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Association of Dietary Acid Load and Mental Health in Adults: Pilot Study

Yetişkinlerde Diyet Asit Yükü ve Mental Sağlık Arasındaki İlişki: Pilot Çalışma

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ABSTRACT

Objective: It was aimed to evaluate the effect of dietary acid load on depression, anxiety and stress in adults. Materials and Methods: Two hundred and fifty-one adult participants (49% male, 51% female) aged 18 years and over and without any chronic disease were included in the study. The data were collected via a questionnaire. The questionnaire consists of general information, Godin Leisure Time Physical Activity Questionnaire, Depression, Anxiety Stress (DASS)-21 Scale and 24-hour retrospective food consumption record. Potential renal acid load (PRAL) and net endogenous acid production (NEAP) calculations were used to assess dietary acid load. Results: Age was significantly lower, and the ratio of single participants was significantly higher in the high PRAL and NEAP groups ($p<0.05$). No significant relationship was found between dietary acid load and DASS-21 ($p<0.05$). Dietary energy, protein, vitamin B12, niacin, phosphorus, zinc intake and red meat consumption were significantly higher in the high PRAL and NEAP groups ($p<0.05$). On the contrary, dietary fiber, antioxidant, vitamin C, potassium intake and fruit consumption were significantly lower ($p<0.05$). While increased dietary intake of thiamine, magnesium, and iron was significantly associated with a decrease in anxiety subscale score ($p<0.05$); increased vegetable consumption was significantly associated with a decrease in DASS-21 scale and stress subscale scores ($p<0.05$). Conclusion: This study did not demonstrate a relationship between dietary acid load and mental health. However, western style eating habits and reduced fruit and vegetable consumption can increase the acid load of the diet, causing health problems in the long term.

Keywords: *Dietary acid load, Mental health, Depression, Anxiety, Stress, BMI*

ÖZ

Amaç: Yetişkinlerde diyet asit yükünün depresyon, anksiyete ve stres üzerine etkisinin değerlendirilmesi amaçlanmıştır. Gereç ve Yöntem: Çalışmaya 18 yaş ve üzeri ve herhangi bir kronik hastalığı olmayan 251 yetişkin katılımcı (%49 erkek, %51 kadın) dahil edilmiştir. Veriler, anket aracılığıyla toplanmıştır. Anket genel bilgiler, Godin Boş Zaman Fiziksel Aktivite Anketi, Depresyon, Anksiyete Stres (DASS)-21 Ölçeği ve 24 saatlik retrospektif besin tüketim kaydından oluşmaktadır. Diyet asit yükünü değerlendirmek için potansiyel renal asit yükü (PRAL) ve net endojen asit üretimi (NEAP) hesaplamaları kullanılmıştır. Bulgular: Yüksek PRAL ve NEAP gruplarında yaş anlamlı olarak daha düşük, bekar katılımcıların oranı anlamlı olarak daha yüksektir ($p<0.05$). Diyet asit yükü ile DASS-21 arasında anlamlı bir ilişki bulunamamıştır ($p<0.05$). Diyet enerjisi, protein, B12 vitamini, niasin, fosfor, çinko alımı ve kırmızı et tüketimi yüksek PRAL ve NEAP gruplarında anlamlı olarak daha yüksektir ($p<0.05$). Buna karşılık diyet posası, antioksidan, C vitamini, potasyum alımı ve meyve tüketimi anlamlı olarak daha düşüktür ($p<0.05$). Tiamin, magnezyum ve demirin diyetle alımının artması anksiyete alt ölçek puanında anlamlı bir azalma ile ilişkiliyken ($p<0.05$); sebze tüketiminin artması DASS-21 toplam ve stres alt ölçek puanlarında anlamlı bir azalma ile ilişkilidir ($p<0.05$). Sonuç: Bu çalışmada diyet asit yükü ile mental sağlık arasında bir ilişki gösterilememiştir. Ancak batı tarzı beslenme alışkanlıkları ve meyve ve sebze tüketiminin azaltılması diyetin asit yükünü artırarak uzun vadede sağlık sorunlarına neden olabilir.

Anahtar Kelimeler: *Diyet asit yükü, Mental sağlık, Depresyon, Anksiyete, Stres, BKİ*

INTRODUCTION

Diet has an important role in the acid-base balance in the body. Phosphorus and proteins—primarily sulfur amino acids like cysteine, methionine, and taurine, as well as cationic amino acids like lysine and arginine—are the dietary components that release acid precursors during metabolism. The nutrients calcium, magnesium, and potassium are alkali precursors. Therefore, meat, cheese, eggs, and other foods high in protein generally cause the body to produce more acid, whereas fruits and vegetables cause the body to produce more alkali (1). It is essential for human health to maintain a proper acid-base balance. Increased dietary acid load can be associated with obesity, insulin resistance, cardiovascular mortality, hypertension, chronic kidney disease, cancer, and metabolic dysfunction–associated steatotic liver disease (2). It is also stated that bone mineral loss may occur in those with high dietary acid load due to the release of calcium from the bones as an acid buffer. However, age, gender, race, physical activity and kidney functions are the determining factors in bone mineral loss (3).

Mental health is another issue where the impact of dietary acid load has been investigated. Limited number of studies have shown that an increase in dietary acid load has a negative effect on mental health-related parameters such as depression, anxiety and stress in adults (4-7). In addition, the results of a study evaluating the effect of dietary acid load on mental health in children and adolescents reported that high dietary acid load may be associated with emotional problems and hyperactivity at 10-years (8). Acid-sensing ion channel-1a in the amygdala, which is essential for mood regulation, can be stimulated by high pH. Additionally, metabolic acidosis might raise cortisol release, which has been linked to mental health (7).

The aim of this planned study was to evaluate the effect of dietary acid load on mental health variables such as depression, anxiety and stress in adults.

MATERIAL and METHOD

Study Participants

This study was planned to evaluate the relationship between dietary acid load and mental health in adults who were over 18 years old, residing in Karaman province and without any chronic disease. When the power analysis was performed with 95% power and 5% margin of error using data regarding the effect of dietary acid load on depression (odds ratio: 0.63, effect size: 0.71) from a similar previous study (7), the number of samples of 106 was found sufficient. The study was completed with 251 participants (49% male, 51% female). Ethical approval was received for the research from Karamanoğlu Mehmetbey University Social and Human Sciences Scientific Research and Publication Ethics Committee on 22.04.2024 with decision number 06-2024/135.

Data Collection

The data were collected using a face-to-face interview technique via questionnaire. The questionnaire consists of general information (gender, age, education level, working status, marital status, smoking and alcohol use), Godin leisure time physical activity questionnaire, Depression, Anxiety Stress-21 Scale and 24-hour retrospective food consumption record. Body weight and height were taken based on declaration.

Godin leisure time physical activity questionnaire, developed by Godin and Stephard in 1985, was used to determine the physical activity level of the participants (9). The purpose of the questionnaire is to remind participants of how many days in a week they engaged in vigorous, moderate, or mild physical exercise for at least fifteen minutes. The frequency of vigorous, moderate, and mild physical activity for at least 15 minutes is multiplied by the coefficients of 9, 5, and 3, respectively, to determine the scale's overall score. A total score of 24 and above indicates active, scores between 14-23 indicate moderately active, and <14 points indicate sedentary participants (10). The Turkish validity and reliability study of Godin leisure time physical activity questionnaire was conducted by Yerlisu Lapa and Yağar in 2015 (11).

Depression Anxiety and Stress Scale (DASS) short form was used to assess the mental health of the participants. DASS was developed by Lovibond in 1983 as a 42-item scale to meet high psychometric standards. The scale is a 4-point Likert-type self-assessment form (12). In order to shorten the application time, a 21-item short form of the scale was published later (13). The Turkish validity and reliability study of the scale was conducted by Yılmaz et al. Cronbach's alpha internal consistency coefficients of the 3 sub-dimensions of the scale were tested as .84 for the anxiety sub-dimension, .91 for the depression sub-dimension, and .90 for the stress sub-dimension (14).

Dietary Assessment and Definition of Dietary Acid Load

Energy and nutrient intakes of the participants were assessed using 24-hour retrospective food consumption records, analyzed with the Nutrition Information Systems Package Program (BEBIS). Dietary Acid Load provides an estimate of endogenous acid production. Potential renal acid load (PRAL) helps estimate the effect of diet on urine acidity (15). High PRAL value indicates increased acidic load. Since there is no cut-off point determined for PRAL value, median values were determined for PRAL, and classification was made as high-low according to the median value. The PRAL calculation formula developed by Remer and colleagues (16) is as follows:

PRAL (mEq/day) = 0.4888 x protein (g/day) + 0.0366 x phosphorus (mg/day) - 0.0205 x potassium (mg/day) – 0.0125 x calcium (mg/day) – 0.0263 x magnesium (mg/day)

Another method used to estimate dietary acid load is net endogenous acid production (NEAP) developed by Frassetto and colleagues (17). Similarly, there is no cut-off point determined for NEAP value, median values were determined for NEAP, and classification was made as high-low according to the median value. The formula used in calculating NEAP is given below. The unit for potassium in the formula is mEq. The amount of potassium obtained from the food consumption record analysis was multiplied by 0.0256 to convert mg to mEq.

NEAP (mEq/day) = [54.5 x protein (g/day) / potassium (mEq/day)] – 10.2

Statistical Analysis

The data were analyzed using SPSS 22.0 program with appropriate statistical methods. The suitability of the variables to normal distribution was examined by Shapiro-Wilk test. Descriptive values are stated as arithmetic mean ($\bar{x}$) and standard deviation (SD). Categorical information was represented by number and percentage. Median values were determined for PRAL and NEAP and classification was made as high-low according to the median value. General characteristics of participants, daily dietary intakes and foods groups were compared by Mann-Whitney U test for descriptive variables and Pearson chi square ($\chi 2$) test for categorical variables according to PRAL and NEAP. Spearman correlation analysis was used to correlate nutrients and food groups with DASS scores. When examining the hypothesis tests, $\alpha=0.05$ and accordingly the confidence interval was determined as 95%, and significance was evaluated at $p<0.05$.

RESULTS

The study was completed with 251 participants (49% male, 51% female). The mean age of participants with high PRAL or NEAP groups was significantly higher than the low PRAL or NEAP groups ($p=0.028$ and $p=0.040$, respectively). Regarding marital status, the ratio of single participants in the high PRAL or NEAP groups was significantly higher than in the low groups ($p=0.024$ and $p=0.004$, respectively). Additionally, significant differences were found in the high NEAP group compared to the low NEAP group in terms of gender, education level and working status ($p<0.05$). NEAP levels are higher in males, participants with higher levels of education and those who are employed. However, there was no significant difference between the groups in terms of physical activity level, BMI and DASS-21 scores ($p>0.05$). Comparison of general characteristics, BMI and DASS-21 scores of participants according to dietary acid load was given Table 1.

Table 1. Comparison of general characteristics, BMI and DASS-21 scores of participants according to dietary acid load

Variables	PRAL		p[1]	NEAP		p[2]
	Low (<11.1, n=126)	High (≥11.1, n=125)		Low (<56.9, n=125)	High (≥56.9, n=126)	
Age (year)						
x̄±SD	31.2±11.07	27.9±9.00	**0.028**	31.4±11.32	27.8±8.65	**0.040**
Gender						
Male	57 (45.2%)	66 (52.8%)	0.231	52 (41.6%)	71 (56.3%)	**0.019**
Female	69 (54.8%)	59 (47.2%)		73 (58.4%)	55 (43.7%)	
Education status						
Before high school	19 (5.1%)	14 (11.2%)		23 (18.4%)	10 (8.0%)	
High school	80 (63.5%)	79 (63.2%)	0.296	76 (60.8%)	83 (65.9%)	**0.025**
Bachelor's degree	27 (21.4%)	29 (23.2%)		26 (20.8%)	30 (23.8%)	
Postgraduate	-	3 (2.4%)		-	3 (2.4%)	
Working status						
Yes	55 (43.7%)	62 (49.6%)	0.345	50 (40.0%)	67 (53.2%)	**0.036**
No	71 (56.3%)	63 (50.4%)		75 (60.0%)	59 (46.8%)	
Marital status						
Single	65 (51.6%)	82 (65.6%)	**0.024**	62 (49.6%)	85 (67.5%)	**0.004**
Married	61 (48.4%)	43 (34.4%)		63 (50.4%)	41 (32.5%)	
Physical activity level						
Sedentary	40 (31.7%)	37 (29.6%)	0.071	38 (30.4%)	39 (31.0%)	0.185
Minimal active	45 (35.8%)	31 (24.8%)		44 (35.2%)	32 (25.3%)	
Active	41 (32.5%)	57 (45.6%)		43 (34.4%)	55 (43.7%)	
Body mass index (BMI)						
x̄±SD	24.0±4.21	24.5±3.81	0.297	24.0±4.15	24.5±3.88	0.334
Underweight	15 (11.9%)	9 (7.2%)		16 (12.8%)	8 (6.3%)	
Normal	64 (50.8%)	63 (50.4%)	0.541	62 (49.6%)	65 (51.7%)	0.336
Overweight	38 (30.2%)	45 (36.0%)		38 (30.4%)	45 (35.7%)	
Obese	9 (7.1%)	8 (6.4%)		9 (7.2%)	8 (6.3%)	
Depression Anxiety and Stress Scale (DASS)-21						
Total score	14.9±9.75	16.1±10.83	0.541	15.1±9.74	15.9±10.85	0.818
Anxiety subscale score	4.1±3.29	4.5±3.72	0.577	4.2±3.30	4.4±3.71	0.826
Depression subscale score	5.0±3.79	5.4±4.18	0.494	5.1±3.81	5.3±4.16	0.800
Stress subscale score	5.7±4.09	6.2±4.28	0.262	5.8±4.07	6.2±4.29	0.472

Medians of PRAL and NEAP scores were used in statistical analysis.
PRAL: Potential renal acid load, DAL, NEAP: Net endogenous acid production
Mann-Whitney U test, Pearson Chi-Square test

Comparison of dietary intake of energy, nutrients and food groups according to dietary acid load was given Table 2. Dietary energy, protein, vitamin B12, niacin, phosphorus, and zinc intake were significantly higher in the high PRAL or NEAP group than in the low groups ($p<0.05$). On the contrary, dietary fiber, antioxidant, vitamin C and potassium intake were significantly lower in the high PRAL or NEAP groups ($p<0.05$). When evaluated in terms of food groups, fruit consumption was significantly lower in the high PRAL or NEAP groups ($p=0.009$ and $p=0.032$, respectively), while red meat consumption was significantly higher ($p=0.040$ and $p=0.021$, respectively). Also, poultry consumption is significantly higher in low PRAL group compared to higher group ($p=0.034$).

Table 2. Comparison of dietary intake of energy, nutrients and food groups according to dietary acid loa

Variables	PRAL		p[1]	NEAP		p[2]
	Low (<11.1, n=126)	High (≥11.1, n=125)		Low (<56.9, n=125)	High (≥56.9, n=126)	
Nutrients						
Energy (kcal)	1533.3±503.84	1934.5±532.74	**<0.001**	1613.5±528.83	1851.7±557.05	**0.001**
Protein (g)	51.3±17.70	78.0±22.57	**<0.001**	54.0±19.59	75.0±23.94	**<0.001**
Dietary fat (%)	35.5±8.09	36.7±6.57	0.230	35.6±7.73	36.7±7.00	0.190
Dietary fiber (g)	20.3±7.57	17.4±7.20	**0.001**	21.2±7.21	16.6±7.10	**<0.001**
Antioxidant content (mmol)	2.0±1.25	1.6±3.32	**<0.001**	2.1±1.17	1.5±3.33	**<0.001**
Vitamin A (mcg)	850.4±1015.3	701.5±526.76	0.632	918.8±1067.48	634.9±382.50	**0.016**

Vitamin E (mg)	15.4±7.57	16.5±7.47	0.164	16.1±7.83	15.8±7.24	0.907
Thiamine (mg)	0.8±0.31	0.8±0.29	0.796	0.8±0.30	0.7±0.30	0.073
Riboflavin (mg)	1.1±0.48	1.2±0.53	**0.004**	1.1±0.48	1.2±0.54	0.478
Niacin (mg)	10.5±5.28	17.4±8.80	**<0.001**	11.2±6.27	16.7±8.60	**<0.001**
Folic acid (mcg)	268.2±127.13	247.9±129.70	0.083	281.4±128.12	234.9±125.24	**<0.001**
Vitamin B_{12} (mcg)	3.3±3.56	5.1±6.23	**<0.001**	3.4±3.59	5.0±6.22	**<0.001**
Vitamin C (mg)	118.9±81.25	53.1±44.87	**<0.001**	121.5±78.69	51.0±46.23	**<0.001**
Potassium (mg)	2224.7±749.92	1988.2±687.40	**0.011**	2335.7±723.05	1879.9±659.93	**<0.001**
Calcium (mg)	544.7±231.40	612.3±283.07	0.147	570.4±232.05	586.2±285.98	0.756
Magnesium (mg)	232.2±81.66	229.0±73.58	0.780	243.1±77.56	218.1±75.91	**0.010**
Phosphorus (mg)	844.4±289.78	1100.7±338.60	**<0.001**	895.9±303.55	1047.5±357.43	**0.001**
Iron (mg)	8.6±3.47	9.0±3.21	0.174	9.0±3.42	8.5±3.26	0.264
Zinc (mg)	7.5±3.03	9.5±3.47	**<0.001**	7.8±3.06	9.3±3.58	**0.001**
Food groups						
Whole grain bread (g)	5.2±22.15	2.6±15.25	0.244	4.8±21.69	3.1±16.02	0.539
White bread (g)	117.0±79.10	118.4±87.30	0.972	115.9±78.22	119.4±87.99	0.928
Fruits (g)	143.5±147.07	103.7±143.02	**0.009**	139.2±147.68	108.2±143.50	**0.032**
Vegetables (g)	175.6±139.31	174.5±152.05	0.760	169.8±142.06	180.3±149.23	0.551
Nuts (g)	4.4±10.72	6.5±11.63	0.068	4.8±11.06	6.2±11.36	0.106
Legumes (g)	13.6±23.19	18.2±24.50	0.054	13.4±22.35	18.4±25.22	0.075
Dairy and dairy products (g)	205.1±163.22	179.0±144.85	0.113	204.0±163.04	180.4±145.42	0.146
Olive oil (g)	1.4±4.93	1.4±5.43	0.969	1.5±4.95	1.3±5.41	0.646
Fish (g)	4.8±28.72	4.5±26.98	0.991	5.3±31.12	4.0±24.20	0.979
Red meat (g)	14.7±39.03	19.8±38.85	**0.040**	14.1±38.60	20.4±39.19	**0.021**
Poultry (g)	46.0±60.03	32.0±56.78	**0.034**	45.0±60.01	33.0±57.06	0.104

Medians of PRAL and NEAP scores were used in statistical analysis.
PRAL: Potential renal acid load, DAL, NEAP: Net endogenous acid production
Mann-Whitney U test

Correlation of dietary acid load, nutrients and food groups with DASS-21 scores was given Table 3. No significant relationship was found between dietary acid load and DASS-21 scores. Increased dietary intake of thiamine, magnesium, and iron was significantly associated with a decrease in anxiety subscale scores ($p<0.05$). When evaluated in terms of food groups, a significant negative relationship was shown only between vegetable consumption and total DASS-21 score ($r=-0.128$, $p=0.043$) and stress subscore ($r=-0.129$, $p=0.041$).

Table 3. Correlation of dietary acid load, nutrients and food groups with DASS-21 scores

Variables	**Total DASS-21**		**Anxiety**		**Depression**		**Stress**	
	r	**p**	**r**	**p**	**r**	**p**	**r**	**p**
Dietary acid load								
PRAL	0.046	0.466	0.028	0.662	0.060	0.341	0.084	0.187
NEAP	0.046	0.464	0.038	0.552	0.062	0.325	0.061	0.334
Nutrients								
Energy	-0.052	0.414	-0.026	0.683	-0.034	0.588	-0.003	0.964
Protein	-0.051	0.421	-0.107	0.091	-0.031	0.630	0.055	0.382
Carbohydrate	-0.053	0.400	-0.015	0.816	-0.043	0.493	-0.016	0.806
Dietary fat	-0.009	0.890	0.012	0.846	-0.005	0.938	0.017	0.787
Dietary fiber	-0.041	0.517	-0.067	0.290	-0.038	0.546	0.000	0.999
Antioxidant content	-0.050	0.433	0.000	0.999	-0.091	0.153	-0.015	0.812
Vitamin A	0.036	0.570	0.046	0.474	-0.030	0.640	0.071	0.261
Vitamin E	-0.075	0.236	-0.028	0.660	-0.062	0.326	-0.066	0.299
Thiamine	-0.107	0.090	-0.151	**0.017**	-0.079	0.212	-0.033	0.601
Riboflavin	-0.066	0.296	-0.087	0.168	-0.077	0.223	0.019	0.768
Niacin	-0.016	0.803	-0.105	0.099	-0.028	0.662	0.113	0.074
Folic acid	-0.079	0.211	-0.088	0.164	-0.102	0.108	-0.023	0.713

Vitamin B_{12}	-0.011	0.857	-0.059	0.350	0.010	0.872	0.049	0.436
Vitamin C	-0.046	0.467	-0.034	0.594	-0.089	0.161	-0.027	0.674
Potassium	-0.094	0.138	-0.319	0.028	-0.098	0.121	0.007	0.916
Calcium	0.014	0.821	0.036	0.573	-0.059	0.354	0.074	0.241
Magnesium	-0.085	0.182	-0.125	**0.048**	-0.080	0.208	0.004	0.944
Phosphorus	-0.050	0.432	-0.087	0.172	-0.051	0.418	0.048	0.450
Iron	-0.088	0.166	-0.129	**0.041**	-0.081	0.203	0.013	0.838
Zinc	-0.048	0.450	-0.093	0.142	-0.035	0.578	0.031	0.627
Food groups								
Whole grain bread	0.017	0.794	-0.012	0.850	0.052	0.414	0.038	0.553
White bread	0.042	0.509	0.035	0.584	0.006	0.924	0.071	0.261
Fruits	-0.021	0.738	-0.050	0.436	-0.042	0.508	0.033	0.599
Vegetables	-0.128	**0.043**	-0.077	0.225	-0.114	0.070	-0.129	**0.041**
Nuts	-0.068	0.286	-0.013	0.836	-0.056	0.381	-0.089	0.159
Legumes	-0.059	0.354	-0.048	0.450	-0.091	0.149	-0.033	0.607
Dairy	0.014	0.824	-0.010	0.873	-0.002	0.980	0.032	0.610
Olive oil	-0.099	0.117	-0.095	0.132	-0.089	0.160	-0.064	0.313
Fish	-0.055	0.385	-0.066	0.301	-0.052	0.412	-0.041	0.516
Red meat	0.036	0.572	0.056	0.381	0.023	0.720	0.040	0.529
Poultry	0.023	0.722	0.019	0.769	0.071	0.261	-0.022	0.732

PRAL: Potential renal acid load, DAL, NEAP: Net endogenous acid production
Spearman Correlation

DISCUSSION

The aim of this planned study was to evaluate the effect of dietary acid load on mental health variables such as depression, anxiety and stress in adults. However, the results have shown that dietary acid load was not associated with depression, anxiety and stress. Limited number of studies have shown that an increase in dietary acid load has a negative effect on mental health-related parameters such as depression, anxiety and stress in adults (4-7). Normally, there are several hypotheses that have been put forward regarding the relationship between dietary acid load and mental health. The first of these is that the acid-sensing ion channel-1 in the amygdala is activated by high dietary acid load. It is known that this pathway may be related to mood regulation. The second hypothesis is that the increase in acid load stimulates the release of cortisol which is a hormone associated with stress (7). Third hypothesis is that diets with high dietary acid load may increase inflammation and negatively affect mental health due to their high content of animal protein and processed foods (4). Lastly, high dietary acid load is a factor that increases plasma lipid levels and the risk of obesity (18) and obesity is a factor that negatively affects mental health and quality of life (19). When evaluated according to these hypotheses, one of the reasons why no relationship was found between dietary acid load and mental health in this study may be that the participants had normal BMI (Table 1). In addition, physical activity/exercise is a promising in the mental health (20). In this study, the low ratio of sedentary participants in the groups (approximately 30% in each group, Table 1) may have played a role in the lack of a relationship between dietary acid load and mental health as a confounding factor.

Another finding obtained in the study is that the mean age was lower, and the ratio of singles was higher in the high PRAL or NEAP groups. In addition, the ratio of males, level of education and the ratio of employed participants were higher in the high NEAP group. The reason for these findings may be that younger, single or employed participants had a habit of consuming outside food (perhaps at least one meal a day). Fast and processed foods are associated with an increase in the acid load of the diets (21). Also, meat and its products, cheese and grain products increase the dietary acid load. Conversely, vegetables and fruits have a low dietary acid load (22). Because phosphorus and proteins are the dietary components that release acid precursors during metabolism. The nutrients calcium, magnesium, and potassium are alkali precursors (1). The fact that the amount of red meat consumption was significantly higher in the high PRAL or NEAP groups and the amount of fruit and poultry was lower proving this (Table 2). Protein and phosphorus intake was found to be significantly higher and potassium intake was found to be significantly lower in the high PRAL or NEAP groups, also supporting the literature (Table 2). In addition, diets with low dietary acid load

are rich in nutrients such as high fiber, antioxidants, vitamin C and folic acid because they contain low processed foods and high amounts of plant-based foods.

Finally, dietary thiamine, magnesium and iron intake were found to be significantly negatively associated with anxiety (Table 3). Vitamin B1, or thiamine, is essential for healthy cell activity. Necessary for energy metabolism and mitochondrial function. Additionally, it is required for the central and peripheral nervous systems to operate properly, as it plays a role in the synthesis of neurotransmitters (23). Therefore, there may be a negative correlation between depressive symptoms and thiamine levels in adults (24). Blockade of the glutamatergic N-methyl-D-aspartate receptor, modulation of the hypothalamic–pituitary–adrenal axis and synergistic effect with selective serotonin reuptake inhibitor are mechanisms for the effect of magnesium on mental health (25). Iron is also a trace element that has important functions in the body. It is necessary for the synthesis of peroxidases, which have antioxidant properties, and catecholamines such as dopamine, epinephrine and norepinephrine, which influence behavior (26). In a cross-sectional in Turkish adults, it was shown that patients with iron deficiency anemia had higher levels of anxiety compared to the control group (27). This study also showed that increasing vegetable consumption can reduce stress levels (Table 3). A similar study showed that perceived stress was 10% less in those with highest fruit and vegetable consumption (28). Another study has reported that participants with higher intakes of cruciferous, yellow/orange/red, and legume vegetables had significantly lower odds (25–27%) of having high perceived stress. Therefore, it may help reduce stress to follow the advice to "eat a rainbow" of colors (29).

CONCLUSION

In conclusion, the results of the study did not show a relationship between dietary acid load and mental health determinants such as depression, anxiety and stress. However, the presence of confounding factors, insufficient number of participants and the assessment of dietary acid load from a one-day food intake record may have affected the results as limitations of the study. In addition, diets that are high in protein, phosphorus, red meat and processed food but low in fruit and vegetables have a high acid load. Following such diets can cause health problems in the long term. Therefore, choosing adequate, balanced and diverse diets is important in protecting mental health and improving the quality of life.

Declaration of Ethical Code

In this study, we undertake that all the rules required to be followed within the scope of the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with, and that none of the actions stated under the heading "Actions Against Scientific Research and Publication Ethics" are not carried out. Ethical approval was received for the research from Karamanoğlu Mehmetbey University Social and Human Sciences Scientific Research and Publication Ethics Committee on 22.04.2024 with decision number 06-2024/135.

Conflict of Interest

The authors declares that there is no conflict of interest.

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Author Contribution

Study design, Data collection, Data analysis, Draft preparation, Critical review for content and Final approval of the version to be published was made by BA.

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