Adherence to the Mediterranean diet and specific lifestyle habits are associated with academic performance in Greek adolescents

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Abstract.
PURPOSE: The purpose of the study was to explore possible links between adherence to the Mediterranean diet (MeD), general dietary behaviors, energy balance behaviors, excess body weight, other lifestyle habits and academic performance in Greek adolescents.
METHODS: A total of 520 students (256 boys; 264 girls), 15–18 years old, were recruited from the four Departments of Secondary Education in the area of Athens, Greece. Students completed a specifically designed energy balance behaviors questionnaire together with the KIDMED index, which evaluates the degree of adherence to the MeD. In addition, various other questionnaires were used such as the Physical Activity and Lifestyle Questionnaire (PALQ), the STAI questionnaire to measure anxiety levels, the Self-Perception Profile for Adolescents (SPPA) and selected subscales of the Multidimensional Body-Self Relations Questionnaire (MBSRQ) to assess the adolescents' attitudes towards health. Academic performance was assessed using the students' average score for all school subjects. Standard anthropometric measurements were also taken.
RESULTS: Block stepwise regression analysis was conducted. Results indicate that family meals ($\beta = 0.087$, $P = 0.017$), adherence to the MeD (0.176, $P = 0.001$), soft drinks consumption ($\beta = -0.104$, $P = 0.004$), TV viewing ($\beta = -0.068$, $P = 0.047$) and smoking ($\beta = -0.159$, $P = 0.001$) are significant factors in predicting academic performance in adolescents.
CONCLUSION: Poor adherence to the MeD, small number of family meals, high soft drinks consumption and smoking, may have a negative influence on academic performance in adolescents.

Keywords: Mediterranean diet, soft drinks consumption, academic performance, adolescents, family meals

1. Introduction

Determining factors related to school performance in adolescents is very important because academic grades seem to influence future educational attainment, which, in turn, affect quality of life and health [1–4]. There is evidence that adolescents who consume a healthy balanced diet [5–7] and who have high levels

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of physical activity [8–10], have better cognitive and academic performance. Excess body weight on the other hand, seems to adversely affect the academic performance of adolescents [11]. There is evidence that factors such as gender; ethnicity, school environment, school experience, child health, and socioeconomic status [12–15] are implicated in school performance. In addition, disordered eating behaviors and poor dietary quality [16], excess body weight [5], low levels of physical activity, increased screen time [17, 18] and lack of adequate sleep [19] can negatively predict the emotional, psychological and cognitive functioning of students. It also has to be underlined, that in the adolescent years, students tend to start tobacco smoking and alcohol drinking, behaviors which could both directly and indirectly affect performance at school [20, 21].

The great majority of the nutritional studies on academic performance to date have mainly focused on the effect of hunger, malnutrition, and specific micronutrient deficiencies [22–24]. As it is anticipated, nutritional deficiencies in children have been linked with decreased attendance, attention, and academic performance and with more health problems in comparison to children with no nutritional deficiencies [22–24]. It has to be noted that even short term fasting, such as skipping breakfast, has been associated with a decreased cognitive ability in adolescents [25].

The prevalence of adolescent obesity in Greece is amongst the highest in Europe and adherence to the Mediterranean diet (MeD) in the youth is low [26]. Adolescents shifted from the traditional MeD towards a less healthy diet behavior [27]. The MeD is characterized by an abundance of plant foods, moderate amounts of dairy products, low to moderate amounts of fish and poultry, red meat in low amounts, and olive oil as the main source of fat in the diet. It is well documented that greater adherence to the MeD is associated with a significant improvement in general physical and psychological health, longevity and lower levels of obesity [28–30]. The possible role of the MeD on academic performance in adolescents has not been thoroughly investigated in the past. To the best of our knowledge, only two studies so far, investigating the possible role of the MeD on academic performance in the youth, have been conducted. Both studies showed that poor adherence to MeD is a potential determinant of poor academic performance in primary school children and adolescents [31, 32].

The purpose of the study was to investigate the possible role of adherence to the MeD, excess body weight and selected energy balance behaviours, on academic performance in Greek adolescents.

2. Methods

2.1. Participants

A total of 520 students 15–18 years old, were recruited from the four Departments of Secondary Education in the area of Athens, Greece. Prior to acceptance, students' parents or guardians were fully informed about the objectives and methods of the study and signed to indicate their informed consent. From a sample of 822 parents, parental consent was received for 567 students, giving an average response rate of 69%. Fifteen participants did not complete all of the questionnaires and were excluded from the analyses in the current study and 32 students were absent from school at the day of the research. The final sample consisted of 520 children (256 boys and 264 girls). Approval to conduct the study was granted by the Greek Pedagogical Institute, the Ethical Committee of Harokopio University and from the Head Teachers of the schools.

2.2. Procedures

The students were instructed to complete the entire questionnaire and ask for help if they had any problems or any questions for clarification. They were clearly informed that they could stop participating to the study, at any time, without consequences. Students' questionnaires were administered by the researcher and were completed in the classroom during class time. During the survey, both students' teacher and the researcher were present.

The completion of the questionnaire lasted on average 50 minutes. After the completion of the questionnaires the anthropometric measurements were conducted.

2.3. Study design

2.3.1. Academic performance
Academic performance was assessed using the students' average score (grade point average) of the previous semester for all school subjects. The average score was obtained from the school's archives.

2.3.2. General background and energy balance behaviors questionnaire
A specially designed self-administered questionnaire was used to collect information from students such as: gender, class attendance, year of birth, occupation and educational level of both parents. Adolescents also had to complete a self-administered questionnaire about their general eating habits and dietary behaviors, such as consumption of water, soft drinks, breakfast consumption, number of daily meals and meals consumption with family members, and fast food intake. Moreover, the time spent on sedentary activities during the day (e.g. TV viewing, video games and internet) and the hours of sleep was recorded. Finally, students were asked to answer questions related to alcohol intake and smoking habits.

2.3.3. Assessment of diet quality
The adherence to the MeD was assessed through the KIDMED, a Mediterranean diet quality index. The KIDMED index was developed in an attempt to combine the MeD guidelines for adults as well as the general dietary guidelines for children and adolescents in a single index [33]. It is based on the principles sustaining healthful, Mediterranean-style dietary patterns (e.g. daily fruit and vegetable consumption, weekly fish and legumes intake), as well as on those that do not support the Mediterranean-style dietary patterns (e.g. frequent intake of fast food, increased consumption of sweets). The index comprises 16 yes-or-no answers to questions. Questions denoting a negative connotation are assigned a value of -1 and those with a positive aspect +1. The total score ranges from 0 to 12 and it is divided into 3 levels. 0–3: diet quality is very low; 4–7: an improvement is needed to adjust intake to follow a Mediterranean-style diet; and 8–12: Mediterranean-style diet is optimal.

2.3.4. Assessment of physical activity
The Physical activity and lifestyle questionnaire (PALQ) is a self-administered questionnaire and is designed to assess the physical activity of ages 10 to 18 years [34, 35]. The questionnaire has two parts: Part 1 records the physical activity during leisure time and Part 2 records the physical activity during the last 7 days. The scoring procedure results in a total score of energy expenditure for each responder that can be calculated using the Compendium of Physical Activities [35]. According to their score, subjects are assigned to one of four categories: very inactive, inactive, moderately active and active. For the purposes of this study only the second part of the PALQ was used.

2.3.5. Assessment of students' anxiety levels
To measure anxiety the Greek version of the State-Trait Anxiety Inventory (STAI) questionnaire [37] was used. It is a questionnaire that consists of two forms (State and Trait anxiety) of 20 items each, that ask the students how they feel generally (trait anxiety scale) and how they feel at a particular moment (state anxiety scale). The total score ranged from 20 to 80. For the purpose of this study, only the trait anxiety scale was used.

2.3.6. Assessment of adolescents' self-perception and self-esteem
In order to assess the adolescents' self-perception and self-esteem, the Self-Perception Profile for Adolescents was used [38], as adapted for use with Greek students. This scale contains eleven separate subscales measuring specific domains of self-perception and one subscale assessing adolescents' general evaluations of self-esteem.

For the present study, only five specific domains (scholastic competence, athletic competence, social acceptance, mathematics competence and Greek language competence) were used, as well as global self-esteem. Items are scored 4, 3, 2, or 1, where a score of 4 represents the highest self-perception and 1 represents the lowest self-perception.

2.3.7. Assessment of adolescents' attitudes towards health

The Multidimensional Body-Self-Relations Questionnaire (MBSRQ) was used to assess the adolescents' attitudes towards health [38] and it has been used in studies in Greece [40]. The MBSRQ is a self-report questionnaire used for the assessment of a person's attitude toward their body image. This questionnaire uses 10 subscales to evaluate peoples' attitudes to their bodies based on evaluation of themselves, their appearance, their fitness, and how healthy they believe themselves to be. The MBSRQ uses a 5-point Likert-type scale ranging from 1 (definitely disagree) to 5 (definitely agree). For the present study, only two subscales (health orientation and illness orientation) were used.

2.3.8. Anthropometric measures

All measurements were performed during morning hours. Standing height was measured using a portable direct-reading stadiometer to the nearest 0.1 cm. Body weight was measured to the nearest 0.1 kg using a digital scale. Adolescents were dressed in light clothing and measured without shoes. Body mass index (BMI) was calculated by dividing weight (in kilograms) by the square of the height (in meters). Overweight and obesity was defined using age and sex specific BMI cut-off points by International Obesity Task Force [41]. Waist circumferences were also measured with a non-elastic tape at the level of the umbilicus and with the subject at a standing position. Abdominal obesity was defined using age and sex specific Waist circumferences cut-off points derived from the Third National Health and Nutrition Examination Survey data (NHANES III) for European-American adolescents [42].

3. Data analysis

The collected data were analyzed using descriptive statistics for calculating the means and standard deviations of continuous variables and the frequencies and percentages of categorical variables. Comparisons between different variables for each gender group of the study were made using the χ^2-test. Both the Pearson and Spearman Rank Order coefficient were used to test for possible correlations among the different variables tested. Multiple regression analysis was conducted in order to explore potential factors that are associated with adolescents' academic performance. Normality of residuals, linearity, homoscedasticity, serial independence and colinearity of the variables were taken into account before deciding on the linear regression model. A *p*-value of less than 0.05 was considered statistically significant. Data were analyzed by using the Statistical Package for the Social Sciences (version18.0, SPSS, Chicago, IL, 2009) software.

4. Results

The baseline characteristics of the adolescents are shown in Tables 1 and 2 and the parental education level is presented in Table 3. Adherence to the MeD was classified as poor for 9% of the adolescent, average for 65% and good for 26%. It is important to note that only 47% of the adolescents in total (42% for boys), reported that they were consuming at least one meal per day with one family member (Table 1). Using the International Obesity Task Force cut off points, 23% of the adolescents classified as overweight and 2.1% were classified as obese, and 19% of the adolescents were classified as abdominally obese.

Table 1
Adolescents' anthropometric, psychometric, and dietary characteristics data ($n = 520$)

| | Males | Females | All subjects |
| | $n = 256$ | $n = 264$ | $n = 520$ |
	Mean (SD)	Mean (SD)	Mean (SD)
Weight (kg)	71.6 (11)	59.4 (9.1)	65.4 (11.9)
Height (cm)	1.77 (0.06)	1.65 (0.05)	1.71 (0.08)
BMI (kg/cm^2)	22.6 (3)	21.6 (2.9)	22.1 (3)
Waist circumference (cm)	86.7 (8.5)	77.7 (8.85)	82.2 (9.8)
STAI A-Trait (20–80)	37.82 (8.3)	41.04 (8.6)	39.45 (8.6)
Self-esteem (1–4)	3.09 (0.4)	2.96 (0.6)	3.02 (0.5)

| | Males | Females | All subjects |
	n (%)	*n (%)*	*n (%)*
BMI category			
Normal weight	177 (69)	212 (80)	389 (75)
Overweight	71 (28)	49 (19)	120 (23)
Obese	8 (3.1)	3 (1.1)	11 (2.1)
Abdominal obesity category			
Normal	205 (80)	216 (82)	421 (81)
Obese	51 (20)	48 (18)	99 (19)
Adherence to Mediterranean diet by KIDMED index scores			
Good (≥8)	66 (26)	68 (26)	134 (26)
Average (4–7)	168 (65)	170 (64)	338 (65)
Poor (≤3)	22 (8)	26 (10)	48 (9)
Soft drinks consumption			
0	35 (14)	57 (22)	92 (18)
1–3 per month	57 (22)	101 (38)	158 (30)
1 per week	54 (21)	55 (21)	109 (21)
2–4 per week	59 (23)	27 (10)	86 (17)
5–6 per week	17 (6, 6)	8 (3)	25 (4, 8)
1 per day	19 (7.4)	11 (4.2)	30 (5.8)
2–3 per dy	15 (5.9)	5 (1.9)	20 (3.8)
Number of meals per day with family member/s			
0	29 (11)	40 (15)	69 (13)
1	108 (42)	135 (51)	243 (47)
2	87 (34)	60 (23)	147 (28)
3	29 (11)	26 (9.8)	55 (11)
4	3 (1.2)	3 (1.1)	6 (1.2)

The trait anxiety score is higher in girls than in boys, however, the difference is not statistically significant (Table 1). Sixty four percent of the adolescents slept for less than 8 hours per day and 52% and 32% had low and medium levels of physical activity, respectively. Boys tended to engage in more vigorous physical activities than girls and this gender difference is statistically significant ($\chi^2 = 33.9$, df = 2, $p < 0.01$). Similarly, boys are more engaged with video games or online games than girls and this gender difference is also statistically significant

Table 2
Adolescents' lifestyle characteristics data ($n = 520$)

	Males $n = 256$	Females $n = 264$	All subjects $n = 520$
	n (%)	n (%)	n (%)
Smoking (yes)			
Yes	65 (25)	47 (18)	112 (22)
Cigarettes per day			
0	191 (75)	217 (82)	408 (78)
<10	52 (20)	30 (11)	82 (16)
10–15	7 (2.7)	11 (4.2)	18 (3.5)
15–20	2 (0.8)	4 (1.5)	6 (1.2)
>20	4 (1, 6)	2 (0.8)	6 (1.2)
Physical activity levels			
Low	100 (39)	168 (64)	268 (52)
Moderate	98 (38)	70 (27)	168 (32)
High	58 (23)	26 (9.8)	84 (16)
Sleep duration			
<8	165 (65)	165 (63)	165 (63)
8-9	82 (32)	93 (35)	93 (35)
>9	9 (3.5)	6 (2.3)	6 (2.3)
TV watching (hours/day)			
No	17 (6.6)	9 (3.4)	26 (5)
<0.5	18 (7)	28 (11)	46 (8.8)
>0.5–1	79 (31)	86 (33)	165 (32)
>1–3	114 (45)	109 (41)	223 (43)
>3–4	22 (8.6)	25 (9.5)	47 (9)
>4	6 (2.3)	7 (2.7)	13 (2.5)
Video-on line games (hours/week)			
No	5 (2)	13 (4.9)	18 (3.5)
<1	11 (4.3)	28 (13)	39 (7.5)
>1–3	58 (23)	90 (34)	148 (29)
>4–6	65 (25)	52 (20)	117 (23)
>7–9	42 (16)	41 (16)	83 (16)
>9	75 (29)	40 (15)	115 (22)

Table 3
Parental education level ($n = 520$)

Parental education	Father	Mother
	n (%)	n (%)
Primary school	20 (3.8)	19 (3.7)
High school graduate	281 (54)	279 (54)
College diploma	12 (2.3)	16 (3.1)
University degree	168 (32)	180 (35)
Med, MSc, MBA, PhD	39 (7.5)	26 (5.0)

Table 4
Correlation coefficients between adolescents' academic performance and socioeconomic, anthropometric, dietary and lifestyle characteristics

	Pearson's r	Spearman's rho
Father's educational level		0.38**
Mother's educational level		0.46**
BMI	–0.11**	
Abdominal obesity	–0.11**	
TV viewing		–0.33**
Time spent on video – internet games		–0.12**
Smoking		–0.30**
Number of meals		0.19**
Number of meals (with family)		0.24**
Adherence to the MD		0.34**
Soft drinks consumption		–0.24**
Trait anxiety level	–0.08*	
Global self-esteem	0.11**	
Health orientation	0.11*	

$^{**}p < 0.01$; $^{*}p < 0.05$.

($\chi^2 = 29.8$, df = 5, $p < 0.01$). Finally, most children spend one to three hours daily watching TV (43%). Apart from the differences in the levels of physical activity and video or online games, no other statistically significant differences were revealed between boys and girls for the variables in Tables 1 and 2.

The correlation coefficients between academic performance and different variables measured are shown in Table 4. There were significant negative correlations between academic performance and BMI ($P < 0.01$), abdominal obesity ($P < 0.01$), trait anxiety level ($P < 0.01$), screen time ($P < 0.01$), time spent on video games or internet ($P < 0.01$), and smoking ($P < 0.01$) and positive correlations with total meals per day with the family ($P < 0.01$), adherence to the MeD, global self-esteem ($P < 0.01$) and health orientation ($P < 0.05$) (Table 2).

Finally, multiple regression analysis has shown that increased number of meals with family ($\beta = 0.087$, $P = 0.017$) and adherence to the MeD ($\beta = 0.176$, $P = 0.001$) are significant factors positively predicting academic performance, whereas, frequent consumption of soft drinks ($\beta = –0.104$, $P = 0.004$), TV viewing ($\beta = –0.124$, $P = 0.001$) and smoking ($\beta = –0.159$, $P = 0.001$) are significant factors negatively predicting academic performance, in adolescents (Table 5). In addition, strong predictors of academic performance were the paternal ($\beta = 0.154$, $P = 0.001$) and maternal education level ($\beta = 0.261$, $P = 0.001$) as well as the ethnicity of the mother ($\beta = –0.124$, $P = 0.001$).

5. Discussion

The current study was set out to concurrently investigate the possible role of the MeD, excess body weight and selected energy balance behaviors on academic performance in adolescents. The study has shown that poor adherence to the MeD, few meals with family, smoking and soft drinks consumption seem to negatively predict academic performance in children.

More specifically, the level of adherence to the MeD in this sample of children was unsatisfactory, with only 26% of the sample reporting the optimal KIDMED score and only 47% of sample reported that they were consuming at least one meal per day with one family member. The above results of the present study demonstrate

Table 5

Multiple regression analyses model exploring the association of lifestyle components with academic performance for Greek adolescents

	Beta	t	p	VIF
Number of meals (with family)	0.087	2.386	0.017	1.126
Soft drinks consumption	–0.104	–2.856	0.004	1.145
Adherence to the MD	0.176	4.762	0.001	1.167
TV viewing	–0.124	–3.418	0.001	1.134
Smoking	–0.159	–4.357	0.001	1.134
Father's educational level	0.154	3.759	0.001	1.431
Mother's educational level	0.261	6.272	0.001	1.486
Mother's ethnicity	0.124	3.519	0.001	1.061

[Adjusted $R^2 = 0.393$; $F = 43.052$; $p < 0.001$].

the transition which has occurred with respect to the eating behaviors of adolescents, to a more westernized type of diet and they are in accordance with other studies conducted in Greece [26, 28]. The low adherence to the MeD seems to coexist with high levels of overweight and obesity, which were 23% and 2.1%, respectively. Poor adherence to the MeD by the students, could be partly attributed to time constrains of most adolescents in Greece related to increased school commitments and to the limited common meals with parents, due to the increased time spent on their work.

Another very important and very statistically significant finding of the current study, is the crucial role of consuming meals with the family, in predicting better academic performance in adolescents. It has been shown in the past that family meals seem to be associated with a more balanced diet [42–44]. It is probable that when adolescents eat together with their parents, or other family members, they may eat healthier foods and adopt better nutritional behaviors. Additionally, there is good evidence that eating while watching TV or playing on the computer [17, 18] is associated with the consumption of unhealthy snacks and obesity. The parents on the other hand, during the family meal time, have the opportunity to express their interest in the child's learning at school, encourage and reward learning behaviors or discuss personal issues of adolescents, contributing in this way to the strengthening of the self-esteem of the child/adolescent. Therefore, the consumption of meals together with family members, is a factor that could strengthen the degree of family cohesion and seems to be associated with school success [31].

Smoking seems to be a strong predictor of poorer academic performance in adolescents. It appears that those students who have good grades in school or come from families with high social and educational level are less likely to smoke during adolescence. Similar to most previous studies that have examined smoking, we argue that between two variables does not necessarily grow causality. More specifically, smoking could be a habit of adolescents with low self-confidence, which could be attributed to a variety of social and interpersonal factors [20, 21]. It is also possible that students with low academic performance start smoking in order to use this practice as a means of identification and inclusion in relevant teenage groups.

Finally, it is worth noting the significant negative correlation between soft drink consumption and academic performance of adolescent students. This is an important finding, because until now, soft drink consumption and school performance has not been adequately investigated [47]. Possible reasons which could explain this correlation is that adolescents who consume large amounts of soft drinks, increase the amount of calories consumed, which is associated with weight gain [47]. Also, high intake of such beverages possibly reduces the intake of milk, water or natural fruit juices [48]. This could lead to a decreased intake of essential micronutrients that are related to proper functioning of the cognitive processes of adolescents.

Another positive behavior that has been identified in this study, as beneficial to academic performance in adolescents, is less hours of TV viewing. Increased screen time has been previously shown to increase both risk

childhood obesity [49, 50] and poorer scholastic achievement [19]. In addition, as far as academic performance is concerned, socioeconomic factors such as parental education level and the ethnicity of the mother seem to be strong predictors of academic performance in this age group. This is in accordance to numerous past studies investigating factors that influence academic achievement [12]. The contribution of diet to academic performance is frequently stated; however, the emphasis of the research so far, has been focused mainly on fasting, malnutrition, specific micronutrient deficiencies and the effect of breakfast intake on cognition.

Limitations of the present study include the use of cross-sectional data for our analyses, which does not provide definitive causal evidence. In addition, our data collection measures were self-reported by the adolescents, apart for the anthropometric measurements. The strength of the study is that, it is one of the very few studies, demonstrating the importance of overall diet quality to academic performance [51]. It is well documented that greater adherence to MeD is associated with a significant improvement in general physical and psychological health, longevity and lower levels of obesity, however, this is among the first studies to show that good adherence to the MeD can significantly positively predict academic performance specifically in adolescents. Most importantly, in the current study it was demonstrated that, above and beyond socioeconomic factors, diet quality is important to academic performance.

Poor adherence to the MeD, few meals with family and soft drinks consumption seem to negatively predict academic performance in adolescents. These findings lead to the conclusion that schools should integrate health education programmes, in order to promote the MeD. It is noted that due to the fact that parents can act as feedback models for their children [52], they should be involved, preferably in experiential learning programs, so that health education programs have better chances of success. These findings reinforce the need for implementation and investment in effective school nutrition and lifestyle intervention programs that have the potential to promote the physical and psychological health and the academic performance of children.

6. Implications for future research

The investigation of the role of dietary patterns, the role of consuming family meals, the role of obesity and soft drink consumption, together with other lifestyle factors, on cognition and academic performance in adolescents, is relatively limited. Understanding the above interrelationships could facilitate the formation of policies focused on improving adolescent's academic achievement. Future longitudinal studies, which can lead to the formation of effective intervention programs focusing on improvement of the students' school performance, are considered necessary.

Acknowledgments

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