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# Nutritional knowledge in European adolescents: results from the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study

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## Abstract

*Objective:* To build up sufficient knowledge of a 'healthy diet'. Here, we report on the assessment of nutritional knowledge using a uniform method in a large sample of adolescents across Europe.

*Design:* A cross-sectional study.

*Setting:* The European multicentre HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study conducted in 2006–2007 in ten cities in Austria, Belgium, France, Germany, Greece (one inland and one island city), Hungary, Italy, Spain and Sweden.

*Subjects:* A total of 3546 adolescents (aged 12·5–17·5 years) completed a validated nutritional knowledge test (NKT). Socio-economic variables and anthropometric data were considered as potential confounders.

*Results:* NKT scores increased with age and girls had higher scores compared with boys (62% *v.* 59%; $P < 0{\cdot}0001$). Scores were approximately 10% lower in 'immigrant' adolescents or in adolescents with 'immigrant' mothers. Misconceptions with respect to the sugar content in food or in beverages were found. Overall, there was no correlation between BMI values and NKT scores. After categorization according to BMI, scores increased significantly with BMI group only in boys. These differences disappeared after controlling for socio-economic status (SES). Smoking status and educational level of the mother influenced the NKT scores significantly in boys, as well as the educational levels of both parents in girls.

*Conclusions:* Nutritional knowledge was modest in our sample. Interventions should be focused on the lower SES segments of the population. They should be initiated at a younger age and should be combined with environmental prevention (e.g. healthy meals in school canteens).

**Keywords**
Nutrition knowledge
Multiple-choice test
Gender
Socio-economic status

Morbidity and mortality associated with lifestyle diseases could be reduced if satisfactory nutritional practices were adopted in early life and maintained in the long term.

Public health strategies to support a healthy lifestyle are based on both an individual and an environmental approach. Regarding nutrition, the individual approach aims to inform people about the basics of a healthy diet in such a way as to enable them to translate their knowledge into dietary practice[1–4].

Compared with the still limited cognitive capacity of children, adolescents are already fully capable of reflecting

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on their dietary practices and food choices. Moreover, adolescence is a period when familial influence on a child's dietary habits diminishes and personal responsibility and autonomy become more important[5]. Therefore, adolescence could be a period when nutritional education and information could be expected to be most successful.

Although nutritional knowledge has been repeatedly assessed in adolescents, results are difficult to compare because different measurement instruments and definitions have been used. In addition, nutritional knowledge is influenced by biological and social factors (e.g. age, gender and social status) in both adolescents and adults[2,3,6–8].

If nutritional knowledge could be measured in a better way and relevant determinants learnt, the needs of adolescents regarding nutritional education and information could be specifically determined. Subsequently, tailored programmes could be designed to support healthy dietary habits in this sensitive age group.

The HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study and, in particular, the HELENA Cross-Sectional Study (HELENA-CSS) provided for the first time the opportunity to examine nutritional knowledge in a large sample of well-characterized adolescents across Europe using a uniform methodology[9–11]. A validated multiple-choice nutritional knowledge test (NKT) designed for children and adolescents was considered the best option as a measuring instrument[12,13].

The objectives of the present data analysis were: (i) to assess the overall degree of formal nutritional knowledge in adolescents across Europe; and (ii) to examine potential sociodemographic determinants of nutritional knowledge such as gender, body weight status, immigrant status and parental educational and financial level, using data from the HELENA-CSS.

## Methods

### *Study design and sample*

Ten large cities (Vienna, Ghent, Lille, Dortmund, Athens, Heraklion, Pecs, Rome, Zaragoza and Stockholm) from nine European countries formed the basis for the sampling selection. Each city has more than 100 000 inhabitants. A random cluster sample (all pupils from a selection of classes from all schools in these cities) of 3000 adolescents aged 12·5–17·49 years, stratified for geographical location, age and socio-economic status (SES), was targeted. All analyses conducted using the HELENA data are adjusted by a weighting factor to balance the sample according to the age distribution of the European adolescent population in order to guarantee true representation of each of the stratified groups.

From a statistical point of view, the group is considered a homogeneous one without the added variability caused by habitat. The sampling procedure was anticipated to give a fair approximation of the average picture of the situation. Such a well-defined large population was considered to be the best option for examining relationships between outcomes of interest, such as nutritional knowledge and sociodemographic status[11].

The general HELENA inclusion criteria were defined as: no simultaneous participation in another clinical trial; and valid data for age, sex and BMI[11].

Between October 2006 and December 2007, a total of 3528 eligible adolescents (1683 boys and 1845 girls) participated in the study and 3322 (1576 boys and 1746 girls) complied with the general inclusion criteria, as well as with the additional criterion of having validly completed the NKT (>75 % of questions completed), which was a requirement for the present analysis.

Participants themselves and their parents signed an informed consent form. The HELENA study received ethical approval from the responsible institutions in the participating countries. Details have been published elsewhere[11,14].

### *Nutritional knowledge test*

To investigate formal nutritional knowledge, an established NKT that had been formerly validated in children and adolescents was used[13,15]. The structure and length of the NKT questionnaire were designed for pupils who had not received any special (trained) education on 'nutrition'[13]. The questionnaire included a total of twenty-three multiple-choice questions (Table 2) that could be categorized into specific subscales regarding knowledge of concepts (e.g. subscales 'Energy Intake and Energy Metabolism' or 'Physical Activity'), instrumental knowledge (e.g. subscale 'Nutrient Contents') and knowledge of causal relationships (e.g. subscales 'Sweeteners' or 'Oral Health').

The phrasing of the wrong answer alternatives was chosen to distract the pupils in order to make their assumptions more difficult. The test also contained questions with common misconceptions among the wrong answer alternatives (e.g. food fibre 'strains the circulatory system' or 'makes people fat'). Finally, questions in a subscale showed different degrees of difficulty; that is, some easy questions were included to keep the participants motivated while conducting the test.

In a pilot study, organized on a small scale in each country, the feasibility of all the questionnaires within the HELENA study programme was checked with respect to procedures, methods and data processing[15,16].

The administration of the NKT questionnaire was embedded within a large set of standardized instruments and methods used to collect the various data included in the HELENA-CSS (e.g. dietary intake, anthropometry, physical fitness and sociodemographic characteristics). Assessments were usually carried out in the schools. The study personnel were free to arrange the timetable for the different instruments as they considered feasible[16]. The NKT questionnaire was completed by the adolescents in the classroom. Instructions were carefully

given by the test leader from among the study personnel, who was present in the classroom. The test was usually completed within approximately 15 min by the study participants.

Each multiple-choice question offered three possible answers (only one was correct) and the 'don't know' category[13]. For evaluation, a correct answer was scored 1 and an incorrect answer was scored 0. Finally the individual scores were summed up and calculated as a percentage of the total (referred to as the total NKT score here).

### *Sociodemographic characteristics*

SES was assessed using a self-reported questionnaire completed in the classroom. The questionnaire was designed to categorize adolescents according to SES and to analyse relationships between SES and nutritional or clinical data. Details have been published elsewhere[16]. The following proxy measures of SES were used here: participant's and mother's nationality, language at home (as an indicator of ethnicity), mother's body weight status, father's and mother's educational level and family's financial situation. Further sociodemographic variables included were the participant's smoking status and the immigrant status of both participants and their parents. Immigrants were defined as those participants or their parents who had been born outside the country where they lived during the study.

### *Body weight status*

Weight was measured with participants wearing underwear and without shoes using an electronic scale (model SECA 861; Seca GmbH & Co KG, Hamburg, Germany) to the nearest 0·1 kg. Height was measured with the participants barefoot in the Frankfort plane using a telescopic height-measuring instrument (model SECA 225; Seca GmbH & Co KG) to the nearest 0·1 cm. All measurements were taken by trained staff. Details have been published elsewhere[17]. BMI was calculated as weight in kilograms divided by the square of height in metres (kg/m$^2$) and subdivided into four categories: 'underweight', 'optimal', 'overweight' and 'obese', according to references suggested for international use[18,19].

### *Statistical analyses*

All statistical analyses were performed using the SAS statistical software package version 8·02 (SAS Institute, Cary, NC, USA).

The primary outcome was total NKT score (percentage of correct answers) by age and gender. Descriptive statistics were computed where necessary and 95 % CI was used in the figures. Gender differences in the frequency of correct answers in the NKT subscales were analysed using the $\chi^2$ test, and gender differences in age, BMI or total NKT score were analysed using the Wilcoxon two-sample test (two-sided).

Analysis of covariance (SAS procedure PROC GLM) was used to control for age or centre differences and to investigate the effect of BMI, SES and sociodemographic variables on NKT scores. Here, two different models were applied for each gender subgroup separately: model 1 to investigate the influence of age, BMI and immigrant status in the total sample; and model 2 to investigate the influence of SES and sociodemographic variables in non-immigrant participants.

*Model 1 (total sample):*
Nutritional knowledge score (or subscales of nutritional knowledge) = centre + age + BMI (or BMI group) + immigration status.

*Model 2 (non-immigrants only):*
Nutritional knowledge score (or subscales of nutritional knowledge) = centre + age + BMI (or BMI group) + smoking status + mother's (or father's) educational level + family's financial status + mother's weight status.

Mean age-adjusted NKT scores (least square mean), together with 95 % CI, were computed and used for figures. Statistical significance was set at $P < 0{\cdot}05$.

## Results

Anthropometric characteristics, smoking and immigration status are shown by gender in Table 1. Overall, no gender differences were observed for age, BMI, smoking status or immigration status, but significantly more boys than girls were categorized as being overweight or obese.

In the total sample, girls had slightly but significantly higher total NKT scores compared with boys (62 % *v.* 59 %; Table 1). Sixteen out of twenty-three questions were answered correctly by more than 50 % of respondents. Between 22 % and 93 % of participants answered the single questions correctly. Subscale scores were very close to the total score (Table 2).

There were only minor differences between male and female participants at this stage of the descriptive data analysis.

Total NKT scores increased significantly with age at approximately 1·8 % (2·7 %) per year of age in both boys ($r = 0{\cdot}160$, $P < 0{\cdot}0001$) and girls ($r = 0{\cdot}236$, $P < 0{\cdot}0001$). Therefore, age-adjusted total NKT scores were calculated. Mean age-adjusted total scores in girls (61 %) remained slightly but significantly higher than in boys (58 %).

Overall, there was no correlation between continuous BMI values and total NKT score (model 1). However, after classification according to BMI group, significant differences were found in boys (model $r^2 = 0{\cdot}098$; BMI group $P < 0{\cdot}0013$), where mean total NKT score increased with BMI group – except for the obese group who had the lowest mean total NKT score (Fig. 1). However, these

**Table 1** Descriptive statistics for characteristics and differences according to gender among adolescents in the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study

| | Male (*n* 1576) | | Female (*n* 1746) | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | *P* value |
| Age (years) | 14·6 | 2·76 | 14·6 | 2·24 | 0·2556§ |
| BMI (kg/m$^2$) | 21·5 | 3·93 | 21·3 | 3·50 | 0·9296§ |
| Nutritional knowledge (%)* | 59·2 | 14·30 | 61·6 | 13·98 | <0·0001§ |
| | *n* | % | *n* | % | |
| BMI category† | | | | | <0·0001¶ |
| Underweight | 77 | 4·9 | 113 | 6·5 | |
| Optimal | 1073 | 68·1 | 1280 | 73·3 | |
| Overweight | 304 | 19·3 | 278 | 15·9 | |
| Obese | 122 | 7·7 | 75 | 4·3 | |
| Smoking (yes, at present) | 277 | 17·6 | 335 | 19·2 | 0·2381¶ |
| Non-immigrant participants‡ | 1322 | 83·9 | 1479 | 84·7 | 0·5140¶ |

*Correct answers as a percentage of total answers.
†According to Cole *et al.*[19].
‡'Non-immigrant' participants or participants with 'non-immigrant' mothers.
§Gender differences: Wilcoxon test (two-sided).
¶Gender differences: $\chi^2$ test.

differences vanished after the inclusion of SES variables in the model. In girls, there was no difference in total NKT score between BMI groups (model 1 $r^2 = 0{\cdot}117$; BMI group $P < 0{\cdot}9375$). The subscale 'Energy Intake and Energy Metabolism' showed almost the same results regarding BMI group as the total NKT score for boys (model 1 $r^2 = 0{\cdot}082$; BMI group $P < 0{\cdot}0130$). For this subscale, a tendency (model $r^2 = 0{\cdot}076$; BMI group $P < 0{\cdot}6073$) of increasing knowledge with BMI group was also observable in girls – except for the obese participants (data not shown). No significant effect of BMI or BMI group on the other nutritional knowledge subscales could be identified.

Mean total NKT scores were slightly (approximately 10 %) but significantly lower in 'immigrant' adolescents or in adolescents with 'immigrant' mothers (model 1). Therefore, for further analyses regarding SES and sociodemographic variables (model 2), 'immigrant' adolescents and adolescents with 'immigrant' mothers were excluded, leading to a subsample of 2801 participants (53 % female) for the subsequent part of the data analysis.

In model 2, which included BMI (or BMI group), SES and sociodemographic characteristics, we found differences in total NKT scores for a number of variables according to gender. In boys, smoking status and educational level of the mother influenced the total NKT score significantly: non-smokers had a slightly higher mean score compared with smokers (57 % *v.* 60 %; $P < 0{\cdot}0201$), and the total NKT score increased with the educational level of the mother (from 55 % to 62 %; $P < 0{\cdot}0001$; Fig. 1). None of the other SES variables or BMI (group) had an influence on the total NKT score in non-immigrant boys.

In girls, the educational levels of both parents influenced the total NKT score significantly. Total NKT score increased significantly with the educational level of the mother (from 58 % to 64 %; $P < 0{\cdot}0128$; Fig. 2) and – except for the lowest educational level – with the educational level of the father as well (from 60 % to 64 %; $P < 0{\cdot}0069$). Similar to boys, none of the other SES variables or BMI (group) had an influence on total NKT scores in non-immigrant girls.

## Discussion

This assessment of formal nutritional knowledge in adolescents from nine European countries using a uniform methodology arrived at the following main conclusions: (i) the overall degree of nutritional knowledge among European adolescents was only modest in both boys and girls, and it increased with age; and (ii) the most convincing determinant of nutritional knowledge was the educational level of the parents, whereas body weight status did not show any association.

By way of study design and the specific random sampling procedures for schools and classes, care was taken to control for potential differences by location and to guarantee a well-defined sample of adolescents across Europe[11].

Although it is difficult to compare the HELENA results with those of other studies on this subject because of the different methodologies used and the backgrounds, our results regarding level of knowledge, as well as the main determinants, seem to fit in well with findings in the literature.

### *Level of nutritional knowledge*

A level of approximately 60 % of questions answered correctly, as in the HELENA study, was also found in smaller samples of adolescents in single European countries[20,21] and abroad[1,22], whereas mostly lower scores (of around

**Table 2** Nutritional knowledge test results (percentage of participants with correct answers, *P* values from the $\chi^2$ test) by gender among adolescents in the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study

| Question | Correct answer | Subscale* | Male (*n* 1576) % | Female (*n* 1746) % | Total (*n* 3322) % | *P* value ($\chi^2$) |
|---|---|---|---|---|---|---|
| 1. What is the other commonly used term for energy? | Joule | A | 48·3 | 47·1 | 47·7 | 0·8710 |
| 2. Bread, cake, pasta, potatoes and rice contain mainly … | Carbohydrates | B | 70·0 | 71·1 | 70·6 | 0·7009 |
| 3. Which row lists three types of edible fish? | Codfish, turbot, carp | D | 69·9 | 72·7 | 71·3 | **0·0390** |
| 4. Raw minced meat should be stored in the refrigerator for a maximum of …? | Half a day | D | 23·1 | 24·6 | 23·9 | 0·3237 |
| 5. How much salt should one consume per day in addition to that contained in the foods eaten? | None at all | E | 42·4 | 43·7 | 43·1 | 0·4191 |
| 6. How many cubes (teaspoons) of sugar are there in a can (0·33 l) of coke or lemonade? | Approximately twelve cubes (seven teaspoons) | D | 42·6 | 41·8 | 42·2 | 0·5853 |
| 7. Which row lists three dishes that have all been prepared using very little fat? | Boiled egg, boiled potatoes, steamed fish | D | 76·8 | 83·7 | 80·4 | **0·0001** |
| 8. A breakfast merely consisting of bread, jam and butter does not contain enough … | Protein | B | 60·6 | 64·4 | 62·6 | **0·0175** |
| 9. What effect does the fibre contained in our food have on the human body? | It stimulates the process of digestion | E | 74·0 | 76·6 | 75·4 | 0·2404 |
| 10. Dietitians use the American term 'Junk Food' to describe certain foods. What do they mean by this? | Foods that contain a lot of energy but are of very little nutritional value | E | 68·8 | 71·4 | 70·2 | **0·0495** |
| 11. What is another name for the coating that develops on teeth when one eats a lot of sweets? | Plaque | C | 69·2 | 73·8 | 71·6 | **0·0029** |
| 12. Marcel has been playing with a ball all afternoon. During this time Kevin has been sitting at home watching television. Which of the following statements is most applicable? | Marcel burns more energy than Kevin | **A** | **90·5** | **92·7** | **91·7** | **0·0306** |
| 13. A small bag of roasted peanuts (125 g) contains as much energy … | As a whole lunch meal | A | 51·1 | 50·8 | 50·9 | 0·8689 |
| 14. Which of the following statements about sugar is correct? | Sugar only provides energy | C | 66·6 | 65·1 | 65·8 | 0·3315 |
| 15. Which one of the following types of mineral water would be the healthiest? | Mineral water with a high Mg content | E | 63·8 | 65·6 | 64·8 | 0·1804 |
| 16. How long must one swim in order to burn the amount of energy contained in a single chocolate? | Approximately 10 min | A | 44·7 | 52·8 | 48·9 | **0·0001** |
| 17. Which row lists three foods that contain a lot of vitamin C? | Peppers, cabbage, citrus fruit | D | 57·9 | 57·4 | 57·6 | 0·7686 |
| 18. How many cubes (teaspoons) of sugar are there in a bottle of ketchup (250 ml)? | Approximately twenty-three cubes (fourteen teaspoons) | **D** | **21·8** | **22·9** | **22·4** | 0·5208 |
| 19. The ingredients list found on food items may contain a number of different terms for sugar. Which row lists three terms for special types of sugar? | Dextrose, fructose, maltose | D | 65·4 | 70·3 | 67·9 | **0·0003** |
| 20. What can consuming large amounts of salt result in or aggravate? | High blood pressure | D | 68·6 | 68·8 | 68·7 | 0·6801 |
| 21. Which substance is good for your teeth? | Fluoride | C | 73·5 | 81·1 | 77·5 | **0·0001** |
| 22. Which of the following fast-food menus contains the most nutrients? | Hamburger with salad and orange juice | B | 64·8 | 72·7 | 69·0 | **0·0001** |
| 23. Which row lists three terms for energy-free sweeteners? | Aspartame, saccharin, cyclamate | C | 46·1 | 46·6 | 46·3 | 0·6430 |

Highest or lowest frequencies and significant *P* values are given in bold.
*Subscales and their mean scores (percentage of correct answers): A, Energy Intake and Energy Metabolism (59·8 %); B, Nutrient Contents (67·4 %); C, Sweeteners and Oral Health (65·3 %); D, Food Knowledge (54·3 %); E, Special terms and Definitions (63·4 %).

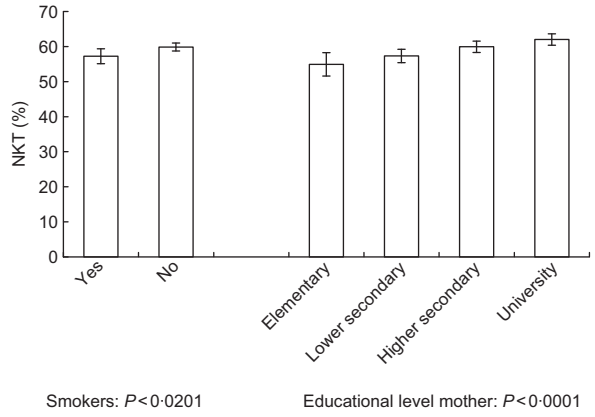



**Fig. 1** Nutritional knowledge test (NKT) scores according to smoking habits and educational level of mother among boys in the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study (model 2; age-adjusted mean and 95 % CI)

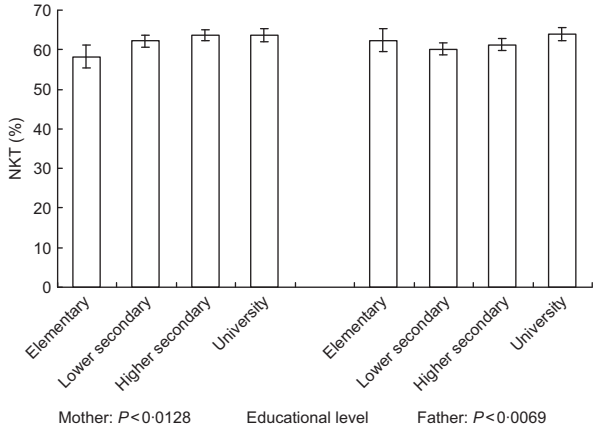



**Fig. 2** Nutritional knowledge test scores (NKT) according to educational level of both parents among girls in the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study (model 2; age-adjusted mean and 95 % CI)

40 %) were found in US adolescents[22–25]. Interestingly, adults do not seem to have any better nutritional knowledge compared with adolescents, not even college students[26–29], although in a recent Australian study 72 % of questions were answered correctly[30].

Therefore, the HELENA results suggest that European adolescents might know more about a healthy diet than their US counterparts, and certainly not less than adults.

In our analysis of the frequencies of correct answers for single questions, we found a general misconception with respect to the sugar content in food (ketchup) or beverages (soft drinks): adolescents underestimated the sugar content of these products. Others have reported similar misconceptions in adolescents[1]. Since consumption of sugar-containing beverages has been suggested to increase the risk of overweight and obesity in children and adolescents[31,32], correcting such a misconception by way of specific nutritional education might also improve the awareness of adolescents for a more prudent selection of beverages.

***Physiological factors: age, gender, body weight***

Nutritional knowledge significantly increased with age by approximately 2 % per year, even within the small age range (12–17 years) examined in the HELENA study. Maturational processes in adolescence may account for such a distinct age effect. Findings in the literature confirm this observation[21], although often a broader age range starting from a younger age (7–10 years) was examined[20]. Therefore, adolescence seems to be a sensitive period for improving nutritional knowledge effectively.

Girls had slightly but significantly higher nutritional knowledge scores compared with boys in the HELENA study. This finding has been confirmed by other studies in both adolescents[1,21–23,25,33–35] and adults[27,28,30,36–38]. In subgroups under 12 years of age, however, gender was less predictive[21,22,33]. It is questionable whether such a slight difference such as that found here is of any clinical or practical relevance. Nevertheless, the HELENA results are plausible, since it is well known that girls are in general more concerned about food selection compared with boys, even before maturational differences occur during adolescence.

However, the HELENA results do not suggest the need for gender-specific nutritional education, nor would this be practicable in real life.

Overall, there was no convincing correlation between BMI values and nutritional knowledge in the HELENA study sample since the significant differences according to BMI group in boys vanished after the inclusion of SES variables in the model. These results are in accordance with other studies in both adolescents[20,35] and adults[37,39–41]. Only among hospitalized patients were the overweight and obese patients found to have higher knowledge scores compared with other patients[42]. Therefore, the HELENA findings support the notion that an inferior nutritional knowledge is not per se associated with the prevalence of overweight or obesity in adolescents. In contrast, the tendencies for higher subscale scores regarding the topic of energy intake and energy metabolism for overweight adolescents suggest a specific nutritional concern in this group of adolescents, but an inability to translate this into dietary practice.

It has been shown repeatedly that proper nutritional knowledge is not necessarily associated with general positive dietary behaviour[1,3,6,43,44]. Nevertheless, in general, and independent of body weight status, some formal knowledge on dietary principles is a prerequisite for an informed food choice. Indeed, two recent studies found a positive association between nutritional knowledge and indicators of a healthy diet in adults[2] and adolescents[4]. Further evaluations of the HELENA data could prove this assumption in European adolescents.

### *Sociodemographic factors*

Among all the variables examined here, the educational level of both adolescents and their parents showed the most convincing association with nutritional knowledge, whereas the family's financial situation failed to show an association. These results are plausible since formal nutritional knowledge was assessed here, which may reflect the body of acquired general knowledge and is related to the level of formal education. These results have also been confirmed by other studies in children and adolescents that used educational level as a proxy for SES[20,35], as well as in many studies with adults where higher SES levels were associated with higher knowledge scores[30,36–38,41,45].

The association of nutritional knowledge with smoking or migrational status was in general weak, or only found in a single gender (e.g. for smoking in boys). Immigrants in the HELENA sample were only defined as those participants or their parents who had been born outside the country where they lived during the study. This definition produced a broad mixture of ethnicities and social levels, and no strong association with nutritional knowledge could be expected. However, the tendencies from HELENA are confirmed by studies from the USA where 'Caucasian' and 'white' US adolescents had higher nutritional knowledge scores compared with other ethnic groups[22,23,46].

## Conclusion

The NKT proved to be feasible in this sample of adolescents across Europe. As our study showed, in European adolescents, nutritional knowledge was modest and similar to results in adults. Intervention should be focussed on the lower SES components of the respective population. They should be initiated at a younger age and should be coupled with environmental prevention (e.g. healthy meals in school canteens).

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## Appendix

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