Adolescents" diet quality in relation to their relatives" and peers" diet engagement and encouragement: the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) study

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ABSTRACT

Objectives: To examine the associations between adolescents' diet quality and their perceived relatives' and peers' diet engagement and encouragement.

Design: Cross-sectional study performed in European countries. Diet quality was scored using the Diet Quality Index for Adolescents (DQI-A) based on four components: quality, diversity, balance, and meal frequency. Perceived diet quality engagement and perceived encouragement of the relatives/peers were assessed using the questions, "How healthy is each of the following persons' diet?" and "How often does each of the following persons encourage you to eat a healthy diet?"

Setting: Vienna, Ghent, Lille, Athens, Heraklion, Pecs, Rome, Dortmund, Zaragoza, and Stockholm.

Subjects: 2943 healthy adolescents.

Results: The perceived engagement level of the mother, father and sister were positively associated with the DQI-A ($P < 0.05$). A positive association was found for the perceived engagement level of siblings, father and mother with all specific components ($P < 0.05$). DQI-A was negatively associated with the perceived encouragement level from a best friend and positively associated with the encouragement level of the mother and father ($P < 0.05$). Diversity, balance and quality components were positively associated with the perceived encouragement level from the mother and father ($P < 0.05$), whereas the best friend's perceived encouragement was negatively associated with meal frequency components ($P < 0.01$).

Conclusions: These findings highlight the role of social engagement and encouragement of relatives and peers in adolescents' diet quality. Intervention or promotion programs aimed at enhancing diet quality in adolescents should target both family and peers.

Keywords: Youth; Assessment; Nutrition; Family; Epidemiological study

Introduction

Adolescence is an important period in life that includes multiple physiological and psychological changes that have a considerable effect on dietary habits [1-2]. Unhealthy food consumption patterns during childhood and adolescence are linked with both the occurrence of obesity in youth and the later risk of developing diseases such as cancer, obesity, and cardiovascular diseases in adulthood [3].

Dietary habits are influenced by individual, social, and environmental factors, including food choice decisions, food choice motivations, religious adherence, food cravings, taste, hunger, time and effort required for food preparation and consumption, cost, body image, and socioeconomic status [4-8]. Dietary habits are also influenced by cultural traditions, which differ between countries [9-10]. Family and peers are considered to be important sociocultural influences that have a strong impact on dietary habits during adolescence [11-17]. Previous studies have consistently demonstrated the importance of parents to healthy eating habits during adolescence, specifically vegetable and fruit consumption [13, 16, 17]. Previous studies of both encouragement and engagement have also found that friends influence the intake of healthy foods, such as vegetables, energy drinks, snacks, desserts, fruits, whole grains, and biscuits [13-15]. However, previous studies have not included the influence of siblings' encouragement and engagement in terms of the diet. Moreover, the aim of previous research was to compare the social influence of parents and friends on eating attitudes of adolescents by focusing specifically on particular food groups [11-17]. To our knowledge, no previous studies have examined the influence of family and peers on the diet quality taking account into quality, diversity, equilibrium and meal frequency in adolescents.

Therefore, the aim of this study was to examine the associations between adolescents' diet quality and their perceived relatives' and peers' (father, mother, brothers, sisters, and best friend) diet engagement and encouragement.

Methods

Study design

This was a secondary data analysis of the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) Study (www.helenastudy.com) performed in European adolescents (2006-2007). The aim of the HELENA Study was to obtain a broad range of standardized, reliable, and comparable nutrition- and health-related data from a random sample of European adolescents aged 12.5-17.5 years.

The random selection of schools and classes was performed centrally. The first step of the recruitment strategy consisted of phone contact with the director/principal of the school. During the call, a meeting with the director/principal and main/principal teachers of selected classes was organized to present the study aims and procedures and obtain consent to participate. The second step consisted of a meeting with adolescents from selected classes and their main/principal teacher. During this meeting, the study aims, procedures, and tests were explained. Information and consent forms were then distributed, and the adolescents were asked to return the written/signed consent form (including the signatures of the adolescent and both parents) within a maximum of 2 weeks after the meeting. Table 1 presents an overview of the participation rate of the different sampling units for the whole study and for each center individually. In total, 3528 adolescents were included in the HELENA Study, 83% of whom completed the dietary habits questionnaire and were therefore included in the present study. The participants' characteristics are presented in Table 2. No significant differences were observed between the included and excluded adolescents' characteristics.

The local ethics committee for each country approved the HELENA study, 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.

Measurements

Assessment of relatives' diet engagement and encouragement

A self-administrated questionnaire was used to assess healthy diet determinants. A paper version of the questionnaire was administrated in a classroom under the supervision of a HELENA fieldworker. Two questions on engagement and encouragement were extracted for the present study [18]. The adolescents were asked about the perceived diet quality engagement of their relatives and peers (father, mother, brother(s), sister(s), and best friend(s) using the following question: "How healthy is each of the following persons' diet: (father, mother, sister(s), brother(s), best friend(s))?" The adolescents' perceived engagement of their relatives and peers was classified as low if the answer to the question was "very unhealthy" or "not very healthy," medium if "average" or "quite healthy," and high if "very healthy." The adolescents were also asked about the perceived diet encouragement provided by their relatives and peers using the following question: "How often does each of the following persons encourage you to eat a healthy diet: (father, mother, sister(s), brother(s), best friend(s))?" The answers were classified as low if the answer to the question was "not at all"

or ‘not much,” medium if “sometimes” or “often,” and high if “very often”. These questions regarding perceived relatives’ diet engagement and encouragement were extracted from a healthy diet determinants questionnaire that has been found to be valid and reliable [18].

Dietary habits

Dietary intake was assessed by two non-consecutive 24-h recalls performed on two convenient weekdays 1 week apart. The 24-h recalls were recorded using the self-administered, computer-based HELENA Dietary Intake Assessment Tool (HELENA-DIAT), which has been validated in European adolescents [19]. The HELENA-DIAT tool is based on intake assessments at six meal occasions (breakfast, morning snack, lunch, afternoon snack, evening meal, and evening snack) on the previous day. Trained dieticians assisted the adolescents to complete the 24-h recalls when needed. To calculate energy and nutrient intakes, data from HELENA-DIAT were linked to the German Food Code and Nutrient Database (*Bundeslebensmittelschlüssel*, version II.3.1) [20]. The Multiple Source Method was used to estimate the usual energy, nutrient, and food intakes.

The DQI-A is composed of four components—quality, diversity, equilibrium, and meal frequency—that were previously validated in the HELENA population [21–24]. Daily diet was divided into nine recommended food groups: (1) water, (2) bread and cereal, (3) potatoes and grains, (4) vegetables, (5) fruits, (6) milk products, (7) cheese, (8) meat, fish, and substitutes, and (9) fats and oils. Dietary quality indicated whether an adolescent made optimal food quality choices within a food group and was represented by a ‘preference group’ (i.e., the healthiest foods: cereal/brown bread, fresh fruit, and fish), an ‘intermediate group’ (e.g., white bread, minced meat), and a ‘low-nutrient, energy-dense group’ (i.e., the unhealthiest foods: soft drinks, sweet snacks, and chicken nuggets) using predefined criteria. The dietary quality score was then calculated by multiplying the amount of the food (in g) consumed with a weighing factor (+1 for the preference group, 0 for the intermediate group and –1 for the low-nutrient, energy-dense group) divided by the total amount of food (in g). The diet quality score was expressed as a percentage, meaning that it could vary between –100 and 100%. The diversity component corresponds to the degree of variation in the diet. The score was obtained by assigning 1 point for each food group that had at least one serving at the preference level, divided by 9 (which represents the maximum score), and then expressed as a percentage between 0 and 100%. Dietary equilibrium was calculated as the difference between the adequacy component (the percentage of food groups with intake above the minimum recommended value) and the excess component (the percentage of food groups exceeding the

upper level of the recommended intake) and ranged between 0 and 100%. Meal frequency was scored as 0 when no food was consumed and 1 when some food was consumed at each of the three main meal occasions. The scores for the three occasions were summed and expressed as a percentage; the possible scores were thus 0% (no consumption at any of the main meals), 33% (consumption at only one main meal), 66% (consumption at two main meals), and 100% (consumption at all three main meals).

The four DQI-A components are presented as percentages. The quality component ranged from –100% to 100%, whereas diversity, equilibrium, and meal ranged from 0% to 100%. The DQI-A was computed as the arithmetic mean of these four components; hence, the DQI-A ranged from –25% to 100%, with higher scores reflecting a higher-quality diet. The score was calculated for each day and the mean daily score was taken as the individual's overall index.

Participants' characteristics

Body weight was measured with the participant wearing light clothes and 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)/height^2 (m^2). The nutritional status was assessed using the International Obesity Task Force scale [25]. An extended and detailed manual of operations was designed for and thoroughly read by every researcher involved in fieldwork before the data collection started (Nagy et al., 2008). In addition, a workshop training week was carried out before the study began to standardize and harmonize the data collect methods. The instructions given to the participants for every measurement were standardized for all cities and translated into the local language.

Parental 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/isced97-en.pdf). Parental educational level was scored as 1 for primary and lower education (levels 0, 1, and 2 in the ISCED classification); 2 for higher secondary (levels 3 and 4 in the ISCED classification); and 3 for tertiary (levels 5 and 6 in the ISCED classification).

Statistical analysis

The data are presented as percentages for qualitative variables and mean ± SD for quantitative variables. Normality of distribution was checked graphically and by using the Shapiro–Wilk test.

To assess the potential bias related to missing or incomplete data for the DQI-A, the main adolescent characteristics were compared between adolescents with and without DQI-A data using Student's *t* test for quantitative variables, the chi-square test for categorical variables, and the Mantel–Haenszel trend test for ordered categorical variables (Table 1)..

We examined the association between the oDQI-A (overall index and each component) and each perceived relative's and peer's diet and encouragement levels using linear mixed models adjusted for prespecified confounding factors, including age, sex, and parental educational level as fixed effects, and city, city*school, and city*school*class as random effects [21,26–27]. The adjusted means for the DQI-A ± SEM were calculated using the least-square means. Because the perceived relatives' diet or encouragement levels were classified into three ordered levels, we used linear contrasts to perform trend test. Comparisons of overall DQI-A between the 10 perceived relatives' diet or encouragement levels (main objective) were adjusted for multiple comparisons using the false discovery rate controlling method [28].

To avoid case deletion in the analyses, missing data were imputed by multiple imputations using the regression-switching approach (chained equations with $m = 20$ imputations obtained using R statistical software, version 3.03) [29]. The imputation procedure was performed under the missing-at-random assumption using all adolescents' characteristics, relatives' and peers' diet engagement and encouragement, DQI components with the predictive mean-matching method for quantitative variables, logistic regression model for binary variables, and ordinal logistic regression for ordered categorical variables. Rubin's rules were used to combine the estimates derived from multiple imputed data sets [30]. We performed a key subgroup analysis according to sex for the associations of overall DQI-A and meal frequency component with each perceived relative's diet and encouragement levels. Inclusion of the corresponding interaction term into the multivariable linear mixed model was used to assess heterogeneity.

All statistical tests were done at the two-tailed α level of $P < 0.05$. Data were analyzed using SAS software (version 9.3; SAS Institute Inc., Cary, NC).

Results

Physical characteristics of subjects are presented in Table 1.

The adolescents' DQI-A score was positively and significantly associated with their perceived mother's, brother's, and sister's diet engagement (Table 3). Having a high level of perceived mother's, brother's, and sister's engagement resulted in 6%, 5%, and 4% higher diet quality scores, respectively, compared with the low level (Table 3). We found also significant positive associations between perceived sister's diet engagement and the adolescents' quality component (39.5 ± 2.8 vs. 43.2 ± 1.8 vs. 48.1 ± 2.6 for low, medium, and high, respectively; $P = 0.004$; + 21.7%) (Fig. 1). Similarly, a significant positive association was observed between perceived brother's diet engagement and the diversity component (72.4 ± 1.1 vs. 73.9 ± 0.9 vs. 76.2 ± 1.3 for low, medium, and high, respectively; $P = 0.003$; + 5.2%), perceived father's diet engagement and the balance (40.1 ± 0.6 vs. 41.0 ± 0.3 vs. 41.5 ± 0.5 for low, medium, and high, respectively; $P = 0.047$; + 3.5%) and diversity components (72.7 ± 1.1 vs. 73.6 ± 0.9 vs. 75.1 ± 1.1 for low, medium, and high, respectively; $P = 0.003$; +3.3%), and between perceived mother's diet engagement and the balance (39.3 ± 0.9 vs. 40.8 ± 0.3 vs. 41.9 ± 0.4 for low, medium, and high, respectively; $P = 0.005$; + 6.6%) (Fig. 1). Similar findings were observed for the diversity (71.2 ± 1.4 vs. 73.4 ± 0.9 vs. 75.3 ± 0.9 for low, medium, and high, respectively; $P = 0.005$; + 5.7%) and meal components (89.8 ± 1.0 vs. 91.7 ± 0.7 vs. 92.6 ± 0.8 for low, medium, and high, respectively; $P = 0.023$; + 3.1%) (Fig. 1).

The DQI-A score was significantly negatively associated with the perceived best friend's encouragement and positively associated with the perceived father's and mother's encouragement (Table 4). Having a high level of perceived best friend's father's and mother's encouragement resulted in 4%, 4.4%, and 4.4% higher diet quality scores, respectively, compared with the low level (Table 4). The perceived father's encouragement level was positively and significantly associated with the quality, diversity, and balance components (Fig. 2). The differences observed in the diet quality score between the low and high levels of perceived father's encouragement were 13.4%, 3.9%, and 3.2% for the quality, diversity, and balance components, respectively (Fig. 2). Positive associations were also found between the perceived mother's encouragement and the quality, balance, and diversity components. Differences observed in the diet quality score between the low and high levels of perceived mother's encouragement were 13%, 4%, and 5.5% for the quality, balance, and diversity components, respectively (Fig. 2). Another positive association was found between the perceived sister's diet encouragement and the balance component with a difference of 4.6% in diet quality score between the low and high perceived encouragement levels (Fig. 2). The perceived best friend's encouragement was negatively associated with the meal component

with a difference of 3.7% in the diet quality score between the low and high perceived encouragement levels (Fig. 2).

The association between adolescents' DQI-A and perceived mother's diet encouragement was stronger in boys than in girls, although the heterogeneity test did not reach the level of significance (*P* for heterogeneity = 0.089). In boys, the adjusted mean DQI ± SEM was 58.8 ± 1.1 vs. 61.0 ± 0.9 vs. 62.2 ± 1.1 for the low, medium, and high perceived mother's diet encouragement levels, respectively (*P* for trend = 0.002). By contrast, in girls, the adjusted mean DQI ± SEM was 63.1 ± 1.1 vs. 64.1 ± 0.8 vs. 64.7 ± 0.8 for the low, medium, and high perceived mother's diet encouragement levels, respectively (*P* for trend = 0.12). We found no other significant heterogeneity based on the adolescents' sex (data not shown).

Discussion

Our study aimed to investigate the associations between adolescents' diet and their perceived relatives' and peers' (father, mother, brothers, sisters, and best friends) diet engagement and encouragement. Since our study directly addressed adolescents, we only have information about perceived engagement and encouragement; relatives' and peers' engagement and encouragement were not directly assessed. Although we acknowledge that this could have influenced our results, we believe that adolescents' perceptions influenced their own diet quality more than relatives' or peers' engagement and encouragement.

The main finding of our study is that both perceived relatives' diet engagement and encouragement were associated with the diet quality of the adolescents studied. However, the magnitude of the associations with the adolescents' DQI-A scores varied according to the perceived parent's, family's, or peer's diet engagement and encouragement. A strong positive association between the perceived mother's diet engagement and the adolescents' diet quality was found. This shows that mothers play a key role in family food choices, including adolescents' choices [31-32]. This is consistent with previous studies showing the importance of mothers to adolescents' meals [33]. This finding also confirms that the perceived mother's engagement is associated with adolescents' diet quality. This finding also concurs with previous studies showing that mother–adolescent communication is more effective than father–adolescent communication in changing adolescents' nutritional behavior [34-35]. Our finding is also consistent with the results of the Healthy Eating Questionnaire, which showed that the mother is the family member most likely to promote healthy dietary habits [36]. However, we also found an association between perceived fathers' encouragement and

adolescents' diet quality. No previous studies have assessed the influence of brothers and sisters, and our data show for the first time a positive relationship between their perceived diet engagement or encouragement and adolescents' diet quality, balance, and diversity components. This outcome shows the importance of siblings on the diet quality of the adolescent. Therefore, this is suggest that intervention programs that aim to enhance diet quality in adolescent populations might be more successful if parents and siblings are also included in the intervention. Our results concur with previous published studies showing that youth diet behaviors, particularly in obese pediatric patients, may be improved when parents attend and are directly involved with services and are provided with training in the skills required to support lifestyle modifications in accordance with expert guidelines [37–40]. In this context and from a practical point of view, primary care may play a major role in the improvement of parenting behaviors linked to child health [41,42]. Indeed, children and adolescents, most of the time accompanied by their parents, regularly access primary care where specialists or generalist physicians are present. Even if health care providers report having inadequate time and a lack of expertise and resources to effectively work with parents and provide key messages regarding a healthy lifestyle, attempting to implement a specific time for discussion with parents and siblings during primary care visits remains important [43]. This point of view is supported by several committees' recommendations regarding the prevention and treatment of youth overweight and obesity and the promotion of family-centered interventions in primary care [44,45]. Caregivers' policies should be discussed and new ways to address child and family care should be created for care providers such as pediatricians, family physicians, nurse practitioners, and physicians' assistants. Concerning the roles of siblings, few existing preventive interventions target sibling relationships [46]. Therefore, clinicians should also consider offering specific sessions for siblings that focus on healthy eating habits and instruction regarding how to promote and reinforce these habits among their siblings.

Most of the previous studies of the influence of relatives and peers have focused on the dietary behaviors of girls, and few studies have also included boys [47-48]. A significant difference between girls and boys was found only for the association between adolescents' DQI-A score and perceived mother's diet encouragement. In contrast to the results of previous studies of dietary behaviors, we found that girls' diet quality did not correlate with the perceived mother's diet encouragement [47]. Indeed, it has been shown that weight control behaviors among young girls are modeled partially on their mothers' behaviors [47,49,50]. In the present study, we focused on diet quality components, but not directly on weight control.

During the transition from childhood to adolescence, children decrease the time spent with parents, and spend more time alone and/or with friends [48]. One unexpected finding of our study is the negative association between perceived encouragement of peers to eat healthily and adolescent unhealthy food consumption. This also contrasts with a recent study showing that friends' unhealthy food consumption was associated with an individual's unhealthy food consumption, although that study examined consumption rather than encouragement [51]. One possible explanation is that those adolescents with unhealthy food consumption are encouraged by their peers to eat more healthily, independently of their peers' food consumption habits. Differences in our study in the associations between the adolescents' DQI-A scores and the perceived relatives (positive association) and perceived peers (negative association) diet engagement might reflect a better awareness of healthy lifestyle in adults than in adolescents. However, the influence of the relatives may have also had adverse effects in the medium term [52]. Indeed, if perceived relatives' engagement or encouragement is too important, it could lead to eating disorders and have a negative impact on future health. Several studies have highlighted concerns about the effectiveness of their role in dieting and the potential for increasing the risk of unintentional weight gain, disordered eating, and eating disorders [52–57].

The strengths of the study are the large sample size of adolescents with sex-specific information in 10 European cities, the use of standardized procedures, the inclusion of many confounding factors in the analyses, and the strong methodology for assessing dietary habits [58]. The limitations of the study include the cross-sectional and observational design to examine the associations, which cannot be interpreted to reflect causal relationships. The proxy report of the parent's, family's, and peer's diet engagement and encouragement is another limitation that could lead to misclassification. Moreover, we cannot rule out bias because of the estimated values for missing data, as the multiple-imputation procedure to replace missing values with a set of plausible values was done under a missing-at-random assumption. Finally, in the present study, we found that the mean differences between variables was low, which raises the question of their clinical significance..

In conclusion, our findings highlight the role of social encouragement and engagement in adolescents' diet quality. Implementing intervention or promotion programs that aim to encourage a healthy diet in adolescents might be more successful if the family and peers are also targeted. Indeed, interventions aimed at improving diet quality in young people might be more successful when family members are also encouraged to engage in healthy diet quality and support adolescents' diet quality. Another important point is the fact that adolescents'

perceptions of their peers'/families' engagement/encouragement may also play a major role in their dietary quality and should be addressed in intervention programs focusing on adolescents.

Acknowledgements

The authors thank the participants for taking part in the study.

Financial Support

The HELENA study is made possible by the financial support of the European Community Sixth RTD Framework Programme (Contract FOOD-CT-20056007034) and the Spanish Ministry of Science and Innovation (RYC-2010-05957 and RYC-2011-09011). 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.

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Legends

Figure 1. Adolescent's diet components, measured by the HELENA-Diat, according to relatives' and peers' diet engagement

Figure 2. Adolescent's diet components, measured by the HELENA-Diat, according to relatives' and peers' encouragement

Table 1. Number of approached/participating classes and adolescents in the HELENA study†

Centers	Athens	Dortmund	Gent	Heraklion	Lille	Pecs	Roma	Stockholm	Vienna	Zaragoza
Number of eligible schools in the city	82	55	43	22	40	12	290	25	347	83
Number of schools approached/participating	17/10	14/11	11/9	11/10	13/12	8/7	18/10	14/10	23/13	16/12
Number of classes approached/participating	14/14	23/23	20/19	22/20	19/18	24/14	24/22	25/23	35/19	26/23
Number of adolescents approached in all approached classes	458	603	429	429	538	720	420	645	870	597
Number of adolescents approached in all participating classes/adolescents participating	458/370	603/515	413/347	400/340	508/308	420/401	430/339	535/377	536/427	537/441
Number of adolescents included in HELENA Study	321 (70%)*	476 (79%)*	336 (78%)*	284 (66%)*	287 (53%)*	394 (55%)*	304 (65%)*	341 (53%)*	403 (63%)*	382 (64%)*

† data collected from 2006 to 2007

* Percentage calculated to reflect ratio of selected adolescents for statistical analysis to adolescents approached in all approached classes

Table 2. Characteristics of the population

	Before imputation		After imputation
	Without missing DQI-A	**With missing DQI-A**	
N	2943	585	3528
Sex (%*M*)	47.2	50.3	47.7
Age (*yr*)	14.8 ± 1.2	14.5 ± 1.2 *	14.7 ± 1.2
Height (*cm*)	166.2 ± 9.2	163.8 ± 8.7 *	165.8 ± 9.1
Body mass (*kg)*	59 ± 12.7	59.9 ± 12.9	59.1 ± 12.7
Z-score BMI	0.32 ± 0.9	0.62 ± 0.9 *	0.37 ± 0.9
Nutritional status (%*UW/%NW/%OW/%O*)[a]	6.7/72/16.4/4.9	3.1/64.6/22.9/9.4 *	6.1/70.8/17.5/5.6
Father education level (%*I/%II/%III*)[b]	37.4/27/35.6	39.9/32/28.1 *	38.7/27.5/33.8
Mother education level (%*I/%II/%III*)[b]	34/30.9/35.1	40.2/33.9/25.9 *	35.5/31.0/33.5

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

[b] Education level: lower education (I); higher secondary education (II); higher education or university degree (III).

* $p<0.05$ for comparison between the two samples, without and with missing data on DQI-A.

Table 3. DQI-A according to their relatives' and peers' diet engagement

Relatives	Diet engagement	N	Mean DQI-A (SEM)	P*
Father				
	Low	475	62.07 (0.98)	
	Medium	2447	62.21 (0.68)	0.077
	High	606	63.92 (0.84)	
Mother				
	Low	203	60.13 (1.27)	
	Medium	2413	62.21 (0.67)	**0.008**
	High	912	63.74 (0.77)	
Brother				
	Low	757	61.84 (0.81)	
	Medium	2443	62.36 (0.68)	**0.008**
	High	328	64.93 (1.06)	
Sister				
	Low	458	61.03 (1.00)	
	Medium	2622	62.53 (0.67)	**0.032**
	High	448	63.45 (0.99)	
Best friend				
	Low	612	62.01 (0.86)	
	Medium	2651	62.75 (0.67)	0.36
	High	265	60.98 (1.16)	

Number, adjusted mean (SEM) and P-value for trend across relatives' diet engagement were calculated using linear mixed models including age, sex, and parental educational level as fixed effects and city, city*school and city*school*class as a random effects after handling missing data by multiple imputation.

* controlled for multiple comparisons using the false discovery rate method.

Table 4. DQI-A according to their relatives' and peers' diet encouragement

Relatives	Diet encouragement	N	Mean DQI-A (SEM)	P*
Father				
	Low	1097	61.52 (0.73)	
	Medium	1791	62.46 (0.68)	**<0.001**
	High	640	64.23 (0.87)	
Mother				
	Low	612	60.77 (0.82)	
	Medium	1865	62.50 (0.67)	**<0.001**
	High	1051	63.46 (0.75)	
Brother				
	Low	2412	62.46 (0.68)	
	Medium	893	62.18 (0.79)	0.23
	High	223	64.10 (1.34)	
Sister				
	Low	2194	62.10 (0.67)	
	Medium	1030	63.10 (0.79)	0.32
	High	304	63.36 (1.26)	
Best friend				
	Low	2235	62.71 (0.69)	
	Medium	1069	62.51 (0.78)	**0.040**
	High	224	60.20 (1.25)	

Number, adjusted mean (SEM) and P-value for trend across relatives' diet engagement were calculated using linear mixed models including age, sex, and parental educational level as fixed effects and city, city*school and city*school*class as a random effects after handling missing data by multiple imputation.

* controlled for multiple comparisons using the false discovery rate method

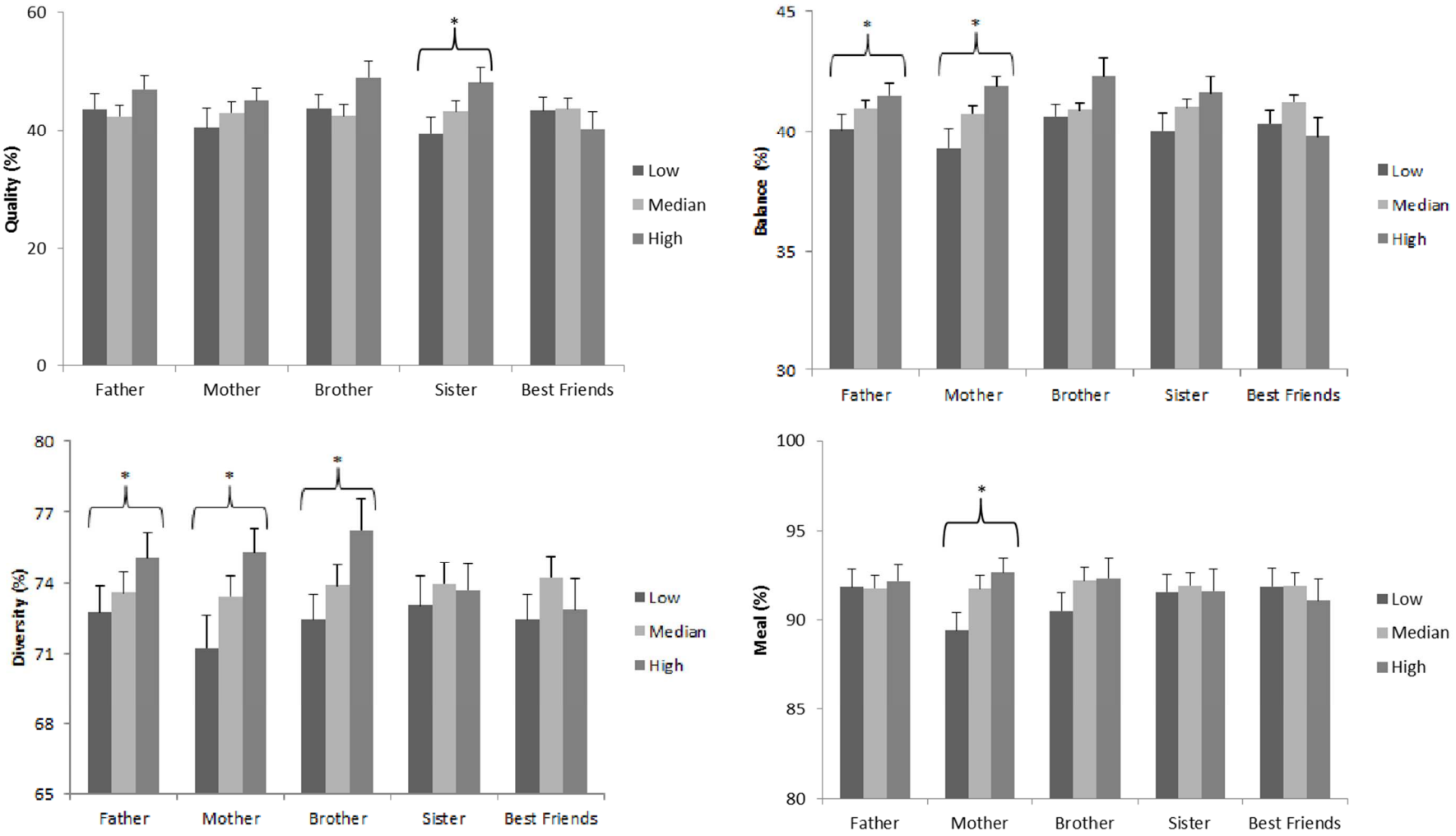

Figure 1. Adolescent's diet components measured by the HELENA-Diat, according to their relatives' and peers' diet engagement.
Values are mean (SEM) of each component, calculated using linear mixed models including age, sex, and parental educational level as fixed effects and city, city*school ans city*school*class as a random effect after handling missing data by multiple imputation. * Adjusted P-values for trend < 0.05 across the relatives' engagement

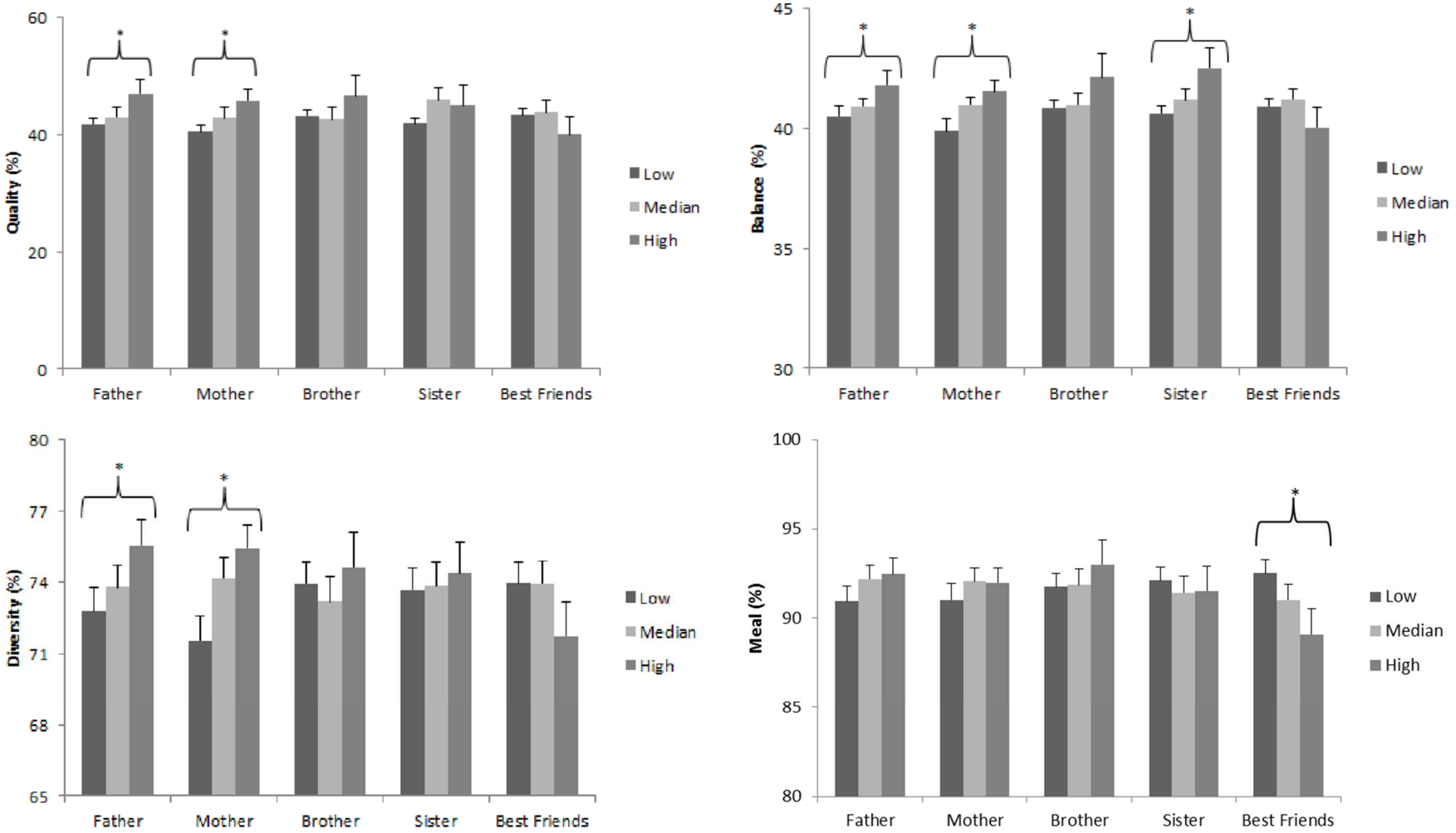

Figure 2. Adolescent's diet components measured by the HELENA-Diat, according to their relatives' and peers' diet encouragement.
Values are mean (SEM) of each component, calculated using linear mixed models including age, sex, and parental educational level as fixed effects and city, city*school ans city*school*class as a random effect after handling missing data by multiple imputation. * Adjusted P-values for trend < 0.05 across the relatives' encouragement