The mediterranean diet, lifestyle factors, dyslexia, ADHD in university students of Greece

Pantelis Papanastasiou[1,2,3] & Athanasios Drigas[2]

[1] Department of Nutritional Science and Dietetics, University of Peloponesse, Greece

[2] Institute of Informatics and Telecommunications, NCSR Demokritos, Athens, Greece

[3] Department of Economics & Sustainable Development, Harokopio University, Athens, Greece

Correspondence: Pantelis Papanastasiou, Department of Nutritional Science and Dietetics, University of Peloponesse, Greece. E-mail: ppapanasta@gmail.com

Received: February 10, 2023 Accepted: March 17, 2023 Published: July 01, 2023

DOI: 10.14295/bjs.v2i7.335 URL: https://doi.org/10.14295/bjs.v2i7.335

Abstract

This study examines the association between diet and other lifestyle factors of students with dyslexia and ADHD and compare it to students without learning disabilities. The study involved 210 students from Greek universities, aged 18-30 years old (ADHD n = 34; Dyslexia n=27, Students without learning disabilities n = 149). Students completed a specifically created questionnaire online, to examine their demographic traits, adherence to the Mediterranean Diet, sleep quality, perceived stress, and life satisfaction. Significant variations were identified in the responses when it came to life satisfaction, with students with ADHD reporting lower levels (p = 0.005). Students in the lower tertile of Mediterranean Diet (OR: 1.52; 95% CI: 1.1-2.0 p = 0.005) were more likely to have learning disabilities than the higher tertile where the odds were 35% lower (OR: 0.65; 95% CI: 0.49-0.87, p = 0.005). The probability that students will have learning disabilities increases with poorer adherence to the Mediterranean Diet. It is necessary to conduct further research on how students with learning disabilities behave when it comes to their nutrition and other health-related activities.

Keywords: mediterranean diet, attention deficit hyperactivity disorder (ADHD), dyslexia, university students.

A dieta mediterrânea, fatores de estilo de vida, dislexia, TDAH em estudantes universitários da Grécia

Resumo

Este estudo examina a associação entre dieta e outros fatores de estilo de vida de alunos com dislexia e TDAH, e compara com alunos sem dificuldades de aprendizagem. O estudo envolveu 210 alunos de universidades gregas, com idades entre 18-30 anos (TDAH n = 34; Dislexia n = 27, Alunos sem dificuldades de aprendizagem n = 149). Os alunos preencheram um questionário *on-line* criado especificamente para examinar suas características demográficas, adesão à dieta mediterrânea, qualidade do sono, estresse percebido e satisfação com a vida. Variações significativas foram identificadas nas respostas quanto à satisfação com a vida, com alunos com TDAH relatando níveis mais baixos (p = 0,005). Alunos no tercil inferior da Dieta Mediterrânea (OR: 1,52; 95% CI: 1,1-2,0 p = 0,005) eram mais propensos a ter dificuldades de aprendizagem do que o tercil superior, onde as chances eram 35% menores (OR: 0,65; 95% CI: 0,49-0,87, p = 0,005). A probabilidade de os alunos terem dificuldades de aprendizagem aumenta com a menor adesão à Dieta Mediterrânica. É necessário realizar mais pesquisas sobre como os alunos com dificuldades de aprendizagem se comportam quando se trata de sua alimentação e outras atividades relacionadas à saúde.

Palavras-chave: dieta mediterrânea, transtorno de déficit de atenção e hiperatividade (TDAH), dislexia, estudantes universitários.

1. Introduction

Neurodevelopmental disorders are conditions that affect the way the brain works and are characterized by the

onset of dysfunction in early childhood in personal, social, academic, or professional functioning. Among others, these disorders include mental disabilities, autism spectrum disorder, learning disabilities, and attention deficit hyperactivity disorder (ADHD) (American Psychiatric Association, 2013). The present study focuses on dyslexia and ADHD. These disorders are often associated with neurobiological, cognitive, behavioral, psychosocial, and environmental factors (Fletcher et al., 2007).

Dyslexia and ADHD are among the most common neurobehavioral disorders. Dyslexia occurs when a person has significant difficulty with the speed and accuracy of word expression as well as text comprehension (WHO) (ICD-11). ADHD, meanwhile, is characterized by persistent symptoms of hyperactivity and impulsivity, as the symptoms of both dyslexia and ADHD are most likely to persist throughout adolescence and adulthood (Siegel, 2006; Wilens; Spencer, 2010). Epidemiological studies show that dyslexia affect 10-15% of the general population (Shaywitz 1996; Shaywitz 2003; Rao et al., 2017), while about 7% of children and 2.5% of adults have ADHD (Simon et al., 2009; Thomas et al., 2015).

Previous research has looked at how diet and particular nutrients may affect learning disabilities (Galland, 2014; Beydoun et al., 2015; Ptomey et al., 2015; Papanastasiou et al., 2021). More specifically, the consumption of antioxidants, sugars, artificial food colors, preservatives, low levels of Zinc, Magnesium, and other micronutrients, and the intake of Omega-3 fatty acids have all been investigated in the past in relation to several learning disorders, including dyslexia and ADHD (Taylor et al., 2000; Cyhlarova et al., 2007; Laasonen et al., 2009; Millichap; Yee, 2012; Ríos-Hernández et al., 2017; Liu et al., 2020).

Studies on college students show that the tendency to eat unhealthily, skip meals and eat fast food is common (Pendergast et al., 2016; Sogari et al., 2018). Analysis of health-related behavior could be the key to improving the daily lives of people with neurodevelopmental disorders. As defined by the World Health Organization, an unhealthy diet combined with an unhealthy lifestyle is associated with a higher risk of chronic diseases and is a growing public health challenge (World Health Organization, 2003). Therefore, what would be the relationship of diet and lifestyle with dyslexia and ADHD? This study aims to investigate the association between diet and other lifestyle factors of students with dyslexia and ADHD and compare it to students without learning disabilities.

2. Materials and Methods

2.1 Recruitment

Participants would be included in the present study if they met the following criteria: (1) if they were undergraduate or post-graduate students; (2) 18 to 30 years old; (3) if they had a diagnosis of dyslexia; or (4) if they had an ADHD diagnosis; or (5) if they had no diagnosed learning disabilities.

A total of 227 people completed the online survey questionnaire. However, 17 people were excluded because they did not meet the inclusion criteria. Therefore, the sample is made up of 210 students between the ages of 18 and 30, of whom 34 have been diagnosed with dyslexia and 27 with ADHD, either by a private or a public institution. As a result, three groups of students were formed: (1) without learning disabilities (n = 149); (2) dyslexia (n = 34); (3) ADHD (n = 27). The questionnaire was distributed with the help of the Pan-Hellenic Association of People with ADHD (ADHD Hellas) and with the help of the Hellenic Dyslexia Society. The questionnaire was distributed in February 2021 until the end of March 2021. The selection of the total sample was done by random sampling. Participation was voluntary and anonymous. The current study was approved by the ethical committee of Harokopio University of Athens (protocol number: G-654/08.02.202).

2.2 Research Tools

Undergraduate and graduate students were given access to a specifically created questionnaire online, to examine their socio-demographic and anthropometric traits, adherence to the Mediterranean Diet (MEDAS), sleep quality (PSQI), perceived stress (PSS-14), and life satisfaction (SWLF).

2.3 Assesment of Adherence to the Mediterannean Diet

The Mediterranean Diet Adherence Screener (MEDAS) MD Adherence Test (Garcia et al., 2020) was used to assess dietary patterns and to analyze the relationship with the potential health benefits of Mediterranean Diet. The MEDAS comprises of 14 questions, 12 of which are about how frequently or how much of the primary Mediterranean Diet ingredients are consumed, and 2 of which are about Mediterranean dietary customs. Each

question receives a score of 0 or 1, with higher scores (up to 14 points) denoting better commitment to Mediterranean Diet's guiding principles. Scores are divided into three categories (low adherence: < = 5; moderate adherence: 6-9; 10 = > high adherence).

2.4. Hours and Quality of Sleep

The Pittsburgh Sleep Quality Index (PSQI) was used (Kotronoulas et al., 2011). The PSQI is a 19-item questionnaire that evaluates the subjective quantity and quality of sleep, sleep behaviors that are associated to quality, and the frequency of sleep disorders in adults during the last 30 days. The following seven scores are derived from the 19 individual items: subjective sleep quality (one item); sleep delay (two items); sleep duration (one item); usual sleep performance (three items); sleep disturbances (nine items); sleep medication use (one item) and daytime dysfunction (two items). On a scale from 0 to 3, where 0 represents no difficulty and 3 represents extreme difficulty, each of the seven scores is equally weighted. Collectively, the aforementioned items lead to a score corresponding to the overall subjective sleep quality, ranging between 0 and 21. Higher scores on the total score indicate more sleep complaints and lower sleep quality.

2.5. Perceived Stress

The Perceived Stress Scale-14 (PSS-14) (Andreou et al., 2011), consists of 14 items intended to measure how unpredictable, uncontrollable, and overwhelmed individuals find their life circumstances. Seven of the fourteen PSS-14 items are considered negative and the remaining seven as positive, representing perceived helplessness and self-efficacy, respectively. Each item is rated on a five-point Likert-type scale (0 = never to 4 = very often). Total scores are calculated after reversing the results of positive items and then summing all scores. Total scores for the PSS-14 range from 0 to 56 (from 0 to 40 and from 0 to 16, for PSS-10 and PSS-4, respectively). A higher score indicates greater anxiety.

2.6. Satisfaction with Life Scale

The Satisfaction with Life Scale (SWLF) (Stalikas; Lakioti, 2012), examines an individual's overall assessment of quality of life using five items rated on a seven-point Likert scale ranging from "Strongly Disagree" to "I strongly agree" (eg, "I am satisfied with my life"). It is a widely used indicator of subjective well-being that evaluates the idea of life satisfaction by assessing people's perceptions of their whole lives and, consequently, the cognitive aspect of subjective well-being.

2.7. Statistical Analyses

Using SPSS version 21, statistical analysis was performed. Respectively independent *t*-test, non-parametric t-test, and chi square test were used to compare mean differences quantitative and qualitative variables across learning disabilities and case groups. Binary logistic regression was performed to ascertain the effects of gender, age, weight, consumption of breakfast and adherence to Mediterranean Diet, on the likelihood that participants have learning disabilities.

3. Results

3.1 Characteristics of Study Population

Demographic and descriptive statistics of students are presented in (Table 1). The mean age was 22 years. Overall, there were more female students (n = 155) than male students (n = 55). The diagnosis of students' learning disabilities was made 62.3% by a public institution and 37.7% by a private institution respectively.

Table 1. Demographic and descriptive statistics of students (n = 210).

Variable	Students without LD (n = 149)	Students with LD (n = 61)	Students with Dyslexia (n = 34)	Students with ADHD (n = 27)
Mean age (SD)	21.98 (2.88)	22.3 (3.17)	21.76 (3.09)	23.07 (3.17)
Gender (%per group)				
Male	33 (22.1%)	22 (36.1%)	10 (29.4%)	12 (44.4%)
Female	116 (77.9%)	39 (63.9%)	24 (70.6%)	15 (55.6%)
Institution (% per group)				
Private	-	23 (37.7%)	10 (29.4%)	13 (48.1%)
Public	-	38 (62.3%)	24 (70.6%)	14 (51.9%)
Ethnicity (% per group)				
Greek	144 (96.6%)	60 (98.4%)	33 (97.1%)	27 (100%)
Albanian	2 (1.3%)	1 (1.6%)	10 (2.9%)	0 (0%)
Armenian	1 (0.7%)	0 (0%)	0 (0%)	0 (0%)
German	1 (0.7%)	0 (0%)	0 (0%)	0 (0%)
Roman	1 (0.7%)	0 (0%)	0 (0%)	0 (0%)
Nutritional status (% per group)				
Underweight	10 (6.7%)	0 (0%)	0 (0%)	0 (0%)
Normal weight	123 (82.6%)	41 (67.2%)	23 (67.6%)	18 (66.7%)
Overweight	11 (7.4%)	17 (27.9%)	10 (29.4%)	7 (25.9%)
Obese	5 (3.4%)	3 (4.9%)	1 (2.9%)	2 (7.4%)

Note: LD: Learning Disabilities; ADHD: attention-deficit/hyperactivity disorder. Source: Authors, 2023.

To test for statistically significant differences between the 3 groups of students and BMI, a non-parametric *Kruskal Wallis* test was performed as shown in Table 2. The results show that there are statistically significant differences in students in terms of BMI ($p < 0.05$).

Table 2. Mean value of the students' BMI by group (n = 210).

Variable	Students without LD	Students with Dyslexia	Students with ADHD	*p* value
BMI (mean ± SD)	21.77 ± 3.29	23.32 ± 3.22	24.04 ± 3.61	0.000

Note: LD: Learning Disabilities; ADHD: attention-deficit/hyperactivity disorder. Source: Authors, 2023.

3.2 Meal Consumption

As shown in Table 3, a parametric t-test was performed with the meals of the day and both groups of students. Statistically significant differences are observed only in terms of breakfast consumption ($p = 0.23$). Students who skip breakfast are more likely to be in the learning disabilities group. Students in both groups appear to consume an average of 3 meals per day.

Table 3. Parametric t-test for meal consumption/day (n = 210).

Variable		Students without LD (n = 149)	Students with LD (n = 61)	*p* value
Breakfast (Column N %)	No	36 (24.2%)	25 (41%)	0.023
	Yes	113 (75.8%)	36 (59%)	
Late breakfast (Column N %)	No	106 (71.1%)	37 (60.7%)	0.155
	Yes	43 (28.9%)	24 (39.3%)	
Lunch (Column N %)	No	8 (5.4%)	7 (11.5%)	0.180
	Yes	141 (94.6%)	54 (88.5%)	
Afternoon meal (Column N %)	No	90 (60.4%)	36 (59%)	0.853
	Yes	59 (39.6%)	25 (41%)	
Dinner (Column N %)	No	30 (20.1%)	13 (21.3%)	0.849
	Yes	119 (79.9%)	48 (78.7%)	
Total meals / day (Column N %)	1	13 (8.7%)	10 (16.4%)	0.542
	2	23 (15.4%)	13 (21.3%)	
	3	60 (40.3%)	13 (21.3%)	
	4	29 (19.5%)	13 (21.3%)	
	5	24 (16.1%)	12 (19.7%)	

Note: LD: Learning Disabilities. Source: Authors, 2023.

3.3 Research Tools

At this point, the breakdown of the tools follows. As presented in Table 4, a non-parametric Kruskal Wallis test was conducted to examine statistically significant differences between the three groups (Students without LD, Students with Dyslexia, Students with ADHD) and the results show that there are statistically significant differences only in terms of the SWLF life satisfaction scale scores ($p < 0.05$).

Then, based on the above, a parametric t-test was performed as presented in (Table 5), between the learning disabilities group and those without. It is observed that students with Learning Disabilities score worse on average 7.08 ± 2.14 on the MEDAS tool, while students without Learning Disabilities score 7.67 ± 1.84, $p = 0.047$.

Table 4. Non-parametric test of Tool scores: MEDAS, PSQI, PSS, SWLF (per group).

Variable	Students without LD (n = 149)	Students with Dyslexia (n = 34)	Students with ADHD (n = 27)	*p* value
MEDAS (mean±SD)	7.67 ± 1.84	7.35 ± 2.14	6.74 ± 2.14	0.115
PSQI (mean±SD)	6.08 ± 3.70	6.08 ± 4.08	7.22 ± 4.60	0.166
PSS (mean±SD)	29.37 ± 5.00	28.58 ± 5.66	30.03 ± 4.72	0.808
SWLF (mean±SD)	17.55 ± 6.28	18.91 ± 6.04	14.25 ± 6.28	0.008

Note: LD: Learning Disabilities; ADHD: attention-deficit/hyperactivity disorder. Source: Authors, 2023.

Table 5. Tool scores: MEDAS, PSQI, PSS, SWLF (between learning disabilities group and without Learning Disabilities).

Variable	Students without LD (n = 149)	Students with LD (n = 61)	p value
MEDAS (mean ± SD)	7.67 ± 1.84	7.08 ± 2.14	0.047
PSQI (mean ± SD)	6.08 ± 3.70	6.59 ± 4.32	0.390
PSS (mean ± SD)	29.37 ± 5.00	29.22 ± 5.28	0.850
SWLF (mean ± SD)	17.55 ± 6.28	16.85 ± 6.52	0.471

Note: LD: Learning Disabilities. Source: Authors, 2023.

3.4. Association Between Adherence to Mediterranean Diet and Odds Of Learning Disabilities

Binary logistic regression was performed to ascertain the effects of gender, age, weight, consumption of breakfast and adherence to Mediterranean Diet, on the likelihood that participants have learning disabilities. As presented in (Table 6), the tertiles of the adherence to the Mediterranean Diet added significantly to the odds of learning disabilities. Students in the lower tertile of Mediterranean Diet (OR: 1.52; 95% CI: 1.1-2.0 $p = 0.005$) were 152% more likely to have learning disabilities than the higher tertile where the odds were 35% lower (OR: 0.65; 95% CI: 0.49-0.87, $p = 0.005$). The model explained 70% (Nagelkerke R^2) of the variance in heart disease and correctly classified 84.8% of cases. The logistic regression model was nearly significant, χ^2, = 14.324, $p = 0.074$.

Table 6. Binary logistic regression on the likelihood of learning disabilities.

Variable	Odds Ratio	Lower	Upper	p value
Gender (1)	6.837	0.393	118.87	0.187
Weight				1
Consumption of Breakfast	0.402	0.113	1.434	0.160
ADHD				
Low adherence to Mediterranean Diet	1.525	1.138	2.042	0.005
Medium adherence to Mediterranean Diet	1.270	1.038	1.554	0.020
High adherence to Mediterranean Diet	0.656	0.490	0.879	0.005

Note: ADHD: attention-deficit/hyperactivity disorder. Source: Authors, 2023.

4. Discussion

In this pilot study, we investigated the association between diet and other lifestyle factors of students with dyslexia and ADHD. According to the study's findings, students with learning disabilities report significantly lower adherence to the Mediterranean diet and are more likely to skip breakfast. Students with ADHD report lower levels of life satisfaction. Considering these findings, we developed a model that examines the relationship between the likelihood of having learning disabilities and gender, age, weight, consumption of breakfast, and adherence to the Mediterranean diet. We found out that the probability that students will have learning disabilities increases with poorer adherence to the Mediterranean Diet.

4.1. Diet and Lifestyle Factors

The effect of lifestyle variability in learning disabilities, and more specifically ADHD, has been thoroughly studied in the literature. College students with ADHD struggle with health-related issues (Merkt & Gawrilow, 2016). In 2015, a randomized controlled trial was conducted that examined the relationship between ADHD and perceived stress in adults, showing that ADHD symptoms are positively related to anxiety and executive functioning problems (Combs et al., 2015). Prior research from randomized controlled trials on sleep suggests that getting less sleep may increase the symptoms of ADHD and oppositional behavior in children and adolescents, as well as possibly have an impact on people without learning difficulties (Gruber et al., 2011; Becker at al., 2019).

In addition, a randomized controlled trial carried out in New Zealand looked at the impact of three antioxidants and 36 micronutrients on stress in adults with ADHD. Adults who received micronutrients after an earthquake, experienced less stress and anxiety than the control group, demonstrating the value of micronutrients for mental health (Rucklidge et al., 2011).

Benefits are also found for dyslexia regarding consumption of Omega-3 LC-PUFA. A clinical study conducted in 2000, showed that signs of fatty acid deficiency were significantly increased in dyslexic group compared to the control group, and particularly in males (Taylor et al., 200). Those findings were also confirmed by a more recent clinical study which was conducted in 2013 (Montgomery et al., 2013). Their study findings showed that concentrations of DHA and other Ω-3 LC-PUFA were low relative to recommendations for cardiovascular health in adults and were directly linked to measures of knowledge and behavior. Finally, the literature notes a significant distinction between the number of daily meals, food structure, and soft drink intake between men with ADHD and men without learning disabilities (Ptacek et al., 2014).

4.2. Universities

Universities are crucial in assisting students, particularly those with learning disabilities, to manage and complete their education. A recent law in Greece (3699/2008) legally recognizes students with learning disabilities as a separate category of students who need special educational support and teaching, and that's until they graduate from High School (Stampoltzis; Polychronopoulou, 2009). Therefore, students entering higher education are not subjected to the law and they won't have their educational support guaranteed.

Prior to this, the overall incidence of dyslexia in the Greek student population was reported at 0.16% (Stampoltzis et al., 2015). Currently, the Greek population requires more data to assess the issue using the data available today, both for dyslexic students and ADHD.

The institution's academic standards need not be compromised to accommodate students with learning difficulties. Written regulations that guarantee that students with learning disabilities receive the same excellent education as their peers are crucial. Moreover, due to swift advancements in Information and Communication Technology (ICT), integrating ICT in teaching and learning is high on the educational reform agenda. Nutrition and ICT research evidence shows the importance of behavior-based applications in maintaining people's health (Drigas; Karyotaki, 2013). Games and gamification techniques and practices within general and special education improves the educational procedures and environment, making them more friendly and enjoyable (Drigas et al., 2014; Papanastasiou et al., 2017)

This study has several advantages. This is the first study in Greece to examine the relationship between the Mediterranean diet and dyslexia and ADHD. It is also the first study in Greece examining the relationship between the Mediterranean diet and university students with learning disabilities. Our study has certain restrictions as well. The diagnosis of learning disabilities was assessed through a simple questionnaire question and candidates were asked to answer by which institution their diagnosis was made. Another limitation one that might not be as significant is that no instrument was employed to gauge the frequency of food consumption, such as the Food Frequency Questionnaire, allowing exact analysis of the frequency of foods that the sampled students tend to select.

5. Conclusions

The current study makes recommendations for potential dietary and health-related behavior weighted assessments in students with learning difficulties. The probability that students will have learning disabilities increases with poorer adherence to the Mediterranean Diet. It is necessary to conduct further research on how students with learning disabilities behave when it comes to their nutrition and other health-related activities.

6. Acknowledgments

No acknowledgments

7. Auhors' Contributions

Pantelis Papanastasiou: is the primary author of the current study. He performed the data collection, data analysis and interpretation. *Athanasios Drigas*: provided access to crucial research components. He provided revisions to scientific content of manuscript.

8. Conflicts of Interest

No conflicts of interest.

9. Ethics Approval

Yes applicable.

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