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Dietary Patterns and Their Relationship With the Perceptions of Healthy Eating in European Adolescents: The HELENA Study

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ABSTRACT

Objective: The aim of this study was to identify dietary patterns (DPs) in European adolescents and to examine the association between perceptions of healthy eating and the obtained DPs.

Method: A multinational cross-sectional study was carried out in adolescents aged 12.5 to 17.5 years and 2,027 (44.9% males) were considered for analysis. A self-reported questionnaire with information on food choices and preferences, including perceptions of healthy eating, and two 24-hour dietary recalls were used. Principal component analysis was used to obtain sex-specific DPs, and linear analyses of covariance were used to compare DPs according to perceptions of healthy eating.

Results: Three and four DPs for boys and girls were obtained. In boys and girls, there were significant associations between some perceptions about healthy food and the Breakfast-DP ($p < 0.05$). In boys, Breakfast-DP and Healthy Beverage-DP were associated with the perception of the own diet as healthy ($p < 0.05$). Healthy Beverage-DP was associated with those disliking fruits and vegetables ($p < 0.05$). Girls considering the own diet as healthy were associated with Mediterranean-DP, Breakfast-DP, and Unhealthy Beverage and Meat-DP ($p < 0.05$). The perception of snacking as a necessary part of a healthy diet was associated with Breakfast-DP in both genders ($p < 0.05$).

Conclusions: In European adolescents, perceptions of healthy eating were mainly associated with a DP characterized by foods consumed at breakfast. Future studies should further explore these findings in order to implement health promotion programs to improve healthy eating habits in adolescents.

Abbreviations: 24H-DR: 24-hour dietary recall; BMI: body mass index; DPs: dietary patterns; FAS: Family Affluence Scale; FCP: Food Choices and Preferences; F&V: fruits and vegetables; HELENA-CSS: Healthy Lifestyle in Europe by Nutrition in Adolescence Cross Sectional Study; PA: physical activity; SES: socioeconomic status

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Introduction

Overweight and obesity in high-, middle-, and low-income countries is a public health issue around the world (1, 2). According to the World Health Organization, the worldwide prevalence of obesity has nearly doubled since 1980 (3).

Worldwide, in 2016, 50 million girls and 74 million boys were obese (4). The rising trends of developed overweight or obesity in children have plateaued in many high-income countries (4). Obesity is a multifactorial disorder originating from genetic and environmental factors and their

interactions (5). Children with high body mass index (BMI) usually present an excess of total body fat, cardiometabolic risk factors, together with a propensity to experience type 2 diabetes, hypertension, and cardiovascular diseases later in life (6). Childhood obesity also represents an additional cost for both societal and health services (6).

Obesity is determined by a chronic energy imbalance involving both excessive dietary intake and low physical activity (PA) levels (7). Dietary patterns (DPs) are measures of the total usual intake of food and beverages combination in individuals and groups (8). It is generally accepted that DPs and other behaviors, as for instance PA, established during childhood, tracked into adolescence and continue into adulthood, and all these behaviors have implications for the development of chronic diseases (9). Consumption of some food groups has been associated with the development of risk factors for obesity and others diseases. For instance, a high consumption of sugar-sweetened beverages has been associated with obesity and future cardiometabolic risk (10). In a previous cross-sectional study which included a sample of 2801 American children, high fruit juice intake was also associated with an increased adiposity gain (11). On the other hand, a high level of intake of fruits and vegetables (F&V) and dairy products was related with a lower risk of obesity in American and European children (11–13).

Diet, PA and sedentary behaviors are acknowledged as major behavioral determinants of energy-balance, behaviors and obesity (14). The analysis of DPs may better predict the risk of diseases than the analysis of isolated nutrients or foods, once the joint effect of various nutrients involved in a DP would be better identified (15). Published studies showed that an unhealthy DP was associated with an overall unhealthy lifestyle (16). Also, it was suggested that there is an association between adolescents' perceptions of their dietary practices and their actual dietary behaviors (17). In previous studies authors observed that those adolescents with the best knowledge about healthy eating will not determine the best food's choices (18, 19).

For all these reasons, the hypothesis of the current study is that those adolescents perceiving their eating habits as healthy also have the healthiest DPs. For this reason, the aims of our study are the following: (1) to identify DPs in European adolescents and (2) to analyze the associations between several perceptions of healthy eating and the obtained DPs.

Methods

Study design sample

The Healthy Lifestyle in Europe by Nutrition in Adolescence Cross Sectional Study (HELENA-CSS) is a multi-center study that aimed to describe the lifestyle and nutritional status of adolescents (20). The HELENA-CSS was carried out between October 2006 and December 2007 in 10 European cities: Athens, Heraklion, Dortmund, Ghent, Lille, Pecs, Rome, Stockholm, Vienna, and Zaragoza (20, 21). Due to logistical reasons, adolescents from Heraklion and Pecs were excluded for the dietary intake assessments (20, 21). A

random cluster sampling (all pupils from a selection of classes from all European schools) of 3000 adolescents, stratified for geographical location, age, and socioeconomic status, was carried out (21). The total sample size was calculated with a confidence level of 95% with ± 0.3 error in the parameter BMI. An error of 0.3 was chosen as a worst case scenario as precision level described by Cochran WG (22).

The general inclusion criteria for HELENA-CSS were (1) being within the age range of 12.5 to 17.5 years, (2) not participating simultaneously in another clinical trial, and (3) being free of any acute infection lasting less than 1 week before inclusion. From a sample of 3528 adolescents, only adolescents with two 24-hour dietary recalls (24H-DRs) and having completed at least 75% of the Food Choices and Preferences (FCP) questionnaire were included.

The HELENA study was performed following the ethical guidelines of the Declaration of Helsinki of 1964 and was approved by each local institutional review board. Written and signed informed consent was obtained from the adolescents and their parents or guardians (23).

Socioeconomic status (SES)

Collected demographic data included information on gender, age, and SES by means of a standardized self-reported questionnaire. A modified version of the Family Affluence Scale (FAS) developed by Currie et al. (24) was used as a proxy indicator of SES. The adolescents completed a questionnaire asking about car ownership, home computers and Internet access. The FAS was slightly modified by replacing the item on frequency of family holidays by Internet availability at home. Adolescents were scored from 0 (very low SES) to 8 (very high SES) and were merged into three groups: a score of 0 to 2 was grouped as low, 3 to 5 as medium, and 6 to 8 as high SES.

Physical examination

Physical measurement (weight and height) were performed by trained staff in a standardized way (25). Weight was measured with an electronic scale (Type SECA861, precision = 100 g, range 0–150 kg), and height was measured with a telescopic stadiometer (Type SECA 225, precision = 0.1 cm, range = 70–200 cm) (26). BMI was calculated from height and weight (kg/m^2). The definition of obesity (including overweight) was based on the international BMI (27). Age- and sex-specific BMI z scores were calculated according to Cole et al. (27).

Dietary assessment

Dietary intake data were obtained using two self-administered 24H-DRs by means of a software developed for the project (28), and it was completed during school time and assisted by dietitians/researchers, who instructed the participants on how to fill it. This method has been used and recommended to assess dietary intake in European children and adolescents. (29)

The program was improved and culturally adapted by adding national dishes to reach a European standard (30). The dietary data collection is organized in six meal occasions, and the participants can select from about 400 predefined food items and are free to add nonlisted foods manually. Special techniques are used to allow a detailed description and quantification of foods, e.g. pictures of portion sizes. Amounts eaten are reported as grams or milliliters or by common household measures.

Participants completed the 24H-DR twice on nonconsecutive days within a time span of 2 weeks. The Multiple Source Method (31) was used to calculate usual energy (kcal/d), nutrients, and foods intake, considering the effect of day-to-day within-person variability and random error in the recalls. The 43 food groups included were aggregated into 30 food groups according to their nutritional values.

Healthy eating preferences

The healthy eating preferences module is part of the self-administered FCP questionnaire, which investigates agreement/disagreement with a series of attitude statements regarding food choices and behaviors, healthy eating, and preferences.

The selected sentences that were answered by the participants were as follows: (1) I think that my diet is healthy; (2) Snacking is a necessary part of a healthy diet; (3) I enjoy eating F&V; (4) Food I eat at home is healthy; (5) I often skip breakfast; (6) Most snack foods that I eat are healthy; and (7) What I eat now will have a big impact on my future health. The predefined response categories were (1) strongly disagree; (2) moderately disagree; (3) slightly disagree; (4) neither agree nor disagree; (5) slightly agree; (6) moderately agree; (7) strongly agree. These categories were grouped into three groups: (1) strongly, moderately, and slightly disagree; (2) neither agree nor disagree; and (3) slightly, moderately, and strongly agree.

Statistical analysis

The Predictive Analytics Software version 20.0 (SPSS Inc.) was used to analyze the data. All analyses were gender-specific because of observed significant differences in FCP and dietary consumption. According to the nature of the studied variables, chi-square test for categorical variables and analysis of variance for continuous variables were used to compare gender-specific sample characteristics.

Principal component analysis (PCA) with varimax rotation was used to obtain DPs in our sample. It is a technique often used in data reduction to identify a small number of factors that explain most of the variance observed in a much larger number of variables by defining sets highly interrelated (32). Each obtained DP represents a linear combination of all food groups, which are weighted by their factor loading (those with an absolute value of > 0.3 were considered important contributors to each DP). The following criteria were used when deciding the number of components to be retained: eigenvalue > 1 , the scree plot (a graphical

presentation of eigenvalues), and the interpretability of each component (33, 34).

To compare the DPs (dependent variable) and healthy eating perceptions, analysis of covariance was used, stratified by gender and adjusted for age, SES, BMI, and energy intake. In addition, a Bonferroni *post-hoc* test was conducted to make pairwise comparisons. A two-sided significance level of 0.05 was considered to be statically significant.

Results

In total, 2027 adolescents (44.9% boys) were included in the analysis. Table 1 presents gender-specific sociodemographic characteristics on age, SES, BMI, food intake, and the questions related with healthy eating perceptions.

Table 2 presents the results of the PCA, including three DPs for boys and four DPs for girls. Only the food groups loading $|> 0.30|$ in each DP are presented. The obtained DPs in boys were namely Mediterranean-DP, Breakfast-DP, and Healthy Beverages-DP. The cumulative variance explained is 27.25%, corresponding with 10.95%, 8.94%, and 7.35% for each DP, respectively. In girls, the obtained DP was namely Mediterranean-DP, Breakfast-DP, Unhealthy Beverage and Meat-DP, and Healthy Snack Foods-DP. The cumulative variance explained is 34.67%, corresponding with 9.92%, 9.17%, 8.80%, and 6.71% for each DP, respectively.

Associations between healthy eating perceptions and DPs are shown separately by gender in Table 3 (boys) and Table 4 (girls). In boys, the perception of their own diet as healthy was associated with the Breakfast-DP ($p = 0.003$) and Healthy Beverage-DP ($p < 0.001$). On the other hand, the perception of snacking as a necessary part of a healthy diet was associated with the Breakfast-DP ($p < 0.001$). Those adolescents who thought that their snacks were healthy were associated with Breakfast-DP ($p < 0.001$). Furthermore, those enjoying eating F&V had the same DP ($p = 0.001$). In contrast, those adolescents who agreed that the food they eat at home is healthy were associated with Breakfast-DP ($p = 0.036$) and Healthy Beverage-DP ($p = 0.001$). Moreover, those boys who usually had breakfast presented the same DP ($p < 0.001$). In addition, those boys who thought that their food consumption would have a big impact on their future health had a high adherence with Mediterranean-DP ($p = 0.001$).

In girls (Table 4), the perception of their own diet as healthy had a high adherence with Breakfast-DP ($p < 0.001$) and Healthy Snack Foods-DP ($p < 0.001$). However, those girls who disagreed with the same statement were associated with Unhealthy Beverage and Meat-DP ($p = 0.010$). Girls who agreed that snacking was part of a healthy diet presented high adherence with Breakfast-DP ($p < 0.001$). Besides, those adolescents who considered that snack consumption was healthy had a high adherence with Breakfast-DP ($p < 0.001$) and Healthy Snack Foods-DP ($p < 0.001$). On the other hand, girls who do not enjoy eating F&V had a high adherence with Mediterranean-DP ($p = 0.005$). At opposite, those who enjoyed eating F&V had a high

Table 1. Descriptive characteristics of the sample of European adolescents from the HELENA study (n = 2027).

	Boys (n = 910)	Girls (n = 1117)	p
Age (years), mean (95% CI)	14.87 (14.79, 14.95)	14.80 (14.72, 14.87)	0.172
AGE CATEGORY, n (%)			0.712
<12.5–13.99	254 (27.9)	334 (29.9)	
14–14.99	237 (26.0)	291 (26.1)	
15–15.99	218 (24.0)	264 (23.6)	
16–>17.5	201 (22.1)	228 (20.4)	
SES, n (%)			0.019
Low	75 (8.3)	135 (12.1)	
Medium	509 (56.1)	599 (53.7)	
High	323 (35.6)	382 (34.2)	
BMI	21.3 (21.0, 21.5)	21.2 (21.0, 21.4)	0.736
WEIGHT STATUS CATEGORY, n (%)			0.008
Lower and optimal BMI	694 (76.3)	906 (81.1)	
Overweight and obese BMI	216 (23.7)	211 (18.9)	
FOOD AND BEVERAGES INTAKE (g or ml) mean (95% CI)			
Bread and rolls (g/d)	117 (113.4, 121.6)	93 (90.1, 95.9)	<0.001
Cereals (g/d)	139.4 (134.1, 144.7)	104.8 (101.1, 108.4)	<0.001
Sweet bakery products (g/d)	58.0 (55.3, 60.9)	51.0 (48.9, 53.1)	<0.001
Savory snacks (g/d)	10.30 (9.1, 11.5)	6.2 (5.5, 6.9)	<0.001
Sugar, honey, jam, syrup, and other sugar products (g/d)	12.1 (10.8, 13.4)	9.9 (9.0, 10.8)	0.008
Confectionery non-chocolate (g/d)	7.3 (6.3, 8.3)	7.8 (7.1, 8.6)	0.359
Chocolate (g/d)	29.9 (27.6, 32.2)	21.4 (20.0, 22.8)	<0.001
Vegetable oils (g/d)	7.5 (6.7, 8.2)	6.00 (5.5, 6.5)	<0.001
Butter and animal fats (g/d)	6.9 (6.1, 7.8)	5.3 (4.8, 5.9)	0.002
Margarine, lipids of mixed origins (g/d)	4.2 (3.5, 4.8)	2.6 (2.3, 3.0)	<0.001
Sauces (g/d)	37.3 (35.4, 39.1)	29.6 (28.3, 30.9)	<0.001
Nuts, seeds, olives, and avocado (g/d)	3.1 (2.4, 3.9)	4.1 (3.3, 4.9)	0.071
Pulses (g/d)	9.8 (7.8, 11.7)	8.6 (7.1, 10.2)	0.373
Vegetables excluding potatoes (g/d)	92.1 (88.0, 96.08)	92.2 (88.9, 95.5)	0.957
Starch roots, potatoes (g/d)	65.3 (62.2, 68.3)	59.0 (56.8, 61.3)	0.001
Fruits (g/d)	124.0 (117.3, 130.7)	128.7 (123.3, 134.1)	0.283
Soups, bouillon (g/d)	37.3 (33.2, 41.4)	37.8 (34.4, 4.3)	0.846
Water (ml/d)	753.9 (718.17, 789.7)	742.3 (713.3, 771.3)	0.616
Coffee, tea (ml/d)	44.4 (37.8, 51.0)	52.5 (46.0, 58.9)	0.089
Fruit and vegetable juice (ml/d)	162.4 (151.8, 172.9)	140.3 (132.4, 148.1)	0.001
Carbonated/soft/isotonic drinks (ml/d)	374.8 (351.4, 398.2)	213.8 (200.5, 227.1)	<0.001
Alcoholic beverages (ml/d)	29.8 (21.6, 38.1)	5.2 (2.3, 8.2)	<0.001
Meat (g/d)	161.6 (156.2, 167.0)	128.5 (124.7, 132.2)	<0.001
Fish products (g/d)	20.6 (19.5, 22.1)	19.6 (18.4, 20.9)	0.309
Eggs (g/d)	13.5 (12.4, 14.6)	10.8 (10.0, 11.6)	<0.001
White milk and buttermilk (g/d)	189.9 (177.3, 202.6)	131.7 (123.5, 139.9)	<0.001
Dairy products (g/d)	83.7 (76.1, 91.3)	71.5 (66.1, 76.8)	0.008
Cheese (g/d)	32.4 (30.7, 33.9)	26.8 (25.7, 27.8)	<0.001
Other milk products (g/d)	12.8 (11.1, 14.6)	15.6 (14.1, 17.2)	0.017
Meat substitutes and vegetarian products (g/d)	1.1 (0.4, 1.8)	2.3 (1.6, 2.9)	0.019
HEALTHY EATING PERCEPTIONS, n (%)			0.658
I think that my diet is healthy			
Strongly, moderately, and slightly disagree	148 (16.3)	180 (16.2)	
Neither agree nor disagree	182 (20.1)	242 (21.7)	
Slightly, moderately, and strongly agree	576 (63.6)	691 (62.1)	
Snacking is a necessary part of a healthy diet			0.304
Strongly, moderately, and slightly disagree	335 (37.3)	380 (34.4)	
Neither agree nor disagree	173 (19.3)	210 (19.0)	
Slightly, moderately, and strongly agree	389 (43.4)	515 (46.6)	
I enjoy eating fruit and vegetables			<0.001
Strongly, moderately, and slightly disagree	150 (16.6)	115 (10.3)	
Neither agree nor disagree	130 (14.4)	109 (9.8)	
Slightly, moderately, and strongly agree	624 (69.0)	890 (79.9)	
Food I eat at home is healthy			0.013
Strongly, moderately, and slightly disagree	63 (7.0)	109 (9.8)	
Neither agree nor disagree	139 (15.4)	200 (18.0)	
Slightly, moderately, and strongly agree	701 (77.6)	803 (72.2)	
I often skip breakfast			<0.001
Strongly, moderately, and slightly disagree	531 (58.5)	589 (52.8)	
Neither agree nor disagree	79 (8.7)	68 (6.1)	
Slightly, moderately, and strongly agree	297 (32.7)	458 (41.1)	
Most snacks foods that I eat are healthy			0.005
Strongly, moderately, and slightly disagree	392 (43.6)	437 (39.5)	
Neither agree nor disagree	235 (26.1)	258 (23.3)	
Slightly, moderately, and strongly agree	273 (30.3)	412 (37.2)	
What I eat now will have a big impact on my future health			<0.001
Strongly, moderately, and slightly disagree	168 (18.6)	122 (11.0)	
Neither agree nor disagree	159 (17.6)	167 (15.1)	
Slightly, moderately, and strongly agree	574 (63.7)	819 (73.9)	

(continued)

Table 1. Continued.

	Boys (n = 910)	Girls (n = 1117)	p
<i>I like the food my parents prepare at home</i>			0.619
<i>Strongly, moderately, and slightly disagree</i>	47 (5.2)	49 (4.4)	
<i>Neither agree nor disagree</i>	64 (7.1)	74 (6.7)	
<i>Slightly, moderately, and strongly agree</i>	786 (87.6)	987 (88.9)	

HELENA = Healthy Lifestyle in Europe by Nutrition in Adolescence; BMI = body mass index; SES = socioeconomic status; CI = confidence interval.

Table 2. Gender-specific factor loadings of identified dietary patterns (DPs).

	Boys			Girls			
	Mediterranean-DP	Breakfast-DP	Healthy Beverages-DP	Mediterranean-DP	Breakfast-DP	Unhealthy Beverages and Meat-DP	Healthy Snack Foods-DP
Bread and rolls		0.632		0.320	0.579		
Cereals (flour, pasta, rice and other cereals)	0.551			0.655			
Sweet bakery products: cakes, pies, and biscuits	0.311						−0.336
Savory snacks							
Sugar products (sugar, honey, jam, syrup, and other sugar products)		0.481			0.565		
Confectionery non-chocolate							
Chocolate							
Vegetable oils	0.814			0.657		−0.404	
Butter and animal fats		0.624			0.487		
Margarine and lipids of mixed origins		0.446					
Sauces (excluding dessert sauces)						0.519	
Nuts, seeds, olives, and avocado						−0.343	
Pulses (excluding fresh peas, sweet corn, and broad bean)	0.341						
Vegetables excluding potatoes	0.569			0.447			
Starch roots, potatoes	−0.301						
Fruits					0.316		0.641
Soups, bouillon			0.359				
Water	0.403		0.359			−0.572	
Coffee, tea		0.359			0.602		
Fruit and vegetable juices						0.344	
Carbonated/soft/isotonic drinks including nonalcoholic wine, nonalcoholic beer			−0.659			0.516	
Alcoholic beverage							
Meat				0.366		0.393	
Fish products							
Eggs							
White milk and buttermilk			0.578				0.640
Dairy products (yogurt and fromage blanc and milk and yogurt beverages)							
Cheese	0.495	0.368		0.596			
Other milk products (dessert and puddings, milk-based and creams)							
Meat substitutes and vegetarian products							
Variance explained (%)	10.95	8.94	7.35	9.92	9.17	8.80	6.71
Cumulative variance explained (%)			27.25				34.67

adherence with Breakfast-DP ($p < 0.001$) and Healthy Snack Foods-DP ($p < 0.001$). Furthermore, those girls who think that food they eat at home is healthy had a high adherence with Breakfast-DP ($p < 0.001$) and Healthy Snack Foods-DP ($p < 0.001$). At opposite, those adolescents who disagreed with this statement were associated with Unhealthy Beverage and Meat-DP ($p = 0.031$). Girls who did not skip breakfast had a high adherence with Healthy Snack Foods-DP ($p < 0.001$). In addition, those girls who thought that their food consumption would have a big impact on their future health had a high adherence with Healthy Snack Foods-DP ($p = 0.011$).

Discussion

The current study evaluated the association between healthy eating perceptions and DPs in European adolescents. Three DPs were identified in boys and four in girls. To our knowledge, this is the first study analyzing the relationship between different adolescents' diet-related perceptions and their adherence to the identified DPs. The most important finding was the association between reported agreement to perceiving their diet as healthy and Breakfast-DP in both genders.

The DPs identified in the current study differ from those identified in a previous HELENA paper (32) because the

Table 3. Mean scores of dietary patterns according to healthy eating perceptions in boys.

	Mediterranean-DP MEAN (95% CI)	<i>p</i>	Breakfast-DP MEAN (95% CI)	<i>p</i>	Healthy Beverage-DP MEAN (95% CI)	<i>p</i>
<i>I think that my diet is healthy</i>						
1: Disagreement	−0.005 (−0.153, 0.143)	0.163	−0.186 (−0.324, −0.048) ^b	0.003	−0.419 (−0.580, −0.259) ^{a,b}	<0.001
2: Neither agree nor disagree	−0.109 (−0.241, 0.022)		−0.081 (−0.203, 0.042) ^c		0.031 (−0.111, 0.174) ^a	
3: Agreement	0.037 (−0.037, 0.111)		0.061 (−0.008, 0.130) ^{b,c}		0.097 (0.017, 0.177) ^b	
<i>Snacking is a necessary part of a healthy diet</i>						
1:Disagreement	0.011 (−0.085, 0.108)	0.173	−0.103 (−0.194, −0.011) ^b	<0.001	0.002 (−0.105, 0.109)	0.625
2: Neither agree nor disagree	0.080 (−0.054, 0.214)		−0.153 (−0.279, −0.026)		−0.064 (−0.213, 0.084)	
3: Agreement	−0.068 (−0.158, 0.021)		0.161 (0.077, 0.246) ^b		0.024 (−0.075, 0.124)	
<i>Most snack foods that I eat are healthy</i>						
1: Disagreement	0.005 (−0.084, 0.094)	0.813	−0.086 (−0.170, −0.001) ^b	<0.001	−0.010 (−0.108, 0.088)	0.955
2: Neither agree nor disagree	0.022 (−0.093, 0.137)		−0.067 (−0.176, 0.042) ^c		−0.013 (−0.139, 0.114)	
3: Agreement	−0.028 (−0.135, 0.079)		0.188 (0.086, 0.289) ^{b,c}		0.011 (−0.107, 0.129)	
<i>I enjoy eating fruit and vegetables</i>						
1: Disagreement	−0.019 (−0.164, 0.127)	0.882	−0.187 (−0.323, −0.052) ^b	0.001	−0.133 (−0.292, 0.026)	0.082
2: Neither agree nor disagree	0.034 (−0.122, 0.190)		−0.137 (−0.282, 0.008) ^c		0.132 (−0.037, 0.302)	
3: Agreement	−0.002 (−0.073, 0.069)		0.066 (0.000, 0.133) ^{b,c}		−0.005 (−0.083, 0.072)	
<i>Food I eat at home is healthy</i>						
1: Disagreement	0.003 (−0.222, 0.229)	0.696	−0.172 (−0.386, 0.042)	0.036	−0.367 (−0.614, −0.120) ^b	0.001
2: Neither agree nor disagree	−0.059 (−0.210, 0.092)		−0.117 (−0.260, 0.026)		−0.134 (−0.300, 0.031)	
3: Agreement	0.013 (−0.054, 0.080)		0.042 (−0.022, 0.106)		0.060 (−0.014, 0.133) ^b	
<i>I often skip breakfast</i>						
1: Disagreement	0.020 (−0.058, 0.098)	0.182	0.046 (−0.028, 0.120)	0.119	0.170 (0.085, 0.254) ^{a,b}	<0.001
2: Neither agree nor disagree	0.136 (−0.064, 0.336)		−0.140 (−0.330, 0.051)		−0.175 (−0.392, 0.042) ^a	
3: Agreement	−0.064 (−0.170, 0.041)		−0.045 (−0.145, 0.055)		−0.262 (−0.376, −0.148) ^b	
<i>What I eat now will have a big impact on my future health</i>						
1: Disagreement	−0.125 (−0.260, 0.011) ^b	0.001	0.039 (−0.092, 0.169)	0.596	−0.116 (−0.266, 0.033)	0.133
2: Neither agree nor disagree	−0.157 (−0.296, −0.018) ^c		−0.055 (−0.189, 0.078)		−0.064 (−0.217, 0.090)	
3: Agreement	0.092 (0.018, 0.165) ^{b,c}		0.008 (−0.063, 0.078)		0.043 (−0.038, 0.124)	
<i>I like the food my parents prepare at home</i>						
1: Disagreement	0.113 (−0.145, 0.372)	0.632	−0.184 (−0.431, 0.063)	0.187	−0.237 (−0.521, 0.046)	0.195
2: Neither agree nor disagree	0.059 (−0.163, 0.280)		−0.092 (−0.303, 0.119)		0.095 (−0.147, 0.338)	
3: Agreement	−0.001 (−0.064, 0.062)		0.022 (−0.038, 0.082)		0.002 (−0.067, 0.071)	

Note. CI = confidence interval; Agreement = strongly, moderately, and slightly agree; Disagreement = strongly, moderately, and slightly disagree; DP = dietary pattern; B-DP, Boy-Dietary Pattern; Bold letter show significant differences between three categories ($p < 0.05$).

^aSignificant differences between disagreement and neither agree nor disagree ($p < 0.05$);

^bSignificant differences between disagreement and agreement ($p < 0.05$);

^cSignificant differences between neither agree nor disagree and agreement ($p < 0.05$).

objective was different. To our knowledge, there is no similar study identifying DPs in adolescents from different European countries. There are several studies limited to some specific European countries or regions (35–37).

As in other studies that were conducted in Greece, Italy, or Spain, (38) a healthy pattern was found in girls. In another study conducted in Spanish young populations, different patterns were observed: snack DP, healthy DP, protein-rich DP, meat-rich DP, and ludicrous DP (35). On the other hand, a study in Portuguese adolescents showed that unhealthier behaviors like sedentary activities were associated with DP characterized by higher consumption of sweets, fast foods, and soft drinks (36).

Assessing the relationship between healthy eating perceptions and DPs, in boys those considering their diet as healthy showed positive associations with Breakfast-DP and Healthy Beverage-DP. Girls considering their diet as healthy also showed positive associations with Breakfast-DP and Healthy Snack Foods-DP. The most consistent finding was the association between perceiving their diet as healthy and Breakfast-DP in boys and girls, which characterized by the consumption of foods regularly consumed at breakfast. We also observed in both sexes that perceptions of snacking as part of a healthy diet was associated by the consumption of foods regularly consumed at breakfast; this is consistent with the results of a literature review showing that

interventions should ensure that foods and beverages consumed by youth at snack occasions contribute to meeting dietary recommendations (39). These findings are important due to the fact that breakfast has been considered as an important meal of the day, and several authors observed that is considered as part of healthy diet (40, 41). Also, a high proportion of young people have the tendency to skip breakfast (42), and it has been related with greater body fatness, overweight and abdominal obesity (43) make essential to focus on this habit. For these reasons, the promotion of breakfast consumption could be an essential key factor in future health policies or strategies to improve lifestyle behaviors, especially in adolescence.

In boys and girls, those who thought their snacks' consumption were healthy were positively related with the breakfast DP characterized by the consumption of breakfast foods in boys and girls. Several authors showed that the frequency of snacking has increased in all age groups, including adolescents (44). Also, dietary intake of frequent snack consumers was characterized by low nutritional quality (i.e., high energy content) across the day (44).

Concerning the question about enjoying eating F&V, we found a significant association with Mediterranean-DP, characterized by the consumption of foods typically consumed in the Mediterranean diet. In a similar study, it was observed that the proportion of individuals having usual low

Table 4. Associations between food choices and preferences and mean scores of dietary patterns in girls.

	Mediterranean-DP MEAN (95% CI)	p	Breakfast-DP MEAN (95% CI)	p	Unhealthy Beverage and Meat-DP MEAN (95% CI)	p	Unhealthy Snacks Foods-DP MEAN (95% CI)	p
<i>I think that my diet is healthy</i>								
1: Disagreement	0.023 (−0.103, 0.148)		−0.125 (−0.261, 0.010) <i>b</i>		0.171 (0.031, 0.311) <i>b</i>		−0.430 (−0.575, −0.285) <i>a, b</i>	
2: Neither agree nor disagree	−0.030 (−0.136, 0.076)		−0.233 (−0.349, −0.118) <i>c</i>		0.058 (−0.061, 0.177)		−0.057 (−0.181, 0.066) <i>a, c</i>	
3: Agreement	0.003 (−0.060, 0.066)	0.803	0.113 (0.044, 0.181) <i>b, c</i>	< 0.001	−0.061 (−0.132, 0.010) <i>b</i>	0.010	0.132 (0.058, 0.205) <i>b, c</i>	< 0.001
<i>Snacking is a necessary part of a healthy diet</i>								
1: Disagreement	−0.069 (−0.154, 0.017)		−0.157 (−0.249, −0.064) <i>b</i>		−0.043 (−0.139, 0.052)		−0.091 (−0.192, 0.010)	
2: Neither agree nor disagree	0.016 (−0.099, 0.130)		−0.091 (−0.215, 0.034) <i>c</i>		0.087 (−0.040, 0.215)		0.005 (−0.130, 0.140)	
3: Agreement	0.050 (−0.024, 0.123)	0.116	0.158 (0.079, 0.237) <i>b, c</i>	< 0.001	0.003 (−0.079, 0.084)	0.275	0.062 (−0.025, 0.148)	0.078
<i>Most snack foods that I eat are healthy</i>								
1: Disagreement	−0.008 (−0.087, 0.071)		−0.215 (−0.299, −0.130) <i>b</i>		0.023 (−0.066, 0.111)		−0.171 (−0.263, −0.079) <i>b</i>	
2: Neither agree nor disagree	−0.005 (−0.108, 0.098)		−0.080 (−0.190, 0.030) <i>c</i>		−0.017 (−0.132, 0.098)		−0.024 (−0.144, 0.096) <i>c</i>	
3: Agreement	0.010 (−0.071, 0.092)	0.946	0.286 (0.199, 0.373) <i>b, c</i>	< 0.001	−0.006 (−0.097, 0.085)	0.844	0.196 (0.101, 0.291) <i>b, c</i>	< 0.001
<i>I enjoy eating fruit and vegetables</i>								
1: Disagreement	0.241 (0.086, 0.396) <i>b</i>		−0.428 (−0.595, −0.261) <i>b</i>		−0.037 (−0.212, 0.138)		−0.347 (−0.529, −0.165) <i>b</i>	
2: Neither agree nor disagree	0.007 (−0.151, 0.164)		−0.368 (−0.538, −0.198) <i>c</i>		−0.035 (−0.213, 0.143)		−0.205 (−0.391, −0.020)	
3: Agreement	−0.035 (−0.090, 0.020) <i>b</i>	0.005	0.099 (0.039, 0.159) <i>b, c</i>	< 0.001	0.009 (−0.053, 0.072)	0.817	0.069 (0.004, 0.134) <i>b</i>	< 0.001
<i>Food I eat at home is healthy</i>								
1: Disagreement	−0.145 (−0.305, 0.016)		−0.124 (−0.299, 0.051)		0.190 (0.011, 0.369) <i>b</i>		−0.364 (−0.550, −0.177)	
2: Neither agree nor disagree	−0.037 (−0.154, 0.080)		−0.216 (−0.343, −0.088)		0.058 (−0.073, 0.189)		−0.229 (−0.365, 0.093)	
3: Agreement	0.025 (−0.034, 0.083)	0.125	0.066 (0.002, 0.130)	< 0.001	−0.047 (−0.112, 0.019) <i>b</i>	0.031	0.103 (0.035, 0.171)	< 0.001
<i>I often skip breakfast</i>								
1: Disagreement	0.006 (−0.063, 0.075)		0.029 (−0.047, 0.104)		−0.033 (−0.110, 0.044) <i>b</i>		0.199 (0.120, 0.278) <i>b</i>	
2: Neither agree nor disagree	−0.041 (−0.242, 0.160)		−0.103 (−0.323, 0.117)		0.127 (−0.097, 0.352)		0.097 (−0.134, 0.327) <i>c</i>	
3: Agreement	0.001 (−0.077, 0.079)	0.909	−0.028 (−0.113, 0.058)	0.414	0.026 (−0.062, 0.113) <i>b</i>	0.322	−0.274 (−0.363, −0.184) <i>b, c</i>	< 0.001
<i>What I eat now will have a big impact on my future health</i>								
1: Disagreement	−0.048 (−0.199, 0.103)		−0.012 (−0.177, 0.153)		−0.006 (−0.175, 0.163)		−0.173 (−0.350, 0.004)	
2: Neither agree nor disagree	−0.023 (−0.151, 0.105)		−0.124 (−0.264, 0.016)		0.069 (−0.074, 0.213)		−0.132 (−0.282, 0.018)	
3: Agreement	0.020 (−0.038, 0.077)	0.636	0.021 (−0.042, 0.084)	0.132	−0.018 (−0.083, 0.047)	0.552	0.053 (−0.014, 0.121)	0.011
<i>I like the food my parents prepare at home</i>								
1: Disagreement 2: Neither agree nor disagree 3: Agreement	−0.241 (−0.477, −0.005) −0.082 (−0.275, 0.110) 0.021 (−0.032, 0.073)	0.072	0.041 (−0.218, 0.301) −0.208 (−0.419, 0.004) 0.012 (−0.046, 0.070)	0.137	−0.251 (−0.516, 0.014) −0.032 (−0.249, 0.184) 0.011 (−0.048, 0.070)	0.162	−0.084 (−0.363, 0.196) −0.133 (−0.360, 0.095) 0.010 (−0.052, 0.072)	0.423

DP = dietary pattern; CI = confidence interval.

Bold letter show significant differences between three categories ($p < 0.05$)

consumption of F&V was significantly higher among those reporting a dislike for that food group (37). Our results could be due to the emphasis of parents supporting the consumption of these foods with high nutritional value. In a previous literature review, it was observed that adolescents' eating habits and food choices may be influenced by their parents, and they play an important role in the formation of eating habits and preferences of children and adolescents (45); therefore, interventions aiming to increase F&V intake among children should also target the parents (46), and also it is important to involve adolescents in food preparation in order to improve diet quality through family interactions (47).

We have also observed, in both genders, a positive association between the same question and the DP, which included foods typically consumed at breakfast. In agreement with our study, in Italian adolescents, a positive association between breakfast consumption and consumption of F&V was observed (48).

Adolescents' perception that the food they eat at home is healthy was positively associated with the Breakfast-DP in both genders. Also in girls, the same perception was associated with the DP characterized by the consumption of unhealthy beverages and meat. In Australian girls, unavailability of healthy foods at home and parents not supporting healthy eating were positively associated with consumption of salty snacks (49).

Also, taking into consideration the Unhealthy Beverage and Meat-DP obtained, it was characterized with the highest proportion of low SES in girls, and by high adherence to sugar-sweetened beverage and F&V juices, and could be behind of the obtained associations. In this direction, in a previous longitudinal study, authors suggested that there is a positive association between SES and diet quality in adolescence (50).

Adolescents who used to often skip breakfast had lower adherence to the Healthy Beverage-DP and Healthy Snack Foods-DP, characterized by the consumption of healthy beverages in boys and healthy snack foods in girls. According to several authors, the habit of skipping breakfast may facilitate weight gain and overweight or obesity risk (41). This relationship could be explained by the fact that those adolescents skipping breakfast or consuming low energy at breakfast consume a high percentage of energy at other meal occasions, especially at dinner (51). In addition, several authors have observed that skipping breakfast was associated with high snacking consumption and an increased intake of low nutritional foods (52). In this sense, all these findings support the idea to support the breakfast consumption as a tool to improve the overall diet quality and nutrient adequacy.

Finally, adolescents considering that what they eat now will have a big impact on their future health had higher adherence to the Mediterranean-DP. In a previous study, it was suggested that parental perceptions regarding healthy eating are an important target for public health interventions because of the possible association between parental perception and child weight (53). On the other hand, eating

influences in adolescents like individual, social, environmental, community setting, or societal influences may explain the adolescents' eating behaviors and food intake (54). In a previous HELENA paper, it was observed that obese adolescents were not able to assess their diet quality regarding to their normal-weight peers (55).

Strengths and limitations

Our study has some limitations, including the lack of possibility to compare the results between countries. Furthermore, the food consumption and the adolescents' perception are based on self-reported questionnaires; however, the questionnaires have been tested and validated (28).

The principal strength of our study is the large sample and their geographical distribution across Europe. The standardized and harmonized methodology and the use of reliable and validated questionnaires are also an important strength. Moreover, the use of PCA to create DPs is also a strength. Besides, the use of DPs takes into account interactions among foods, which is not possible using the single food approach.

Conclusions

In the present study, we have analyzed the relationships between different DPs and healthy eating perceptions in a large group of European adolescents. Dietary habits are one of the key elements in the development of healthy lifestyles, especially from childhood. This is relevant because lifestyles acquired in these life stages are key factors in the development of diseases such as overweight and obesity.

In conclusion, we observed significant associations between different DPs and perceptions of healthy eating. Analyzing relationships between perceptions of healthy eating and food and beverage consumption should contribute to developing effective strategies to increase awareness of healthy lifestyles among young Europeans, and this in turn could influence food intake as well as other lifestyles. Investing in improving adolescents' knowledge can be a strategy to promote healthy habits and healthy lifestyles.

Conflict of interest

The authors declare no conflicts of interest.

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Author's contribution

J.D., C.G., M.G.G., S.H., A.K., M.K., C.L., Y.M., D.M., M.S., K.W. and L.M. conceived and designed study. N.G.L., A.M.S.P., and L.A. conducted the interpretation of data. N.G.L., A.M.S.P., L.B., J.D., A.O., C.G., M.G.G., S.H., A.K., M.K., C.L., Y.M., D.M., M.S., K.W., I.H., and L.M. critically reviewed the manuscript. N.G.L., A.M.S.P., and L.M. wrote the paper, and I.H. and L.B. participated in data interpretation. All the authors read and approved the final version of the manuscript.

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Appendix

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