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Inflammatory Potential of Medical Nutrition Therapy Plans in Some Neurologic Diseases: A Descriptive Cross-Sectional Research

Bazı Nörolojik Hastalıklarda Tıbbi Beslenme Tedavi Planlarının İnflamatuar Potansiyeli: Tanımlayıcı Kesitsel Araştırma

Elif EDE ÇİNTESUN[a], Büşra Nur AŞIK[b], Halime UĞUR[c], Jale ÇATAK[d]

[a]İstanbul Sabahattin Zaim University Faculty of Health Sciences, Department of Nutrition and Dietetics, Department of Nutritional Sciences, İstanbul, Türkiye
[b]İstanbul Sabahattin Zaim University, Institute of Graduate Education, Department of Nutrition and Dietetics, İstanbul, Türkiye
[c]İstanbul Medeniyet University Faculty of Health Sciences, Department of Nutrition and Dietetics, Department of Mass Nutrition Systems, İstanbul, Türkiye
[d]İstanbul Sabahattin Zaim University, Department of Nutrition and Dietetics, İstanbul, Türkiye

ABSTRACT Objective: This study aims to evaluate the Dietary Inflammatory Index (DII) of medical nutrition therapy menus of neurological diseases. **Material and Methods:** Medical nutrition therapy menus compatible with Alzheimer's, Parkinson's, Multiple Sclerosis (MS), and Migraine, and the ketogenic diet model were taken from the source containing the diets for Medical Nutrition Therapy in Adult Diseases. The energy and nutrient values obtained from the diets were analyzed using the BeBiS program and then calculated in Microsoft Excel 365 using the formula developed for the DII calculation method. The amounts of the analyzed values that meet the requirement were evaluated by comparing them with TUBER 2022 data. **Results:** The DII scores of the medical nutrition therapy menus used for Parkinson's, Alzheimer's, MS, and migraine were -6.93, -6.27, -5.39, and -3.43, respectively, from largest to smallest; a negative DII score indicates anti-inflammatory. In the ketogenic diet, a positive DII score was found and the diet was found proinflammatory (1.74). According to the DII scores of the diets, it was determined that menus used for Parkinson's, Alzheimer's, MS, and migraine had an antiinflammatory effect, while the ketogenic diet had an inflammatory effect. **Conclusion:** It has been observed that Parkinson's, Alzheimer's, MS, and migraine menus have antiinflammatory effects, while the ketogenic diet has inflammatory effects. In neurological diseases, inflammation plays a critical role in the progression of the disease and the exacerbation of symptoms. Dietary components that reduce or increase inflammation can affect the course of diseases. Therefore, determining the DII helps to understand the relationship between nutrition and inflammation.

Keywords: Dietary Inflammatory Index; neurological diseases; nutrition

ÖZET Amaç: Bu çalışmanın amacı, nörolojik hastalıkların tıbbi beslenme tedavisi menülerinde Diyet İnflamatuar İndeksini (Dİİ) değerlendirmektir. **Gereç ve Yöntemler:** Alzheimer, Parkinson, Multipl Skleroz ve Migren ile uyumlu tıbbi beslenme tedavisi menüleri ve ketojenik diyet modeli, Yetişkin Hastalıklarında Tıbbi Beslenme Tedavisi diyetlerini içeren kaynaktan alınmıştır. Diyetlerden elde edilen enerji ve besin öğesi değerleri BeBiS programı kullanılarak analiz edilmiş ve ardından Dİİ hesaplama yöntemi için geliştirilen formül kullanılarak Microsoft Excel 365'te hesaplanmıştır. Analiz edilen değerlerin gereksinimi karşılama miktarları TÜBER 2022 verileri ile karşılaştırılarak değerlendirilmiştir. **Bulgular:** Parkinson, Alzheimer, Multipl Skleroz ve migren için kullanılan tıbbi beslenme tedavisi menülerinin Dİİ skorları sırasıyla -6,93, -6,27, -5,39 ve -3,43 olup; negatif Dİİ skoru antiinflamatuar olduğunu göstermektedir. Ketojenik diyette ise pozitif bir Dİİ skoru bulunmuş ve diyetin proinflamatuar olduğu görüşmüştür (1,74). Diyetlerin Dİİ puanlarına göre Parkinson, Alzheimer, Multipl Skleroz ve migren için kullanılan menülerin antiinflamatuar etkiye sahip olduğu, ketojenik diyetin ise inflamatuar etkiye sahip olduğu belirlenmiştir. **Sonuç:** Parkinson, Alzheimer, Multipl Skleroz ve migren tedavisinde uygulanan menülerin antiinflamatuar, ketojenik diyetin ise inflamatuar etkileye sahip olduğu görülmüştür. Nörolojik hastalıklarda inflamasyon, hastalığın ilerlemesinde ve semptomların şiddetlenmesinde kritik bir rol oynar. İnflamasyonu azaltan veya artıran diyet bileşenleri hastalıkların seyrini etkileyebilir. Bu nedenle, Dİİ'yi belirlemek beslenme ve inflamasyon arasındaki ilişkiyi anlamaya yardımcı olmaktadır.

Anahtar Kelimeler: Diyet İnflamatuar İndeksi; nörolojik hastalıklar; beslenme

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Correspondence: Elif EDE ÇİNTESUN
İstanbul Sabahattin Zaim University Faculty of Health Sciences, Department of Nutrition and Dietetics, Department of Nutritional Sciences, İstanbul, Türkiye
E-mail: elif.ede@izu.edu.tr

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Neurological diseases are among the leading causes of morbidity and mortality, and rapidly increasing prevalence poses a serious health problem for millions of people worldwide.[1] Common neurological diseases, which have been shown to be the leading cause of disability globally and the 2nd most common cause of death, include Alzheimer's, Parkinson's, Multiple Sclerosis (MS), epilepsy, and stroke. The development of neurological diseases is highly complex due to the large number of possible causes.[2,3] Brain traumas, spinal cord injuries, and nerve injuries play an important role in the etiology of neurological disorders. In addition, genetic and environmental factors, congenital anomalies, infections, and unhealthy lifestyles are among the possible causes of central nervous system diseases.[4] In addition, micronutrient deficiencies (especially vitamin B_2 and vitamin B_{12}, iron, and copper) can lead to the onset of different neurological symptoms.[5] Increasing evidence suggests that inflammation and imbalances in the composition of the gut microbiome play an important role in the pathogenesis of different neurological diseases. Diet, as a modifiable lifestyle factor, plays an important role in regulating inflammation.[6] Therefore, inflammation can be effectively reduced by appropriate medical nutrition therapy.[7] A diet rich in fruits, vegetables, lean protein sources, omega 3 fatty acids, fiber, and whole grains is associated with lower levels of the inflammation markers C-reactive protein and interleukin-6. In contrast, the Western-style dietary pattern, rich in processed and high-fat foods, refined grains, simple carbohydrates, and red meat, increases inflammation and is associated with risks of various chronic diseases, including neurological diseases. Adequate and balanced dietary intake can influence the onset and course of many neurological disorders by restoring metabolic and oxidative balance and modulating inflammatory pathways in various tissues, including the brain.[6] In this context, the Dietary Inflammatory Index (DII) developed to evaluate the effects of diet on inflammatory processes is considered as an effective method. An increase in the DII score indicates that the diet has inflammation-enhancing properties.[8] In a study investigating the relationship between DII and Parkinson's disease, it was determined that the increase in DII scores was associated with the incidence of Parkinson's disease.[9] Another study on migraine patients found a direct relationship between headache frequency and DII.[10] In addition, a cohort study determined that higher DII scores increased the risk of Alzheimer's dementia.[11]

Current studies suggest that the Mediterranean-style dietary pattern has protective effects against Alzheimer's, Parkinson's, and MS diseases. In addition, the ketogenic diet has been shown to cause promising results in managing symptoms of drug-resistant epilepsy, MS, and Alzheimer's disease.[6,12] Calculation of the DII of diets applied in neurological diseases helps to determine the effect of nutrition on inflammation in the management of these diseases, contributing to the optimization of treatment strategies. In neurological diseases, inflammation plays a critical role in disease progression and exacerbation of symptoms. Dietary components that reduce or increase inflammation may affect the course of diseases.[13] Therefore, determining the inflammatory index of diets helps to understand the relationship between nutrition and inflammation. For that purpose, the present study aims to determine the DII of menus compatible with Alzheimer's, Parkinson's, MS, and Migraine, and the ketogenic diet model applied in the medical nutrition therapy of neurological disorders.

MATERIAL AND METHODS

SELECTION OF DATA

Medical nutrition therapy menus compatible with Alzheimer's, Parkinson's, MS, and Migraine, and the ketogenic diet model were taken from the source containing the diets for Medical Nutrition Therapy in Adult Diseases and are presented in Table 1.[14]

Dietary patterns applied in the medical nutrition therapy of neurological diseases were adapted to be 2,000 calories in all dietary patterns without changing the carbohydrate, protein, and fat percentages. In addition, the nutrients that may affect DII scores were chosen the same in all diet models. For example, since omega 3 intake affects the DII total score, fish was preferred instead of meat, chicken, and fish alternatives in all diet types. Thus, DII total scores were standardized.

TABLE 1: Medical nutrition therapy menus compatible with Alzheimer's, Parkinson's, MS and Epilepsy, and Migraine

Alzheimer's	Parkinson'	MS	Epilepsy	Migraine
Breakfast 1 tea glass of tea (without added sugar), 1 medium boiled egg, 1 slice of white cheese, cold cuts salad (oil-free), 1 teaspoon olive oil,	Breakfast 1 tea glass of tea (without added sugar), 2 walnuts, cold cuts of salad (without oil), 1 teaspoon of olive oil, 2 thin slices of whole wheat bread	Breakfast 1 tea glass of tea (without added sugar), 1 slice of white cheese, 2 walnuts, 3 thin slices of whole wheat bread	Breakfast 1 tea glass of tea (without added sugar), 1 teaspoon of coconut oil, 1 egg and omelet (with 1 teaspoon of butter), 1 slice of white cheese, 6 olives, 1 tablespoon of olive oil, 1 tablespoon of clotted cream, 1.5 teaspoons of butter, 1 thin slice of unsalted white bread	Breakfast 1 glass of milk, 1 large boiled egg, 1 slice of white cheese, 2 walnuts, 3 thin slices of whole wheat bread
Snack 1 medium orange, 15 almonds	Snack 1 small bowl of lemon curd, 2 walnuts	Snack 1 large orange, 3 tablespoons of yoghurt, 10 almonds	Snack 2 walnuts, 1 tablespoon tahini	Snack 1 small apple, 4.5 tablespoons of yoghurt
Lunch 1 ladle of lentil soup, 4 tablespoons of meat and vegetable dish, 3 tablespoons of rice pilaf, 4 tablespoons of yoghurt, 1 medium bowl of seasonal salad (oil-free), 2 thin slices of whole wheat bread	Lunch 1 ladle of lentil soup, 6 tablespoons of meatless vegetable dish, 1 medium bowl of seasonal salad (oil-free), 1 medium orange, 3 thin slices of whole wheat bread	Lunch 2 ladles of lentil soup, 4 tablespoons of meat and vegetable dish, 3 tablespoons of yoghurt, 1 medium bowl of seasonal salad (oil-free), 3 thin slices of whole wheat bread	Lunch 2 meatballs (fried without adding oil), 2 tablespoons of meatless vegetable dish, 2 tablespoons of olive oil, 1 teaspoon of mayonnaise	Lunch 1.5 scoops of lentil soup, 6 tablespoons of meat and vegetable dish, 5 tablespoons of yoghurt
Snack 1 large pear, 3 tablespoons of yoghurt, 1 medium sized rusk	Snack 1 glass of milk, 1 large apple	Snack 1 medium apple, 1 medium pear, 3 tablespoons of yoghurt	Snack 5 hazelnuts, 2 walnuts, 1 teaspoon tahini	Snack 1 large banana, 3 strawberries, 4 tablespoons of yoghurt
Dinner 2 meatballs (fried without adding oil), 4 tablespoons of meatless vegetable dish, 4 tablespoons of yoghurt, 3 thin slices of whole wheat bread	Dinner 3 tablespoons of meatless vegetable dish, 3 meatballs (fried without adding oil), 2 tablespoons of rice pilaf, 2 tablespoons of yoghurt, 1 medium bowl of seasonal salad (1 teaspoon of olive oil), 3 thin slices of whole wheat bread	Dinner 2 meatballs (fried without adding oil), 4 tablespoons of meatless vegetable dish, 4 tablespoons of rice pilaf, 3 tablespoons of yoghurt, 3 thin slices of whole wheat bread	Dinner 2 palm-sized boiled chicken, 2 tablespoons of meatless vegetable dish, 2 tablespoons of olive oil, 4 walnuts	Dinner 2 meatballs (fried without adding oil), 10 tablespoons of meatless vegetable dish, 5 tablespoons of rice pilaf, 5 tablespoons of yoghurt, 3 thin slices of whole wheat bread
Snack 1 medium apple, 1 tea glass of milk	Snack 1 glass of milk, 1 medium banana	Snack 1 glass of milk, 2 medium sized crackers	Snack 2 walnuts, 5 almonds	Snack 1 tea glass of milk, 1 medium apple, 2 medium sized crackers

ANALYSIS OF ENERGY AND NUTRIENTS

Energy and nutrient values of diets were analyzed with the Nutrition Information System (BeBis, Bebispro for Windows, Germany; Turkish Version/ BeBis 7) program. The analyses include macronutrients such as energy, carbohydrates, protein, and total fat (including saturated fat, monounsaturated fatty acids, polyunsaturated fatty acids, omega 3, omega 6, and cholesterol). Micronutrients analyzed include vitamin A, beta-carotene, vitamin D, vitamin E, thiamine, riboflavin, niacin, vitamin B_6, folic acid, vitamin B_{12}, vitamin C, iron, magnesium, zinc, and selenium. Spices and beverages, including green tea, black tea, onion, garlic, pepper, thyme, ginger, saffron, turmeric, and rosemary, are also included in the analyses. The amounts of the analyzed values meeting the requirement were evaluated by comparing them with TUBER 2022 data.[15]

DIETARY INFLAMMATORY INDEX

DII scores were calculated with the method developed by Shivappa et al. The data obtained from diets were calculated in Microsoft Excel 365 (Microsoft, USA) using the formula developed for the DII calculation method after being analyzed through the BeBiS program. 38 nutrient parameters in the BeBiS program were evaluated for including carbohydrates, protein, total fat, saturated fat, monounsaturated fatty acids, polyunsaturated fatty acids, omega 3, omega 6, cholesterol, fiber, vitamin A, beta-carotene, vitamin D, vitamin E, thiamine, riboflavin, niacin, vitamin B_6, folic acid, vitamin B_{12}, vitamin C, iron, magnesium, zinc, selenium and alcohol, green tea, black tea, onion, garlic, pepper, thyme, ginger, saffron, turmeric, rosemary, and trans fatty DII. After analyzing the data obtained from the diets through the BeBiS program, the formula developed for the DII calculation method was applied in Excel. First, for each dietary parameter, the individual's intake amount was subtracted from the global average intake, and the result was divided by the global standard deviation to obtain a Z-score. Then, the Z-score was transformed into a percentile score to minimize the effect of right skewness. The percentile score was multiplied by 2 and then reduced by 1 to obtain a centered percentile score ranging from -1 to +1. The calculated centered percentile score for each dietary parameter was then multiplied by the inflammatory effect score assigned to that nutrient. After determining the DII score for each dietary parameter, all these values were summed to calculate the overall DII score. The DII formula is shown below.[8]

DII formula=[(amount of nutrients consumed per day-global daily mean intake)/(standard deviation of a nutrient)]x[raw inflammatory effect score].

RESULTS

Table 2 shows the energy, macronutrient, and micronutrient values of the diets used in the medical nutrition therapy of neurological diseases and their percentages of compliance with the Dietary Guidelines for Turkey [Türkiye Beslenme Rehberi (TÜBER-2022)] reference values.[15] The menu for Alzheimer's disease meets the recommended vitamin and mineral requirements, but the amount of polyunsaturated fat and omega 6 was below the requirement. In Parkinson's disease and MS, the values of vitamin D, vitamin E, and cholesterol in the recommended menu were found to be below the requirement. In the ketogenic diet that used in the treatment of epilepsy, total fat, cholesterol, and omega fatty acids are above the requirement as a result of the ketogenic approach, while carbohydrates, fiber, vitamin C, thiamine, riboflavin, vitamin B_6, folic acid, iron, and magnesium did not meet the requirement. The diet recommended for migraine was found to be sufficient to meet all requirements except for vitamin E.

In Table 3, the DII scores of the types of diets applied in the medical nutrition therapy of neurological diseases are provided. The DII scores of the diets used for Parkinson's, Alzheimer's, MS, and migraine were -6.93, -6.27, -5.39, and -3.43 respectively, from largest to smallest, with a negative DII score indicating antiinflammatory. In the diet used in the disease of epilepsy, a positive DII score was found and it was observed that the diet was pro-inflammatory (1.74).

Table 4 shows the intakes of specific foods according to the types of diets used in medical nutrition therapy for neurological diseases such as Alzheimer's, Parkinson's, MS, epilepsy, and mi-

TABLE 2: Energy, macro, and micronutrient values and TUBER-2022 recommendations meeting percentages of diets applied in neurological diseases in compliance with according to the parameters used in DII calculation

Nutrients	Alzheimer	TÜBER (%)	Parkinson	TÜBER (%)	MS	TÜBER (%)	Epilepsy	TÜBER (%)	Migraine	TÜBER (%)
Energy (kcal)	1,999.97	124.12	2,000.12	124.13	1,999.98	124.12	1,999.99	124.12	1,999.83	124.11
Carbohydrate (g)	238.84	123.87	264.55	137.21	241.63	125.32	40.00	64.37	234.91	121.84
Carbohydrate (%)	47.76	94.57	52.90	104.75	48.32	95.68	8.00	15.84	46.98	93.02
Protein (g)	81.43	144.89	72.47	128.95	77.16	137.29	49.59	88.23	85.62	152.34
Protein (%)	16.28	112.27	14.49	99.93	15.43	106.41	9.91	68.34	17.12	118.06
Total fat (g)	76.93	121.34	68.62	108.23	78.02	123.05	184.59	291.15	76.33	120.39
Total fat (%)	34.61	100.31	30.87	89.47	35.10	101.73	83.06	240.75	34.35	99.56
Saturated fat (g)	28.22	141.80	21.76	109.34	28.29	142.16	51.94	261.00	27.81	139.74
Monounsaturated fat (g)	28.57	133.50	22.91	107.05	27.50	128.50	80.73	377.24	24.73	115,56
Polyunsaturated fat (g)	12.20	84.13	20.46	141.10	16.80	115.86	43.22	298.06	17.29	119.24
Omega 3 (g)	1.29	129.00	3.09	309.00	2.33	233.00	6.64	664.00	2.21	221.00
Omega 6 (g)	10.70	81.67	17.27	131.83	14.12	107.78	36.58	279.23	14.82	113.12
Cholesterol (mg)	412.85	206.75	150.00	75.11	161.08	80.66	416.53	208.57	372.40	186.47
Fiber (g)	45.39	236.40	37.74	196.56	42.37	220.67	9.60	50.00	34.58	180.10
Vitamin A (RE)	1,291.44	-	1,313.16	-	1,000.11	-	879.27	-	1,347.95	-
Beta carotene (µg)	5,370.00	-	6,680.00	-	3,940.00	-	1,750.00	-	5,830.00	-
Vitamin C (mg)	204.46	220.79	252.53	272.71	165.29	178.49	33.01	35.64	171.87	185.60
Thiamine (mg)	1.35	168.75	1.21	151.25	1.31	163.75	0.69	86.25	1.35	168.75
Riboflavin (mg)	2.09	209.00	1.76	176.00	1.85	185.00	0.87	87.00	2.43	243.00
Niacin (mg)	14.98	146.86	14.17	138.92	15.05	147.54	10.47	102.64	14.90	146.07
Vitamin B_6 (mg)	1.76	176.00	2.09	209.00	1.78	178.00	0.97	97.00	2.29	229.00
Folic acid (µg)	461.30	156.47	431.66	146.42	402.63	136.57	203.01	68.86	417.10	141.48
Vitamin B_{12} (µg)	5.28	195.55	5.10	188.88	4.80	177.77	3.80	140.74	6.62	245.18
Vitamin D (µg)	2.13	152.14	0.78	55.71	0.99	70.71	2.46	175.71	1.92	137.14
Vitamin E (µg)	17.47	111.27	13.88	88.40	14.54	92.6	17.71	112.80	13.92	88.66
Iron (mg)	15.67	174.11	15.00	166.66	15.67	174.11	7.27	80.77	13.84	153.77
Magnesium (mg)	467.84	186.61	436.36	174.05	478.45	190.84	212.02	84.57	452.20	180.37
Zinc (mg)	15.40	192.50	13.61	170.12	15.47	193.37	8.63	107.87	15.63	195.37
Selenium (µg)	16.14	-	0.00	-	0.00	-	12.55	-	13.45	-

TÜBER: Türkiye Beslenme Rehberi; MS: Multiple Sclerosis; RE: Retinol equivalent

TABLE 3: DII scores of the types of diets applied in the medical nutrition therapy of neurological diseases

Diseases	Total DII
Alzheimer	-6.27
Parkinson	-6.93
MS	-5.39
Epilepsy	1.74
Migraine	-3.43

DII: Dietary Inflammatory Index; MS: Multiple Sclerosis

graine. The foods listed in this table were used to calculate the DII as in Table 2, and the results show similar and different food intakes in each diet. Consumption of green/black tea was similar (2.5 g) in the diets used in the medical nutrition therapy of Alzheimer's disease, Parkinson's disease, MS, and epilepsy, while it was not used at all in migraine patients (0.0 g); onion intake was higher in Parkinson's disease and MS (59.0 and 67.0 g, respectively), lower in migraine (50.0 g) and Alzheimer's disease (38.0 g), and lowest in epilepsy (18.0 g). Garlic consumption was found to be at the same level (1.0 g) in the different diets used for the medical nutritional therapy of all these diseases, and a constant amount was used. The intake of pepper and thyme showed a similar trend; 2.0 g of pepper and 0.5 mg of thyme were used in each dietary treatment. None of the diets included ginger, saffron, turmeric, and rosemary.

TABLE 4: Intake amounts of certain foods according to the types of diets applied in the medical nutrition therapy of neurological diseases

Nutrients	Alzheimer	Parkinson's	MS	Epilepsy	Migraine
Green/black tea (g)	2.5	2.5	2.5	2.5	0.0
Onion (g)	38.0	59.0	67.0	18.0	50.0
Garlic (g)	1.0	1.0	1.0	1.0	1.0
Pepper (g)	2.0	2.0	2.0	2.0	2.0
Thyme (mg)	0.5	0.5	0.5	0.5	0.5
Ginger (g)	0.0	0.0	0.0	0.0	0.0
Saffron (g)	0.0	0.0	0.0	0.0	0.0
Turmeric (g)	0.0	0.0	0.0	0.0	0.0
Rosemary (g)	0.0	0.0	0.0	0.0	0.0

MS: Multiple sclerosis

DISCUSSION

This study evaluated the nutrient profiles and inflammatory potential of medical nutrition therapy menus for Alzheimer's, Parkinson's, MS, drug-resistant Epilepsy, and Migraine diseases. The energy, macronutrient, and micronutrient values of menus regarding Alzheimer's, Parkinson's, MS, drug-resistant Epilepsy, and Migraine and TÜBER recommendations are given in Table 2.

In Alzheimer's disease's diet plan, it was found that the menu has a balanced distribution of carbohydrates, proteins, and fats, and is particularly high in fiber, vitamin C, vitamin B_{12}, folic acid, and omega 3 fatty acids. These properties support brain health by reducing inflammation and strengthening antioxidant defenses. The high protein level is advantageous for cellular repair and neurotransmitter production, while carbohydrate content supports brain function by meeting energy needs. Among neurological diseases, the Alzheimer's diet had the highest fiber content which helps to support brain and vascular health, reduce inflammation, and protect the gut-brain axis. Overall, the antiinflammatory effect of diet and dietary diversity have significant potential to improve the quality of life of people with Alzheimer's disease.[11]

The special diet for Parkinson's disease is high in carbohydrates and low in protein. Among neurological disease diet plans, the amount of carbohydrates was highest in Parkinson's. Drugs commonly used to treat Parkinson's disease are absorbed in the intestines and brain in competition with proteins. Therefore, limiting protein and increasing carbohydrate intake is recommended in diet therapy. Increasing carbohydrate intake does not adversely affect the absorption of the drug, but helps to meet the energy requirement.[16] In Parkinson's diet plan, low fat and cholesterol values protect brain cells by reducing oxidative stress and lowering cardiovascular risks. Also, foods that support dopamine production are prioritized, while saturated fats are limited in order to protect both brain and heart health. In addition, the high fiber content may improve gut health and reduce inflammation. Overall, the anti-inflammatory properties and balanced nutrient distribution of this diet may favor symptom management and overall health status of patients with Parkinson's disease.[17]

The recommended diet for MS provides a basis for meeting overall nutrient requirements. Energy, carbohydrates, protein, and fat are maintained at appropriate levels, however may be high in saturated fat and omega 6, which has the potential to increase inflammation. The fiber, vitamin, and mineral content (especially vitamin C, vitamin B_6, folic acid, and zinc) was adequate for immune and nervous system health, but Vitamin D levels were found low, which may require supplementation for MS patients.[18]

The recommended diet for drug-resistant Epilepsy meets energy requirements and supports the ketogenic diet, especially with its low carbohydrate content. The carbohydrate amount was found quite low, which is a reflection of the ketogenic diet. When carbohydrates are limited, the body converts fats into ketones to produce energy. The brain can use ketones as an alternative energy source and this may help reduce the frequency and severity of seizures in some drug-resistant Epilepsy patients. Low carbohydrate consumption plays an active role in seizure control by helping to stabilize blood sugar and regulate the brain's energy balance. The severe restriction of carbohydrate intake on the ketogenic diet also limits the consumption of fiber foods. Keeping protein intake low in a ketogenic diet maintains ketosis by limiting glucose production and thus contributes to seizure control. Excess protein consumption may impair ketosis and make epileptic seizures more difficult to

control.[19] However, it was found that the amount of thiamine, riboflavin, vitamin B_6, vitamin C, iron, and magnesium in the ketogenic diet was lower than the daily requirement. The ketogenic diet can reduce the intake of these vitamins because it limits the natural sources of B vitamins by significantly restricting carbohydrate intake. High-fat consumption leads to the exclusion from the diet of foods rich in B vitamins, such as whole grains and legumes, which results in these vitamins playing a less prominent role in metabolism. The ketogenic diet also naturally reduces iron, magnesium, and zinc intake as it limits their dietary sources. Deficiencies of these micronutrients should managed with supplements or careful diet planning.[20]

The recommended diet for migraine showed that energy and macronutrients are at a level to meet the general requirements. The proportion of carbohydrates met the energy requirement, while the amounts of total fat and protein were balanced. Adequate protein intake in migraine may help to prevent the triggering of migraine attacks by stabilizing blood sugar. Proteins provide the amino acids required for the production of neurotransmitters such as serotonin, and since an imbalance in serotonin levels can trigger migraine, adequate protein intake can stabilize this. In addition, trigger foods to which migraine sufferers are sensitive can be limited and attacks can be better managed by choosing high-protein, non-trigger foods such as unprocessed meat and fish.[21]

According to DII scores of the diets, it was seen that the Parkinson's, Alzheimer's, MS, and migraine diets have an antiinflammatory, while the ketogenic diet has an inflammatory effect on the diet. Oxidative stress in the brain plays an important role in Parkinson's disease. High inflammation combines with oxidative stress to damage nerve cells. Therefore, dietary strategies to reduce inflammation in Parkinson's disease often focus on foods with antiinflammatory properties such as fruit, vegetables, whole grains, fish, and omega 3 fatty acids. Zeng et al. also revealed that higher DII scores are positively correlated with Parkinson's disease in adults over 40 years of age, suggesting that diet may play a role in the management of the condition.[12] Similarly, Melo van Lent. et. al indicated results from the Framingham Heart Study offspring cohort and concluded that higher DII scores were associated with a higher risk of incident all-cause dementia and Alzheimer's Disease; low DII scores may prevent late-life dementia.[22] Rad et al. also stated in their metaanalysis study that there was a positive association between higher DII scores with the likelihood of developing MS, highlighting that dietary inflammation could play a role in MS risk.[23] Sun et al. found that greater levels of DII were significantly related to an increased likelihood of migraine onset, especially among women and young and middle-aged populations.[24] Consistent with the results of these studies, the DII scores of Parkinson's, Alzheimer's, MS, and migraine diets were lower in the present study. The higher score of the DII in migraine compared to Parkinson's, Alzheimer's, and MS may be related to the lower content of vegetables and fruits in this diet. On the contrary, as expected, the high DII scores in drug-resistant epilepsy may attributed to high saturated fat values, limited availability of fiber and antioxidant-rich foods, and omega 6/omega 3 imbalance.[20]

Some foods, beverages, and spices that are used in calculating DII are indicated in Table 4. As seen, spices such as ginger, saffron, turmeric, and rosemary, positively affect the DII scores, however, they are not included in the dietary plan, increasing the consumption of these spices may help to improve DII scores. In this regard, it may be recommended to include these products including green tea, onion, garlic, pepper, thyme, ginger, saffron, turmeric, and rosemary in menu planning in accordance with diet therapy for improving DII scores.

This study evaluated the nutrient profile and DII of diets in neurological diseases including Alzheimer's, Parkinson's, drug-resistant Epilepsy, MS, and migraine. Considering the importance of inflammation in neurological diseases, the results of the present study are important in terms of clarifying this relationship, however, this study also has some limitations. The limitations of this study include difficulty in assessing individual differences, disease-specific dietary effects, lack of long-term data, diet sustainability, individual variability of the DII, and incomplete calculation of nutrient interactions which may limit the generalisability and accuracy of the results.

CONCLUSION

In this study, the nutritional profile and DII of diets applied in medical nutrition therapy for neurological diseases such as Alzheimer's, Parkinson's, drug-resistant epilepsy, MS, and migraine were evaluated. According to the DII scores of the diets, it was seen that Parkinson's, Alzheimer's, MS, and migraine diets had an antiinflammatory effect, while the ketogenic diet had an inflammatory effect. Considering the importance of inflammation in neurological diseases, the results of this study are important in terms of clarifying this relationship. Adequate and balanced dietary intake may influence the onset and course of many neurological disorders by restoring metabolic and oxidative balance and regulating inflammatory pathways in various tissues, including the brain. In this study, Parkinson's, Alzheimer's, MS, and migraine diets had lower DII scores. The higher DII score in the migraine diet compared to Parkinson's, Alzheimer's, and MS may be related to the lower content of vegetables and fruits in this diet. On the contrary, as expected, the higher DII scores in the ketogenic diet may be attributed to high saturated fat values, limited availability of fiber and antioxidant-rich foods, and omega 6/omega 3 imbalance.

Ethical Approval

This study did not require ethical approval, informed consent, or adherence to the Declaration of Helsinki as it did not involve human participants or identifiable personal data.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Elif Ede Çintesun;* ***Design:*** *Elif Ede Çintesun, Jale Çatak;* ***Control/Supervision:*** *Elif Ede Çintesun;* ***Data Collection and/or Processing:*** *Büşra Nur Aşık;* ***Analysis and/or Interpretation:*** *Elif Ede Çintesun, Büşra Nur Aşık, Jale Çatak, Halime Uğur;* ***Literature Review:*** *Elif Ede Çintesun, Büşra Nur Aşık;* ***Writing the Article:*** *Elif Ede Çintesun, Büşra Nur Aşık, Jale Çatak, Halime Uğur;* ***Critical Review:*** *Jale Çatak, Halime Uğur.*

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