contributed 1 point to a maximum possible DDs score of 5 points.

Energy and fat were selected for this report to characterize nutrient intake and to evaluate the data from the pilot study for cross-country comparisons.

Assessing nutritional knowledge

Structure and length of the validated nutritional knowledge test (NKT) was designed for pupils not having any special (trained) education concerning 'nutrition'.[25] The final version covered a total of 23 multiple choice questions assigned to seven categories, for example, nutrients and nutrient content, energy content and physiology, vitamins and minerals, food science, sweeteners and oral health, special terms and dietary habits. The test can be completed within 15 min.

Each multiple choice question offers three possible answers (only one is correct) and the 'don't know' category. At first, pupils are asked to tick the right answer based on their knowledge ('A-score'). If they tick the 'don't know' category, they can guess the right answer in a second run ('B-score' = 'A-score' + right answers from second run). If the second time reflects pure guessing—because of missing partial knowledge—the marked answers would be evenly distributed on the three answering alternatives. However, in evaluations of the NKT, analyses of the guess showed higher percentages of right answers than expected by randomness alone. For the analysis of the knowledge level of adolescents, therefore, both scores are of diagnostic relevance.[25]

During the compilation of the questions, the phrasings of the wrong answer alternatives were chosen to distract the pupils to make their guesswork more difficult, for example, for the question 'which row lists three terms for calorie-free sweeteners?', 'sulphate—dextrin—sodium' is given as the wrong answer. The test also contains questions with common misconceptions in the wrong answer alternatives, for example, food fibre 'strains the circulatory system' or 'makes people fat'. Finally, questions in the categories show an increasing degree of difficulty. Some easy questions were added to keep the motivation high while conducting the test.

Assessing diet-related attitudes

The EWI[26] covers 60 questions or statements assigned to 10 subscales (between three and eight questions per subscale), for example, strength and motivation to eat, importance and impact of eating, eating as a means of coping with emotional stress, problems concerning eating and weight, dietary restraint, attitude towards healthy nutrition, attitude towards the obese, parental pressure to eat, fear of gaining weight and figure dissatisfaction. This inventory can be completed within 15 min.

Each question or statement has the same answer categories: does not apply at all (1), seldom applies (2), occasionally applies (3), and always applies (4)—scores in brackets. The subscale 'figure dissatisfaction' consists of four statements, for example, 'I am content with my figure', 'I think my hips are too wide.' The subscale score of a participant is generated by summing up the item scores, now being defined within the integral codomain of 0 to fourfold of the item number (score A). As the number of questions varies between subscales, one needs a relative scale score. To calculate this (score B), score A is divided by the number of questions of a scale and then multiplied by 10; thus establishing a codomain ranging from 0 to 40.

Items directly referring to bulimic behaviour, such as binge eating and (self-imposed) vomiting, were not included.

However, EWI results with certain (extremely high) scale scores point to a suspicion of an existing eating disorder. That would be the case with adolescents being underweight and showing extreme dissatisfaction with their body figure and weight.

Statistical analysis

All statistical analyses were performed using SAS (Release 8.02). On the basis of the data from the feasibility study, descriptive statistics were computed where necessary. Analysis of variance (Proc GLM) was used to detect gender and centre differences, and regression analyses were used to investigate the effect of body mass index (BMI) and age on outcome variables. The statistical significance was set at $P<0.05$.

Results

A total of 170 pupils (eight centres with 4–18 participants per centre by gender) completed 24-h recalls, 192 pupils (between 5 and 18 participants per centre by gender) completed the NKT questionnaire and 187 pupils (between 5 and 18 participants per centre by gender) completed the EWI questionnaire (Table 1) in the feasibility study.

FCDB

The results from the short questionnaire showed that national FCBDs to be used for HELENA cover a wide range of different food items (between 700 and 10 000) and nutrients (between 26 and 133) (Table 2). The list of available nutrients in all centres includes protein, carbohydrates, fat, alcohol and six minerals, eight vitamins, fibre and cholesterol (Table 3).

Energy and nutrient intake

Mean energy intake per day ranged from 1532 to 2868 kcal day^{-1} in boys and from 1450 to 2818 kcal day^{-1} in girls. After adjusting for age, energy intake per day ranged from 2478 to 2797 kcal day^{-1} in boys and from 1653 to 2820 kcal day^{-1} in girls (data not shown). In girls, energy intake differed significantly between centres. In boys, energy intake was age dependent. Overall, there was a tendency to report a lower energy intake with increasing BMI in both boys and girls.

Mean fat intake (in percentage of energy intake) ranged from 28 to 38% and differed significantly between centres. Age, BMI and gender had no significant effect on fat intake. There was a tendency for lower fat intake with increasing BMI in both sexes.

Dietary quality

Between 50 and 80% of the maximum 5 points of the DDS were reached in the different centres on average. Mean DDS scores were significantly different between centres with a tendency to higher values in the southern European centres. Age and gender had no significant effect on the DDS. There

Table 1 HELENA participating countries (cities) and number of participants per assessment tool in the HELENA feasibility study

Town	*Country*	*EWI*[a]	*NKT*[b]	*Recall*[c]	*Centre*
Athens	Greece	11	11	10[d]	GRA
Dortmund	Germany	25	25	25[d]	GE
Ghent	Belgium	11	11	11[d]	BE
Heraklion	Greece	19	27	0	GRC
Lille	France	18	17	18[d]	FR
Pecs	Hungary	20	20	20	HU
Rome	Italy	20	20	21[d]	IT
Stockholm	Sweden	17	16	19[d]	SW
Vienna	Austria	30	29	30[d]	AU
Zaragoza	Spain	16	16	16[d]	ES
Total		187	192	170	

Abbreviations: AU, Austria; BE, Belgium; ES, Spain; FR, France; GE, Germany; GRA, Greece (Athens); GRC, Greece (Heraklion); HU, Hungary; HELENA, Healthy Lifestyle in Europe by Nutrition in Adolescence; IT, Italy; SW, Sweden. [a]EWI, eating behaviour and weight problems inventory. [b]NKT, nutritional knowledge test. [c]Self-administered 24-h recall. [d]Nutrient intake data available.

Table 2 Details of the FCDBs in the HELENA Study (status of October 2005)

Country	*Institute*	*FCDB name*	*Food code*[a]	*English translation*	*Food classiffication system*	*No. of items*	*No. of nutrients*	*Analytical information*	*Last update*
AU and GE	MUW and FKE	BLS II.3.1	A	Yes	Langual[b]	10.200	133	No	2005
BE 1	BE-TUG	NEVO 2001	N	No	—	1.600	29	Yes	2005
BE 2	BE-TUG	NUBEL 2004	N	No	—	1.000	26	No	2004
ES	UNIZAR	CESNID	N	Yes	—	700	35	No	2003
FR	UL2	CIQUAL	A	Yes	Langual	3120	26	No	1995
GRA	HUA	Nutritionist V	A	No	Food groups	700	—	No	2005
GRC	UOC	Netwisp	N	No	—	5500	109	Some	2000
HU	PTE	NutriComp	N	No	Food groups	1000	29	Yes	2005
IT	INRAN	Foodtab	A	No	—	1300	36	Some	2005
SW	KI	Livsmedels-databasen	A	Yes	Langual	1970	52	Yes	2004

Abbreviations: AU, Austria; BE, Belgium; ES, Spain; FCDBs, food composition databases; FR, France; GE, Germany; GRA, Greece (Athens); GRC, Greece (Heraklion); HU, Hungary; HELENA, Healthy Lifestyle in Europe by Nutrition in Adolescence; IT, Italy; SW, Sweden. [a]Food code: A, alphanumeric; N, numeric. [b]In process.

Table 3 Available nutrients in the FCDBs in the HELENA Study centres

Nutrient	*AU*	*BE*	*ES*	*FR*	*GE*	*GRA*	*GRC*	*HU*	*IT*	*SW*
Water (g)	●[a]	●	●	●	●	●	●	●	●	●
Protein (g)	●	●	●	●	●	●	●	●	●	●
Fat (g)	●	●	●	●	●	●	●	●	●	●
Carbohydrates (g)	●	●	●	●	●	●	●	●	●	●
Alcohol (g)	●	●	●	●	●	●	●	●	●	●
Fibre (g)	●	●	●	●	●	●	●	●	●	●
Sodium (mg)	●	●	●	●	●	●	●	●	●	●
Calcium (mg)	●	●	●	●	●	●	●	●	●	●
Magnesium (mg)	●	●	●	●	●	●	●	●	●	●
Phosphorus (mg)	●	●	●	●	●	●	●	●	●	●
Iron (mg)	●	●	●	●	●	●	●	●	●	●
Zinc (mg)	●	●	●	●	●	●	●	●	●	●
Thiamin (μg)	●	●	●	●	●	●	●	●	●	●
Riboflavin (μg)	●	●	●	●	●	●	●	●	●	●
Pyridoxine (μg)	●	●	●	●	●	●	●	●	●	●
Folate (μg)	●	●	●	●	●	●	●	●	●	●
Vitamin C (mg)	●	●	●	●	●	●	●	●	●	●
Vitamin D (μg)	●	●	●	●	●	●	●	●	●	●
Vitamin B12 (μg)	●	●	●	●	●	●	●	●	●	●
Vitamin A (Retinol) (μg)	●	●	●	●	●	●	●	●	●	●
Cholesterol (mg)	●	●	●	●	●	●	●	●	●	●
Fatty acids, saturated (g)	●	●	●	●	●	●	●	○[b]	●	●
Fatty acids, monounsaturated (g)	●	●	●	●	●	●	●	○	●	●
Fatty acids, polyunsaturated (g)	●	●	●	●	●	●	●	○	●	●
Copper (mg)	●	●	○	●	●	●	●	●	○	○
Potassium (mg)	●	○	●	○	●	●	●	●	●	○
Manganese (μg)	●	○	○	○	●	●	●	●	○	●
Iodine (μg)	●	○	○	○	●	○	●	●	○	○
Retinol equivalents (μg)	●	○	●	○	●	●	●	●	●	●
β-carotene (μg)	●	○	○	○	●	●	●	●	●	●
Tocopherol equivalents (μg)	●	○	●	○	●	●	●	●	●	●
Niacin (mg)	●	○	●	○	●	●	●	●	●	●
Niacin equivalents (mg)	●	○	●	○	●	○	●	○	○	●
Pantothenic acid (mg)	●	○	○	○	●	●	●	●	○	○
Biotin (μg)	●	○	○	○	●	●	●	●	○	○
Vitamin K (μg)	●	○	○	○	●	●	○	○	●	○
Fibre, soluble (g)	●	○	○	○	●	●	○	●	○	○
Fibre, insoluble (g)	●	○	○	○	●	●	○	●	○	○

Abbreviations: AU, Austria; BE, Belgium; ES, Spain; FCDBs, food composition databases; FR, France; GE, Germany; GRA, Greece (Athens); GRC, Greece (Heraklion); HU, Hungary; HELENA, Healthy Lifestyle in Europe by Nutrition in Adolescence; IT, Italy; SW, Sweden. [a]● = available. [b]○ = not available.

was a tendency for lower DDS with increasing BMI independent of gender.

Nutritional knowledge

Total NKT scores in the different centres ranged between 50 and 70% of the maximum 23 points. Mean scores were significantly different between centres. Age, BMI and gender had no significant effect on knowledge results. In general, girls had higher values than boys. In girls, there was a tendency for higher scores with increasing age and lower scores with increasing BMI. Owing to the small sample sizes in the pilot study, we abandoned evaluation of the different scores or categories separately.

Diet-related attitudes

Calculating a sum over all 10 scales, between 40 and 60% of the maximum score of 400 was reached in the different centres. Mean scores were significantly different between centres. In boys and girls, EWI scores increased significantly with increasing BMI, whereas gender and age had no significant effect. Owing to the small sample sizes in the pilot study, we abandoned evaluation of the different scales separately.

Discussion

Healthy Lifestyle in Europe by Nutrition in Adolescence, the first integrated approach for a pan-European dietary assessment and evaluation in adolescents, posed a big challenge to all participating centres, but pilot data show that the chosen methods are feasible across all countries.

For dietary assessments in the young, it has to be considered that the required cognitive abilities include an adequately developed concept of time, a good memory and attention span, as well as a knowledge of the food names.[28,29] However, by the age of 10 years, children can reliably report their food intake.[30,31] The increased availability of computers in schools and at home, the efficiency and economy (that is, standardization, savings in study personnel for interviewing, coding and data processing), as well as the attractiveness of computer software especially for adolescents makes it technically, financially and practically feasible to use self-administered computer-assisted tools for dietary assessments particularly in these age groups.[5,32]

Energy and nutrient intake

From a review on dietary intake of children and adolescents across Europe,[1] data are available for a rough comparison with the HELENA pilot data. For males (females) of the same age range and from the same countries, energy intakes from 2300 to 3300 kcal day^{-1} (1600 to 2500 kcal day^{-1}) were reported, and total fat intake expressed as percentage of total energy intake ranged between 32 and 37%. For both variables, HELENA pilot data fit into these ranges.

Dietary quality

In the HELENA pilot study, at best mean values of 3 out of 5 points for assessment of dietary quality were achieved in the different centres. There is a lack of studies using dietary scoring systems in adolescents.[17] A few newer reports address the food pattern in adolescents in Europe by the 'classical' one-dimensional approach. A low average consumption of fruit and vegetables was found in Spanish children and adolescents.[33] Approximately 47% of the participants aged between 2 and 24 years reported a dislike of vegetables.[34] In Germany, the consumption of plant foods in children and adolescents ranges far below the food-based dietary guidelines, whereas the consumption of meat/sausages and confectionery is higher than recommended.[35]

Nutritional knowledge

The HELENA pilot data suggest an at-best moderate dietary knowledge across the participating centres. Despite the intuitive appeal of education as a means of improving diet, some studies in adults gave conflicting results regarding associations between nutritional knowledge and dietary behaviour.[36,37] Studies in children and adolescents are scarce. In an Austrian study (13–18 years), nutrient intake showed close coherence to the degree of nutritional knowledge. Better nutritional knowledge was accompanied by higher consumption of fibre and lower consumption of protein and cholesterol in girls compared with boys.[38] In US students, eating behaviour correlated with nutritional knowledge in seventh and eighth but not in sixth grade students.[39] Increasing age and type of school was found to correlate significantly with nutritional knowledge but not with the degree of overweight.[40] In addition, in the pilot study, in general, girls had higher knowledge scores than boys, and there was a tendency for higher scores with increasing age and lower scores with increasing BMI in girls only.

Diet-related attitudes

In the pilot study, EWI scores increased significantly with increasing BMI, whereas gender and age had no significant effect.

In general, eating attitudes are determined differently for boys and girls.[41] For instance, weight-conscious adolescents, especially girls, exhibit restrictive eating practices and a preoccupation with a slim image.[42] However, dieting for boys and girls was associated with similarly elevated rates of extreme weight control behaviours, body dissatisfaction and depression in non-overweight and overweight groups.[43] In addition, in adolescent girls and boys, lower body satisfaction predicted higher levels of dieting and unhealthy weight control behaviours.[44]

Owing to the small sample sizes in the pilot study, we abandoned the separate evaluation of the different scales. However, in the main study, the different scales have to be analysed separately and in combination with other data for example, body weight. Items referring to bulimic behaviour were not included in the questionnaire here. But individuals with certain (extremely high) scale scores point to a suspicion of an existing eating disorder.

Conclusion

Within the HELENA pilot study, for the first time a uniform methodology for assessing and evaluating dietary intake and a harmonized approach for using national FCDBs proved to be feasible. Considering the results from the feasibility study, quite consistent and plausible results were found between centres. In general, only weak age effects are to be expected because of the small samples with a narrow age range (13–15 years). However, tendencies in correlations between BMI and DDS, NKT and EWI were found. Against this background, data from the feasibility study are promising so that from the main HELENA Study useful data collected using standardized and uniform methodology are to be expected.

This study could also serve as a first reaction to the request from the International Life Sciences Institute Europe[45] that steps towards achieving harmonization of dietary surveys in European children and adolescents are urgently needed to come to conclusions about the dietary intake and nutritional status of these age groups.

Acknowledgements

We are very grateful to Ellen Koeppen for proofreading. The HELENA Study was carried out with the financial support of the European Community Sixth RTD Framework Programme (Contract FOOD-CT-2005-007034). The content of this paper reflects only the authors' views, and the European Community is not liable for any use that may be made of the information contained therein. The researchers from the University of Zaragoza, Spain (MIM) are complementarily supported by FUNDACIÓN MAPFRE (Spain).

Conflict of interest

The authors state no conflict of interest.

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