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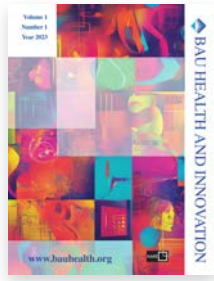

Original Article

Is Adherence to a Plant-based Diet Associated with Mental Health and Academic Achievement?

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Abstract

Objectives: It is thought that plant-based diets may improve the mental health and academic achievement of individuals. The aim of our study was to evaluate the effect of adherence to plant-based diets on mental health and academic achievement in university students.

Methods: Students' adherence to a plant-based diet was determined by the plant-based diet index (PDI) score. The mental health status was determined using the Depression–Anxiety–Stress Scale (DASS). Students' academic performance was determined based on the university grade point average (GPA) question asked.

Results: Our results showed that women studying in the health department have higher healthy plant-based diet scores ($p<0.001$). In addition, it was determined that students who adapted to a healthier plant-based diet had better mental health and academic achievement ($p<0.05$). Fourth-grade students had lower unhealthy PDI values than 1st-grade students ($p<0.001$). Alcohol users had lower PDI, and smokers had higher healthy PDI (hPDI) ($p<0.001$). It was found that hPDI values explained 2.5–3.7% of DASS scores and 1.6% of GPA ($p<0.05$).

Conclusion: In our study, plant-based diet was related to mental health and academic achievement in university students. It is also recommended to develop plant-based diet interventions due to their effects on mental health and academic achievement.

Keywords: Academic success, depression, mental health, plant-based.

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Psychological disorders, which are defined as behavioral, mental, or emotional abnormalities that may affect the quality of life of the person, significantly affect mortality in developed countries and show alarming trends in developing countries.[1,2] The three most prevalent psychological conditions are stress, anxiety, and depression.[1] Reports reveal that more than 300 million people globally demonstrate depression signs, while more than 260 million people suffer from anxiety disorders (4.4% and 3.6%, respectively, of the worldwide population).[2,3] In Türkiye, the prevalence of depression has been reported as 13.1% in women, 5% in men, and 9.1% in total.[4] Depression has a relationship that affects nutrition behavior. A study conducted in Türkiye revealed an association between night-time eating and depression risk among adolescents.

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Nutrition is a crucial and modifiable environmental factor that can affect psychological health.[1,5,6] Globally, it is emphasized that the transition to "western-type" diets rich in energy, sodium, sugar, and trans and saturated fats is increasing rapidly.[7] Adoption of unhealthy eating habits may negatively affect mental health by increasing oxidative stress.[5,8] In various studies, the roles of different nutrients on psychological health have been reported. Saturated fatty acids, refined carbohydrates, and meat and meat products have all been directly linked to mental health disorders (major depressive disorder).[9] Consuming plant-based diets high in fruits and vegetables, however, has been linked to a lower incidence of depression and anxiety.[1,10–12]

Evaluation of diet quality indexes through the interaction and combination of macro- and micronutrients in a balanced diet offers an approach to find diet-disease associations.[1] Nonetheless, there have been conflicting and inconsistent reports about the link between depression and plant-based eating habits. Plant-based diets have been linked in some studies to better mental and emotional health,[13,14] but other research have found reverse relationship between the two.[15] It is possible that being a vegetarian or not fish consumption may cause psychological mechanisms showing various relations with mental disorders.[15]

In recent years, indexes have been developed to indicate adherence to a plant-based diet. These indexes include the general plant-based diet index (PDI), which emphasizes increased plant food consumption with decreased animal food intake; the healthy PDI (hPDI), which emphasizes intake of healthy plant foods associated with healthier outcomes, such as fruits, whole grains, and vegetables; and the unhealthy PDI (uPDI), which emphasizes consumption of less nutritious plant foods that are linked to various disease risks.[16] There are studies on the effectiveness of these indexes on diseases such as general mortality, metabolic syndrome, fatty liver disease, cancer, and obesity.[17–20] Studies showing the effects of plant-based dietary indexes on mental health have differed between countries, and the number of studies conducted is insufficient.[5,6]

Based on reports, university students worldwide frequently develop symptoms of anxiety and depression, which may affect their academic performance.[21] In addition, it is thought that there is strong evidence between healthy eating behaviors and academic performance.[22] Indeed, studies conducted among university students have identified a positive correlation between more breakfast consumption or reduced fast food intake and students' academic achievement.[23,24]

As far as we are aware, limited research has examined this relationship among university students. Based on this information, our study aims to determine the effect of PDI scores on the mental health and academic achievement of university students.

Materials and Methods

In this cross-sectional study, the data collection process was carried out between May and July 2022. The ethical approval of the research was prepared according to the ethical standards of the Declaration of Helsinki and approved by the ethics committee of Bahcesehir University (no.: E-20021704–604.02.02–44469, approved on September 28, 2022). The researchers used the face-to-face interview style to collect the data. The population of the study consisted of university students living in Istanbul, the largest city in Türkiye. The power of the study was determined by G*Power (G*Power 3.1.9.2, Duesseldorf, Germany) package program.[25] Power analysis was performed in sample selection; type 1 error rate α=0.05 and type 2 error rate β=0.20, power of test 1-β=0.80, and effect size 0.25 were calculated. According to this information, it was demonstrated that the study required a minimum of 159 participants. The study was completed on 259 healthy university students who accepted and signed the informed consent form. Individuals who were diagnosed with a mental illness such as depression by a psychiatrist, who were receiving medication for these diseases, vegan/vegetarian individuals, who had been on special diet therapy in the last 1 year before the study, and who omitted to sign the informed consent form were not allowed to participate in the research. Sociodemographic information, anthropometric measurements, dietary habits, grade level, and academic achievement of the individuals were questioned with a questionnaire form.

PDI

A semiquantitative food frequency questionnaire, which has been validated and proven to be accurate for Turkish adults, was used to evaluate dietary intakes to determine the plant-based dietary indices of individuals.[26] Food frequency data were divided into 18 food groups: Animal foods (dairy products, eggs, fish and seafood, meat, and other animal-based foods), less healthful plant foods (fruit juices, refined grains, potatoes, sugar-sweetened beverages, and sweets), and nutritious plant foods (whole grains, fruits, vegetables, nuts, legumes, vegetable oils, and tea/coffee). Foods with a mixed composition were categorized according to the predominant ingredient. After being split into quintiles based on how much of

each food group they consumed, participants were assigned either positive or negative scores. In a food group, participants received a score of 5 for consuming more food than the highest quintile and a score of 1 for consuming less food than the lowest quintile. This scoring method will be inverted for reverse scores. Regarding the PDI calculation, dietary groups that were plant-based scored highly, while food groups that were animal-based scored negatively; healthier plant food groups received positive scores and less healthy plant and animal food groups received reverse scores for the hPDI calculation. Finally, the uPDI showed negative ratings for healthy plant and animal food categories and positive scores for less nutritious plant food groups. The indices were created by adding the scores of the 18 dietary groups. The scores for PDI, hPDI, and uPDI values range from 17 to 85.[16]

Depression, Anxiety, and Stress States

The participants' levels of stress, anxiety, and depression were assessed using the Depression–Anxiety–Stress Scale (DASS)-21, which was developed by Lovibond and Lovibond (1995).[27] Sarıçam (2018) adapted the scale into Turkish, and the 21-item scale consists of three subdimensions based on exploratory factor analysis.[28] It should be known that the DASS-21 gives an overall assessment of the stress, anxiety, and depression levels of healthy people and may offer a chance to assess and diagnose disorders, psychiatry, psychotherapy, and counseling techniques. The scale has three subdimensions: depression, anxiety, and stress. There are 7 items to evaluate each subdimension and the scale consists of 21 items in total. Scale items are scored between 0 (never) and 3 (always). For scale scoring, the scores obtained from the subscales are summed within themselves.[28]

Evaluation of the Data

The data obtained were statistically evaluated using the Statistical Package for the Social Sciences 21.0 package program (SPSS Inc., Chicago, IL, US). Statistical significance was accepted as $p<0.05$ in all analyses. The conformity of the data to normal distribution was checked by the Shapiro–Wilk test. Number, percentage, mean, standard deviation, median, and interquartile range values were given in descriptive statistics. Chi-square test was applied to analyze qualitative variables. The "independent samples t-test" was used in the comparison of two independent groups, and the "one-way ANOVA test" was used in the comparison of more than two groups. The relationships between the scales were determined by "Pearson's correlation coefficient." "Regression analysis" was used to test the effect between variables.

Table 1. General characteristics of the participants

	n	%
Age (years)	22.0 (21.0–23.0)	
Gender		
Female	196	75.7
Male	63	24.3
Body mass index groups		
Lean	25	9.7
Normal weight	195	75.3
Overweight/obese	39	15.1
Body mass index	21.8 (19.8–23.8)	
Department		
Health sciences	130	50.2
Other	129	49.8
Grade level		
Grade 1	23	8.9
Grade 2	54	20.8
Grade 3	64	24.7
Grade 4	118	45.6
Grade point average	2.81±0.47	
Smoking		
Yes	111	42.9
No	148	57.1
Alcohol consumption		
Yes	111	42.9
No	148	57.1
Depression–Anxiety–Stress scale (DASS)		
Stress	6.13±4.12	
Anxiety	4.49±3.69	
Depression	5.5±4.35	
Total	16.1±11.1	
Plant-based diet index		
PDI	53.57±7.4	
hPDI	54.65±8.91	
uPDI	55.53±9.15	

Continuous variables are expressed as mean±standard deviation and median (interquartile range); categorical variables are expressed as percentage. PDI: Plant-based diet index, hPDI: Healthy plant-based diet index, uPDI: Unhealthy plant-based diet index.

Results

A total of 259 students with a median age of 22.0 (21.0–23.0) years participated in our study. The median body mass index was 21.8 (19.8–23.8) (kg/m^2), and 75.3% of them were normal weight. 50.2% of the participants were studying in health departments and 45.6% of them were in the 4^{th} grade. The overall grade point average (GPA) of the students was 2.81±0.47. While the maximum and minimum scores for PDI, hPDI, and uPDI values ranged between 17 and 85, they were found to be 53.57±7.4, 54.65±8.91, and 55.53±9.15, respectively (Table 1).

Table 2. Comparison of plant-based diet indexes of individuals

	PDI	p	hPDI	p	uPDI	p
Gender						
Female	54.1±7.1	0.191	56.2±8.7	**<0.001**	55.5±9.5	0.476
Male	52.3±8.1		49.6±7.8		54.9±8.3	
Body mass index groups						
Lean	50.2±8.5	0.848	55.3±9.3	0.915	57.3±8.9	0.576
Normal weight	51.5±8.4		54.5±8.9		55.3±9.2	
Overweight/obese	51.8±8.7		54.7±8.7		55.6±9.3	
Department						
Health sciences	54.2±7.1	0.185	56.6±9.1	**<0.001**	54.8±9.4	0.311
Other	53.1±7.6		52.7±8.3		56.1±8.9	
Grade level						
Grade 1	50.7±6.6	0.058	53.6±8.9	0.594	60.8±7.1	**<0.001**
Grade 2	52.6±6.6		53.6±7.9		57.1±10.2	
Grade 3	53.3±7.6		54.6±8.8		56.2±8.9	
Grade 4	54.7±7.6		55.4±9.4		53.2±8.6	
Smoking						
Yes	53.1±8.1	0.298	82.2±8.6	**<0.001**	55.3±9.29	0.986
No	53.9±6.8		56.5±8.7		55.4±9.12	
Alcohol consumption						
Yes	51.7±7.6	**<0.001**	53.7±8.7	0.139	55.0±9.6	0.651
No	54.9±6.9		55.4±9.1		55.7±8.8	

"Independent samples t-test" was used for two independent group comparisons and "one-way analysis of variance test" was used for more than two group comparisons. PDI: Plant-based diet index, hPDI: Healthy plant-based diet index, uPDI: Unhealthy plant-based diet index.

Table 3. Correlation coefficients of plant-based diet indexes of individuals

	PDI		hPDI		uPDI	
	R	p	R	p	R	p
DASS-stress	0.123	0.051	-0.166	**0.007**	0.041	0.51
DASS-anxiety	0.104	0.095	-0.149	**0.016**	0.098	0.115
DASS-depression	0.062	0.323	-0.17	**0.006**	0.124	**0.047**
DASS-total	0.103	0.098	-0.181	**0.004**	0.098	0.116
Grade point average	0.048	0.441	0.126	**0.043**	-0.061	0.332

The relationships between variables were determined by "Pearson's correlation coefficient". DASS: Depression–Anxiety–Stress scale.

When we analyzed the plant-based dietary indices of the individuals participating in the study, we found that the "hPDI" values of females were significantly higher than those of men (p<0.001). We also found that students studying in health departments had higher hPDI values compared to other departments (p<0.001). However, uPDI values of 4th-grade students were found to be lower than 1st-grade students (p<0.001). PDI values of alcohol users were found to be significantly lower (p<0.001) and hPDI values of smokers were found to be significantly higher (p<0.001; Table 2).

Analysis of the relationship between plant-based dietary indexes and students' DASS scores and GPAs revealed a significant negative association between the healthy Plant-Based Diet Index (hPDI) and DASS subscales—stress (p=0.007), anxiety (p=0.016), depression (p=0.006), and total score (p=0.004). In contrast, a significant positive association was observed between hPDI and students' GPA (p=0.043). We also found a positive correlation (p=0.047) between uPDI and DASS depression scores (Table 3).

"Regression analysis" was performed to determine the effect of hPDI values on the DASS scores of the individuals

Table 4. The effect of individuals' plant-based diet indexes on DASS scores and grade point average

	Variable	Unstandardized		Standardized			F	R^2
		β	SE	Beta	t	p		
DASS-stress	(Constant)	3.030	1.869	–	1.621	0.106	2.800	0.011
	PDI	0.058	0.035	0.104	1.673	0.095		
	(Constant)	10.097	1.578	–	6.399	0.056	6.497	0.025
	hPDI	-0.073	0.028	-0.157	-2.549	**0.011**		
	(Constant)	4.600	1.577	–	2.916	**0.004**	0.964	0.004
	uPDI	0.028	0.028	0.061	0.982	0.327		
DASS-anxiety	(Constant)	1.823	1.674	–	1.089	0.277	2.596	0.01
	PDI	0.05	0.031	0.1	1.611	0.108		
	(Constant)	8.639	1.406	–	6.143	**<0.001***	8.915	0.034
	hPDI	-0.076	0.025	-0.183	-2.986	**0.003**		
	(Constant)	2.939	1.412	–	2.082	**0.038**	1.247	0.005
	uPDI	0.028	0.025	0.069	1.117	0.265		
DASS-depression	(Constant)	4.241	1.983	–	2.139	**0.033**	0.41	0.002
	PDI	0.023	0.037	0.04	0.64	0.523		
	(Constant)	10.484	1.658	–	6.322	**<0.001***	9.271	0.035
	hPDI	-0.091	0.03	-0.187	-3.045	**0.003**		
	(Constant)	2.603	1.659	–	1.569	0.118	3.129	0.012
	uPDI	0.052	0.029	0.11	1.769	0.078		
DASS-total	(Constant)	9.093	5.027	–	1.809	0.072	1.991	0.008
	PDI	0.131	0.093	0.088	1.411	0.159		
	(Constant)	29.215	4.210	–	6.940	**<0.001***	9.932	0.037
	hPDI	-0.24	0.076	-0.193	-3.152	**0.002**		
	(Constant)	10.141	4.227	–	2.399	**0.017**	2.055	0.008
	uPDI	0.108	0.075	0.089	1.433	0.153		
Grade point average	(Constant)	2.650	0.215	–	12.335	**<0.001***	0.596	0.002
	PDI	0.003	0.004	0.048	0.772	0.441		
	(Constant)	2.451	0.181	–	13.508	**<0.001***	4.122	0.016
	hPDI	0.007	0.003	0.126	2.030	**0.043**		
	(Constant)	2.988	0.181	–	16.55	**<0.001***	0.953	0.004
	uPDI	-0.003	0.003	-0.061	-0.976	0.33		

"Regression analysis" was used to test the effect between variables; *: $p<0.001$ indicate levels of statistical significance. DASS: Depression–Anxiety–Stress scale, SE: Standard error, PDI: Plant-based diet index, hPDI: Healthy plant-based diet index, uPDI: Unhealthy plant-based diet index.

participating in the study. The analysis's findings showed that hPDI values explained 2.5%, 3.4%, 3.5%, 3.5%, 3.7%, and 1.6% of DASS stress, anxiety, depression, total score, and GPA of the individuals, respectively ($p<0.05$). Based on these findings, it was found that a one-unit increase in the "hPDI" values of the individuals would cause a decrease of approximately 0.073, 0.076, 0.091, and 0.240 on the DASS stress, anxiety, depression, and total scores, respectively, and an increase of approximately 0.007 on the GPA (Table 4).

Discussion

In our study, we investigated the relationship between university students' adherence to a plant-based diet and their mental health and GPA. To our knowledge, this is the first study to examine this relationship among university students to date. The main findings of the current study were that students who followed a healthier plant-based diet had higher GPAs and better mental health. We also found that female students and students studying in health departments were more adherent to a plant-based diet.

In our study, we found that female individuals had higher hPDI scores. One of the factors that most consistently affects whether people eat meat or plant-based foods is gender. It is more common for men to eat less plant-based foods and more meat.[29,30] There are studies in the literature drawing attention to the fact that meat implies power and masculinity and that males are expected to consume meat according to traditional gender norms.[29–32]

This finding of our study is consistent with the data in the literature. In a recent study conducted on 1130 individuals, the reason for this situation was analyzed. According to the study's findings, men may view a decrease in meat intake as a danger to their independence and negatively impact plant-based diets.[33]

In addition to gender differences, we found that students studying in health departments had higher hPDI scores. This finding is supported by the findings of studies, in which medical, and health sciences students or students with more nutrition knowledge showed healthier consumption.[34–37] This suggests that students studying in health departments are more exposed to healthy nutrition information and this information may affect their eating habits. However, there are also studies showing that students studying in medical and health departments show low adherence to a vegetarian diet or Mediterranean diet.[38–40] With this result, it can be considered that studying in medical faculty or health departments does not guarantee the development of the right behavioral model about nutrition.[36,38]

According to our research, students' DASS ratings and adherence to the hPDI were negatively correlated. These results are in line with a prior study that used the same dietary index on female patients. According to this study, women who relied more on animal products were more likely to develop mental health issues.[6] In addition, the majority of current research indicates that students who following the Mediterranean diet more closely have reduced rates of depression and that lower intake of fruits and vegetables is linked to higher levels of stress.[41] It has been proposed that the high flavonoid content often seen in plant diets. In addition, a literature review including 37 studies confirmed a negative relationship between polyphenol consumption and depressive symptoms.[42] Through the regulation of the body's natural defense mechanisms, the stabilization of free radicals, and the reduction of oxidative damage, polyphenols exhibit beneficial effects on mental health. Furthermore, neuroprotective qualities have been noted, which could alter cellular signaling pathways related to cognitive functions.[43]

Interestingly, in a recent systematic review and meta-analysis, vegan/vegetarian diets were related with lower anxiety scores and greater depression scores. These results suggest that vegetarian/vegan diets, which are among the plant-based dietary models, may indicate poorer mental health due to possible nutrient deficiencies (certain amino acids, long-chain omega-3 fatty acids, vitamins B6 and B12, and zinc).[44] In light of these inconsistent results, further high-quality studies on the impact of vegan or vegetarian diets on mental health are required.

It is also possible that individuals with poorer mental health are more likely to adopt unhealthy dietary patterns, rather than unhealthy diets being the primary cause of poorer mental health. This potential reverse causality should be considered when interpreting the findings. One study found no direct association between following a plant-based diet and depression.[44] However, they identified a significant positive relationship between plant-based eating, junk food consumption, and depression.[45]

On the other hand, in our study, it was observed that adherence to hPDI was positively associated with students' GPA. When the literature was examined, no study examining the relationship between PDI and academic performance was found. However, there are studies showing a positive relationship between adherence to the Mediterranean diet or vegetable and fruit consumption and achievement scores in school.[46–48] These findings add to an abundance of research, suggesting that kids' academic performance may benefit from following a plant-based diet. It also supports the necessity of concentrating on interventions meant to raise academic performance in students following unhealthy lifestyles.[49]

This study has several limitations. First, this research was designed as a cross-sectional study and participation was voluntary. Therefore, prospective experimental research should be conducted to confirm the relationship between students' adherence to a plant-based diet and academic performance. Although the surveys were conducted in Istanbul, the most crowded city in Türkiye, the results are not representative of Türkiye as a whole. This study did not use any cognitive performance test to measure academic achievement. Students' GPA scores have not been evaluated as their academic performance. Furthermore, the participants' grade average point and DASS-21 scale information were based on self-reports and qualitative data; therefore, potential bias is a limitation.

Conclusion

The current study demonstrated that there is a relationship between university students' adherence to a plant-based diet and their mental health. This research highlights the importance of dietary status in the setting of mental health. In addition, there was an association between plant-based diet and academic achievement. Prospective cohort or intervention studies on plant-based diets should be conducted to confirm our findings. It should be encouraged to assess the effect of plant-based diets and develop nutritional interventions to promote and sustain mental health and academic achievement.

Disclosures

Ethics Committee Approval: The study was approved by the Bahcesehir University Ethics Committee (no: E-20021704–604.02.02–44469, date: 28/09/2022).

Authorship Contributions: Concept – G.G., E.A.Y., T.Ö.K.; Design – G.G., E.A.Y., T.Ö.K.; Supervision – G.G., S.A.Ö.; Materials – E.A.Y., T.Ö.K.; Data collection and/or processing – E.A.Y., T.Ö.K.; Data analysis and/or interpretation – S.A.Ö., E.A.Y., T.Ö.K.; Literature search – G.G., S.A.Ö., E.A.Y., T.Ö.K.; Writing – E.A.Y., T.Ö.K.; Critical review – G.G., S.A.Ö.

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