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Article title: Do adolescents accurately evaluate their diet quality? The HELENA study

Short running head: adolescents' dietary awareness

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Abbreviations: Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA), Diet Quality Index for Adolescent (DQI-A), HELENA Dietary Intake Assessment Tool (HELENA-DIAT), Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA), Flemish food-based dietary guidelines (FBDGs), Body mass index (BMI), International Standard Classification of Education (ISCED).

SUMMARY

Background and aims: The aim of this study was to assess the diet quality awareness and associated factors in a large sample of European adolescents.

Methods: The study included 3389 healthy adolescents, aged 12.5–17.5 years, who participated in the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) Study. The adolescents' diet quality was based on repeated 24 h recalls and scored into a Diet Quality Index for Adolescents (DQI-A) considering four components: meal, equilibrium, diversity and quality. A self-rated diet quality questionnaire was administered to adolescents to assess their dietary awareness. The association of DQI-A with dietary awareness was studied using a linear mixed model including the center as the random effect and dietary awareness as the fixed effect.

Results: There was a positive association between DQI-A scores and diet quality perception levels ($p < 0.0001$). The mean DQI-A was 59.0 (SD = 14.8) in adolescents with a low dietary awareness compared with 65.4 (SD = 12.6) in adolescents with high dietary awareness ($p < 0.0001$). Similar results were found for all the DQI components. When analyses were stratified, we found a significant heterogeneity across the nutritional status, with no significant association between DQI-A and dietary awareness level in obese adolescents, but a positive association in overweight, normal and undernourished groups. We found also a significant heterogeneity associated with the lunch location (school or home). No other factor affected dietary awareness (gender, pubertal status and maternal educational level).

Conclusion: European adolescents evaluate well their food quality whatever their pubertal status, gender and parental educational level, except for the obese who are not able to assess their diet quality. Improving the dietary awareness in obese adolescents might help to induce behavioral changes.

Keywords: Youth; Assessment; Nutrition; Awareness; Epidemiology study

1. Introduction

The prevalence of obesity has tripled in European countries in the last 30 years, and continues to rise at an alarming rate, especially in young people [1]. Overweight and obesity have many health consequences, making prevention particularly important [2]. In children, dietary habits are closely related to overweight and obesity [3-4].

Adolescence represents a period during which multiple physiological and psychological changes occur that considerably affect dietary habits [5-6]. The rapid physical growth that occurs during this period is associated with an increase in nutritional needs. Adolescence is marked by an increasing intake of energy-dense foods that are low in nutrients such as snacks and sugar-sweetened beverages and a decrease in intake of nutrient-dense foods such as fruits and vegetables [7-9]. Intervention or promotion programs for a healthy diet have been shown to have limited success in childhood and adolescence [10-11]. Lack of awareness of personal dietary habits has been identified as a major barrier to motivating adults to change to healthier diets [12]. We hypothesized that a similar barrier would apply for adolescents. Indeed, adolescents may think that they achieve healthy dietary habits because they wrongly assess their diet quality.

Therefore, the aim of the present study was to examine the diet quality awareness in a large sample of European adolescents. A secondary aim was to investigate factors associated with diet quality awareness.

2. Methods

2.1 Study design

The Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-Sectional Study (HELENA-CSS) is a multicenter study performed in 10 European cities belonging to nine

countries. The HELENA-CSS was designed to obtain reliable and comparable data on nutrition and health-related parameters from a sample of European adolescents aged 12.5 – 17.5 yr. A sample of 3,528 adolescents met the HELENA general inclusion criteria. A detailed description of the HELENA study's methodology and sampling has been published elsewhere [13-15].

Written, informed consent was obtained from the adolescent and the parents. The HELENA study was approved by the local ethics committee in each country, and all procedures were performed in accordance with the ethical standards of the Helsinki Declaration of 1975 as revised in 2008 and the European Good Clinical Practices [16].

2.2 Measurements

2.2.1 Self-rated diet quality

Self-rated diet quality was assessed using a questionnaire. The adolescent was asked the single question: "Your diet is: rather unhealthy, not healthy or unhealthy, rather healthy, healthy, very healthy". A healthy eating was defined as "a healthy diet is a well-balanced diet which contains a lot of fruit, vegetables and dairy products, a good portion of starchy foods like bread, potatoes and pasta, a moderate portion of meat or fish, and not too much fat and sugar. Also the intake of a large amount of fluid is very important in a healthy diet. The energy content of a healthy diet is in accordance with the needs of the human body" [17]. For the assessment of diet quality, the answers were classified *a priori* into three categories: low when the answer was "rather unhealthy" or "not healthy or unhealthy", medium when the answer was "rather healthy" and high when the answer was "healthy" or "very healthy". This question about awareness was extracted from a healthy diet determinants questionnaire that has been previously found to be reliable and valid, specifically awareness question correlated well with fresh fruit, soft drinks and ascorbic acid [18].

2.2.2 Diet quality assessment

Dietary intake was assessed by two nonconsecutive 24-hour recalls performed on any two convenient days of the week [19]. The 24-hour recalls were recorded using a self-administered, computer-based HELENA Dietary Intake Assessment Tool (HELENA-DIAT) that has been validated in European adolescents [20]. Detailed descriptions of data collection and analysis have been published elsewhere [20-24].

2.2.3 Participants' characteristics

Weight was measured in light clothes, without shoes, to the nearest 0.1 kg using an electronic scale (SECA 871; SECA, Hamburg, Germany). Height was measured without shoes to the nearest 0.1 cm using a telescopic height-measuring instrument (SECA 225; SECA). Body mass index (BMI) was calculated as weight (kg)/height² (m²). Nutritional status was assessed according to the International Obesity Task Force scale [25]. Pubertal status was assessed by a physician through direct observation according to Tanner and Whitehouse [26].

Maternal educational level was classified into one of four categories using a specific questionnaire adapted from the International Standard Classification of Education (ISCED) (<http://www.uis.unesco.org/Library/Documents/isc97-en.pdf>), and was scored as 1: primary and lower education (levels 0, 1 and 2 in the ISCED classification); 2: higher secondary (levels 3 and 4 in the ISCED classification); and 3: tertiary (levels 5 and 6 in the ISCED classification).

2.3 Statistical analysis

Data are presented as percentages for qualitative variables and mean $\pm$ standard deviation (SD) for quantitative variables. Normality of distribution was checked graphically and using the Shapiro–Wilk test.

To assess the selection bias related to missing or incomplete data, the main characteristics of the included and nonincluded adolescents were compared using a Student *t*-test for quantitative variables, a chi-square test for categorical variables and the Mantel–Haenszel trend test for qualitative ordinal variables.

The association of DQI-A with dietary awareness was studied using a linear mixed model including the center as a random effect and diet quality perception level as the fixed effect (treated as an ordinal factor). We performed key subgroup analyses based on gender, pubertal status, nutritional status, maternal educational level and place adolescents used to have lunch (school or home). Heterogeneity in the association of DQI-A with dietary awareness level across subgroups was assessed by adding a multiplicative term into the linear mixed model.

All statistical tests were performed at a 2-tailed α level of 0.05. Data were analyzed using SAS version 9.4 [SAS Institute Inc., Cary, NC 27513, USA].

3. Results

Of 3528 adolescents meeting the inclusion criteria, 3389 (96%) were finally included in the statistical analysis after excluding those with missing or incomplete data for self-rated quality of diet. Characteristics of the population studied are presented in Table 1. Except for maternal educational level, there were no significant differences found between the included and nonincluded groups.

As shown in Figure 1, the DQI-A score increased gradually with the adolescent's dietary awareness level ($p < 0.0001$). The mean DQI-A was 59.0 (SD = 14.8) in adolescents with a low dietary awareness compared with 65.4 (SD = 12.6) in adolescents with a high dietary awareness. Similar results were found for all the DQI components.

When analyses were stratified according to key subgroups, no heterogeneity in the association of DQI-A and dietary awareness level was found for gender, pubertal status or maternal education level (Table 2). We found a significant heterogeneity associated with the lunch location (school or home). The positive association between DQI-A and diet awareness was stronger in adolescents who eat at home than those eating at school (Table 2). In addition, we found also a significant heterogeneity associated with nutritional status, with obese adolescents showing no significant association between DQI-A and dietary awareness, while a positive association was found for the overweight, normal and underweight groups (Table 2). The mean difference in DQI-A between the highest and lowest dietary awareness level was 9.3 in the underweight, 6.9 in those of normal weight, 5.2 in the overweight and 0.5 in the obese. Similar results were found for each DQI component (Table 3).

4. Discussion

Although several studies have been performed to evaluate the perception of dietary intake in children and adolescents, our study is the first to investigate the relationship between diet quality and the awareness of diet quality in European adolescents [27]. We hypothesized that a lack of awareness of personal dietary habits could be a major barrier for intervention programs aimed at promoting a healthy diet.

Unexpectedly, our main finding was that European adolescents, regardless of gender, pubertal status, maternal educational level and lunch location, correctly assess their own diet quality. While adolescents have been shown to have difficulties in qualifying their daily physical activity (they tend to overestimate their physical activity patterns), our data show that is not the case for their assessment of diet quality [28]. This probably results from education and information about a “healthy” diet in the European countries included in the study.

Gender, pubertal status or educational level did not affect diet quality awareness, whereas these variables were demonstrated to have an influence on physical activity awareness [29].

Another important finding from our study is that obese adolescents do not have a valid perception of their diet quality. In addition to underestimating their weight and energy intake, our results show that obese adolescents do not discriminate well between a healthy or unhealthy diet [28-32]. This is an additional factor that could contribute to the failure of intervention programs that aim to reduce obesity. Our observation that obese adolescents misreport their diet quality emphasizes the importance of improving awareness of diet quality, the first step in any intervention to promote a healthy diet. Based on the results presented in our study, regular feedback to obese adolescents on their dietary quality might be beneficial and could motivate them to adjust their own diet throughout the day. New technology, such as nutrition applications for mobile devices, could be used to give regular and rapid feedback on dietary intake quality, and therefore might improve dietary intake quality perception and behaviors [33-35]. This method presents a great opportunity to modify awareness and might instill healthy behaviors, while providing objective information about individual dietary quality might bring about a more realistic estimation of dietary quality by obese European adolescents. Another possible explanation for the misperception of diet quality by obese adolescents is the influence of social desirability (the tendency to respond so as to avoid criticism) and social approval (the tendency to seek praise), which can bias answers in self-reporting [35].

In our study, we found a stronger positive association between DQI-A and diet awareness in adolescents who eat at home compared to those eating at school. This difference might be due to the influence of the family on healthy diet awareness. However a significant positive between DQI-A and awareness was found both in adolescent eating at home and those eating at school.

The current study has strengths and limitations. The strengths of the study are the large sample size of adolescents in 10 European cities, the use of standardized procedures, and the strong methodology used to assess dietary habits [36]. The limitations of the study include the cross-sectional design with observed associations, which cannot be interpreted to reflect causal relationships. In addition, even though the HELENA-DIAT has been validated against dietary recall with an interviewer, the main limitation is the subjectivity, especially in obese people, of the assessment of dietary intake that was evaluated only by the adolescent participants. Then, as this study was performed ten years ago (2006-2007), we could not exclude our results represent the present situation.

5. Conclusions

Adolescents evaluate well their food quality independent of their pubertal status, gender and parental educational level, except for obese adolescents who are not able to assess accurately their diet quality. Improving dietary awareness in obese adolescents might help to induce behavioral changes.

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Conflict of interest

The authors do not have any competing interests.

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371 **Legends**

372 **Figure 1.** DQI-A according to the adolescents' diet quality awareness.

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Table 1. Comparison of mean characteristics between the included and non-included adolescents

	Included	Not included	P
Number of adolescents	3389	139	
Gender (% <i>boys</i>)	47.4	55.4	0.06
Age (<i>yr</i>)	14.7 ± 1.2	14.7 ± 1.3	0.69
Nutritional status (% <i>UW</i> /% <i>NW</i> /% <i>OW</i> /% <i>O</i>) ^a	6.2 / 70.9 / 17.3 / 5.6	3.6 / 67.6 / 22.3 / 6.5	0.09
Pubertal status (% <i>II</i> /% <i>III</i> /% <i>IV</i> /% <i>V</i>) ^b	6.0 / 22.3 / 42.2 / 29.5	8.0 / 27.0 / 41.0 / 24.0	0.11
Mother education level (% <i>I</i> /% <i>II</i> /% <i>III</i>) ^c	34.7 / 31.4 / 33.9	47.1 / 30.0 / 22.9	0.02
Place adolescents used to have lunch (% <i>school</i>)	23.8	26.1	0.68
<i>For boys</i>			
Z-score for height	0.64 ± 1.04	0.56 ± 1.04	0.53
Z-score for weight	0.68 ± 0.98	0.80 ± 0.97	0.29
Z-score for BMI *	0.40 ± 1.00	0.60 ± 1.00	0.08
<i>For girls</i>			
Z-score for height	0.31 ± 1.02	0.21 ± 0.97	0.47
Z-score for weight	0.45 ± 0.83	0.43 ± 0.69	0.86
Z-score for BMI*	0.34 ± 0.87	0.35 ± 0.80	0.94

^a Nutritional status: underweight (UW), normal weight (NW), overweight (OW), obese (O)

^b Pubertal status staging according to Tanner

^c Education level: lower education (I); higher secondary education (II); higher education or university degree (III).

* Body Mass Index

Table 2. DQI-A according to the adolescents' diet quality awareness and key subgroups

		Diet quality self-assessment			P*	P het
		Low	Median	High		
<i>Gender</i>						
	Boys	56.0 (15.6)**	61.7 (13.8)	63.4 (13.2)	<0.0001	0.59
	Girls	61.5 (13.6)	63.5 (13.2)	67.3 (11.7)	<0.0001	
<i>Nutritional status</i>						
	Undernourished	57.0 (12.8)	62.6 (13.6)	66.3 (12.8)	<0.0001	0.006
	Normal Weight	58.7 (14.9)	62.2 (13.3)	65.6 (12.3)	<0.0001	
	Overweight	59.2 (15.1)	64.0 (14.0)	64.4 (13.7)	0.002	
	Obese	62.2 (14.3)	67.8 (14.7)	62.7 (13.9)	0.42	
<i>Pubertal status</i>						
	II	60.0 (13.6)	63.3 (11.7)	65.4 (13.0)	0.016	0.12
	III	58.9 (14.9)	64.4 (12.9)	65.0 (13.1)	<0.0001	
	IV	58.9 (14.7)	61.8 (13.8)	64.5 (13.1)	<0.0001	
	V	58.8 (15.4)	62.7 (13.8)	67.5 (10.9)	<0.0001	
<i>Mother education level</i>						
	I	55.7 (15.3)	59.0 (14.3)	59.7 (13.9)	<0.0001	0.27
	II	61.3 (13.6)	64.0 (12.8)	66.5 (11.3)	<0.0001	
	III	62.3 (13.4)	65.6 (12.1)	68.9 (10.6)	<0.0001	
<i>Place adolescents used to have lunch</i>						
	School	61.5 (12.4)	64.3 (12.3)	66.9 (11.6)	<0.0001	0.043
	Home	58.8 (15.3)	62.6 (14.0)	66.1 (12.6)	<0.0001	

P het indicates p-values for heterogeneity in relation to DQI-A and diet awareness level across key subgroups.

* P for trend adjusted for center using linear mixed effect model (diet perception level was treated as an ordinal factor).

**mean (Standard Deviation)

Table 3. DQI components according to the adolescents' diet quality awareness and nutritional status

	Diet awareness			
	Low	Median	High	P*
<i>Underweight</i>				
DQI-Quality	28.0 (35.4)	38.6 (33.5)	43.4 (33.8)	0.013
DQI-Equilibrium	37.8 (9.9)	40.5 (11.1)	44.5 (12.4)	0.001
DQI-Diversity	72.0 (14.4)	76.6 (13.3)	79.4 (12.6)	<0.0001
DQI-Meal	91.7 (12.1)	94.9 (12.4)	96.5 (8.6)	0.019
<i>Normal Weight</i>				
DQI-Quality	35.7 (38.5)	40.9 (34.6)	46.7 (32.7)	<0.0001
DQI-Equilibrium	38.6 (10.0)	40.8 (10.4)	43.1 (10.2)	<0.0001
DQI-Diversity	70.9 (14.5)	74.1 (14.0)	78.0 (13.2)	<0.0001
DQI-Meal	90.0 (14.8)	93.1 (12.3)	94.9 (10.9)	<0.0001
<i>Overweight</i>				
DQI-Quality	40.2 (40.1)	50.1 (35.3)	49.3 (36.4)	0.004
DQI-Equilibrium	39.1 (10.7)	42.3 (10.5)	42.5 (11.2)	0.0007
DQI-Diversity	71.0 (14.8)	72.5 (14.9)	74.5 (15.3)	0.045
DQI-Meal	87.6 (16.0)	91.7 (13.5)	91.5 (13.9)	0.017
<i>Obese</i>				
DQI-Quality	48.3 (39.5)	54.7 (33.4)	51.8 (32.6)	0.41
DQI-Equilibrium	40.0 (9.6)	44.6 (12.4)	42.3 (10.2)	0.11
DQI-Diversity	70.6 (15.2)	75.0 (16.9)	71.0 (16.0)	0.50
DQI-Meal	90.2 (14.4)	95.4 (10.8)	84.5 (15.0)	0.23

* P for trend adjusted for center using linear mixed effect model (diet awareness level was treated as an ordinal factor).

Values are mean (Standard Deviation)

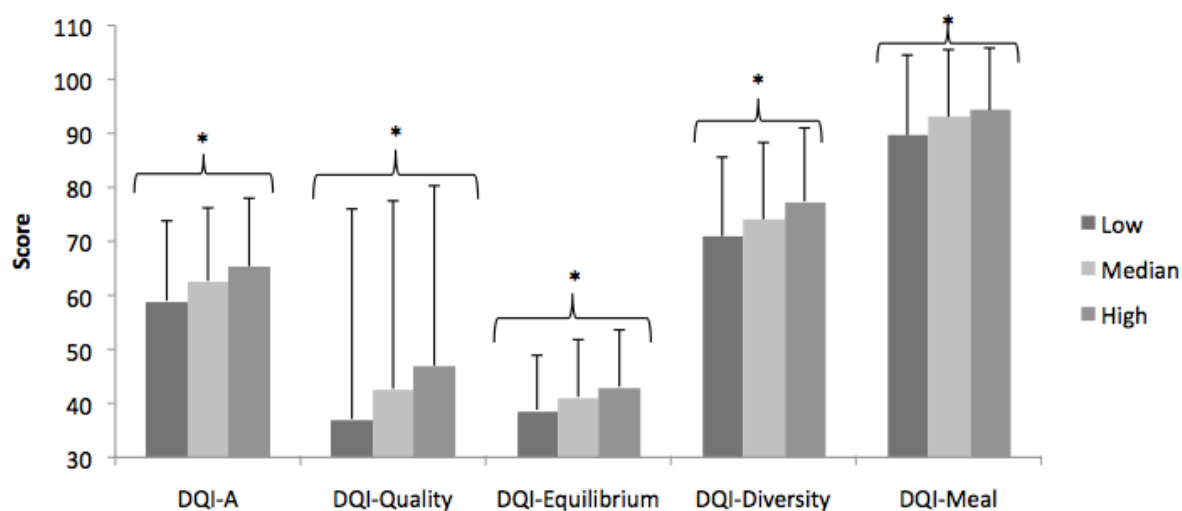


Figure 1. DQI-A according to the adolescents' dietary quality awareness

[†]DQI-A: Diet Quality Index-Adolescents

* P for trend adjusted for center using linear mixed effect model (diet perception level was treated as an ordinal factor) ($p < 0.0001$)

Values are mean (Standard Deviation)