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ORGINAL ARTICLE

Comparative analysis of the depressive symptoms and diet quality between Polish vegetarians and omnivores using Beck's Depression Inventory-II

Analiza porównawcza objawów depresji i jakości diety polskich wegetarian oraz osób spożywających mięso z wykorzystaniem Inwentarza Depresji Becka-II

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Abstract

Introduction and Objective. Among the factors influencing the development and inhibition of depression symptoms are food and nutrients. The aim of the study was analysis of depression symptoms among vegetarians and omnivores in Poland using BDI-II and assessment of the quality of their diet.

Materials and method. The study involved women, 50 vegetarians and 50 omnivores, aged 17–50. BDI-II, author›s questionnaire and nutritional diary were used for the analysis.

Results. Statistical analysis showed no significant relationship between the duration of the vegetarian diet and the occurrence of depression. There was no correlation between supplementation and the appearance or absence of depression symptoms. Vegetarians with symptoms of depression provided adequate amounts of magnesium. The results were statistically significant. Vitamin B_{12} deficiency was found in vegetarians with and without depressive symptoms (p>0.05). The consumption of omega-3 fatty acids, tyrosine and tryptophan was higher among non-depressives among vegetarians and omnivores. These results were not statistically significant. Vegetarians with symptoms of depression consume more alcohol (p>0.05). Vegetarians with symptoms of depression and omnivores without symptoms also consumed the most caffeine (p>0.05).

Conclusions. Depressive symptoms were more common among vegetarians. Analysis shows that it is impossible to find a nutritional cause that would have a significant impact on the development of depressive symptoms. In the studied group of vegetarians, nutrition was a insignificant factor in the presence or absence of depressive symptoms. Nevertheless, there is a need for additional research on the impact of a plant-based diet on the mental health of the vegetarian community, among both men and women.

Key words

depression, depressive symptoms, vegetarian diet, BDI-II, nutrition of vegetarians

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Streszczenie

Wprowadzenie i cel pracy. Jednym z czynników wpływających na rozwój i hamowanie objawów depresji jest żywność i składniki odżywcze. Celem pracy była analiza objawów depresji wśród polskich wegetarian i wszystkożerców za pomocą BDI-II oraz ocena jakości ich diety.

Materiał i metody. W badaniu wzięło udział 50 wegetarianek i 50 kobiet spożywających mięso w wieku od 17 do 50 lat. Do analizy wykorzystano BDI-II, autorski kwestionariusz oraz dzienniczek żywieniowy.

Wyniki. Analiza statystyczna nie wykazała istotnego związku między czasem trwania diety wegetariańskiej a występowaniem depresji. Nie stwierdzono korelacji pomiędzy suplementacją a pojawieniem się lub brakiem objawów depresji. Wegetarianki z objawami depresji dostarczały swojemu organizmowi odpowiednie ilości magnezu, przy czym wyniki te były istotne statystycznie. Niedobór witaminy B_{12} stwierdzono zarówno u wegetarianek z objawami depresji, jak i u tych bez takich objawów ($p > 0,05$). Spożycie kwasów tłuszczowych omega-3, tyrozyny, tryptofanu było wyższe wśród osób bez depresji zarówno w grupie wegetarianek, jak i wszystkożernych, jednak wyniki te nie były istotne statystycznie. Wegetarianki z objawami depresji piły więcej alkoholu ($p > 0,05$). Wegetarianki z objawami depresji i wszystkożerne bez objawów również spożywały najwięcej kofeiny ($p > 0,05$).

Wnioski. Objawy depresyjne częściej występowały wśród wegetarianek. Z przeprowadzonej analizy wynika, że nie jest możliwe znalezienie przyczyny żywieniowej, która miałaby istotny wpływ na rozwój objawów depresyjnych. W badanej grupie wegetarianek odżywianie nie miało większego wpływu na wystąpienie lub brak objawów depresyjnych. Niemniej jednak istnieje potrzeba dodatkowych badań nad wpływem diety roślinnej na zdrowie psychiczne społeczności wegetariańskiej, nie tylko kobiet, ale także mężczyzn.

Słowa kluczowe

depresja, objawy depresji, dieta wegetariańska, BDI-II, żywienie wegetarian

INTRODUCTION

Depression is a mental illness that affects approximately 350 million people worldwide, and affects women more often than men [2]. In Poland alone, the number of people suffering from the disease exceeds 4 million [1]. Depression is characterized by malaise, mood instability, sadness, emptiness, irritability, negative self-esteem, and withdrawal behaviour from social life [3]. Many tools are used to diagnose and monitor depression; however, the one most frequently used is the Beck Depression Inventory-II, a standardized diagnostic tool for assessing depression symptoms in the general population, tracking changes in the severity of symptoms, and monitoring the course of treatment [4].

One factor that affects the risk of its occurrence is diet. Along with food, nutrients are consumed which play a crucial role in the functiong of the human mind [5]. The right amount of specific food ingredients is required to produce neurotransmitters. These include amino acids (tyrosine, tryptophan), B vitamins (B_6, B_{12}, folic acid), as well as minerals: zinc, copper, iron, and magnesium [6,7]. The above-mentioned nutrients are commonly found in foods (Tab. 1.

An insufficient supply of the above ingredients increases the risk of depression. In the case of, e.g., lack of an adequate amount of tyrosine and tryptophan will result in a deficiency of noradrenaline and dopamine, consequently leading to depression [19]. Omega-3 fatty acids are important for the proper functioning of nerve transmission and affect the production of serotonin, noradrenaline and dopamine. A deficiency of omega-3 fatty acids can disrupt the balance and lead to mood disorders, including depression [20]. Vitamin B_{12}, B_6, and folic acid also have neurotransmitter functions, and deficiency leads not only to dysfunction but also to increased levels of homocysteine which, among other things, disrupt the functioning of the brain, [21]. In turn, zinc and iron play an important role in the regulation of cellular functions and neuromodulation. Copper, as a component of enzymes, plays a key role in anti-oxidant protection, reducing oxidative stress, which is one of the causes of depression [22]. Magnesium is an essential element involved in the reactions that regulate the body›s response to stress on several levels. It is essential for the proper functioning of receptors and enzymes involved in neural transmission, including the synthesis of neurotransmitters such as serotonin [23].

Table. 1. Natural sources of food ingredients responsible for the production of neurotransmitters

Nutrient	Food source
Tyrosine	Cheese, soybeans, beef, lamb, pork, fish, chicken, nuts, eggs, dairy, beans, and whole grains [8].
Tryptophan	Mozzarella cheese, pumpkin seeds, sesame seeds, sunflower seeds, cheese, pork, poultry, linseed, tuna, trout, cocoa, cod, salmon, cashew nuts, walnuts, hazelnuts, boiled eggs [9].
Vitamin B_6	Chickpeas, beef liver, tuna, salmon, chicken breast, boiled potatoes, turkey, banana, bulgur, nuts, spinach and tofu [10].
Vitamin B_{12}	Beef, beef liver, mussels, salmon, milk, natural yogurt, cheddar cheese, eggs, turkey breast, as well as in plant based-products. e.g. tempeh, sea-buckthorn jam and pickled parsley juice [11,12].
Folic acid	Beef liver, wheat germ, peanuts, as well as green vegetables: cooked spinach, asparagus, brussels sprouts, romaine lettuce, avocado, raw spinach, broccoli and green peas [13].
Zinc	Beef tenderloin, oatmeal, pumpkin seeds, wholegrain products [14]
Copper	Beef liver, dark chocolate, shiitake mushrooms, boiled potatoes, cashew nuts [15].
Iron	Canned white beans, beef liver, cooked lentils, cooked spinach, tofu [16].
Magnesium	Pumpkin seeds, chia seeds, almonds, spinach, cashews, peanuts, soy milk, black beans, peanut butter [17].
Omega-3 fatty acids	Flaxseed, flaxseed oil, chia seed, herring, canola oil, mackerel, salmon, soybean oil, rainbow trout, mayonnaise, tuna, canned beans, wholegrain bread [18].

The traditional omnivore diet is based on all foods, and there are no restrictions on consuming meat and animal products; it is usually rich in saturated fatty acids, arachidonic acid, found in meat and associated with lowering mood [24]. Vegetarian diets are the opposite of omnivorous diets. They are characterized by resignation from eating meat and, depending on the restrictions, animal products such as dairy products, eggs, and honey in favour of more vegetables, fruits, and cereal products [25]. Research confirms that plant-based diets mainly reduce the risk of diet-related diseases, such as hypertension, obesity, type II diabetes, metabolic syndrome, and cancer, e.g., large intestine and prostate [25, 26, 27, 28].

The results of some studies indicate a correlation between the use of a plant-based diet and the occurrence of depression [29, 30, 31]. In a comparative study of mood, lifestyle, and diet among vegans and people on a conventional diet, herbivores had better mental health associated with less stress and anxiety [32]. Askari et al. summarized the results of more than a dozen studies that included European and Asian vegetarians and vegans, examining their tendency to develop depression or anxiety. Although most analyzes did not link the use of plant-based diets with the occurrence of depression [33], different results have been presented in the meta-analysis by Iguacel et al. [34]. Studies have shown that vegan and vegetarian diets were associated with a higher risk of depression and anxiety. Also, in Germany, anxiety and depressive disorders more often affected adult vegans after considering socio-demographic characteristics with cross-sectional data [35].

In contrast, an Australian study, also designed to show the effect of a plant-based diet on depression, emphasized the quality of the diet. 219 vegetarians and vegans aged 18–44 were surveyed. It was shown that a low-quality plant-based diet was associated with increased depressive symptoms and a high-quality plant-based diet with a reduction in the symptoms [36].

To date, no such studies have been conducted among the Polish population.

OBJECTIVE

Due to such divergent results, the aim of the study was to carry out a comparative analysis of the occurrence of depressive symptoms among Polish vegetarians and omnivores using the Beck Depression Inventory, and assess the quality of their diet. The research hypothesis assumed that providing the right amount of nutrients with diet and supplementation is associated with a lower risk of depressive symptoms. In the case of subjects using a plant-based diet, it was also checked whether the length of the plant-based diet significantly impacted the appearance of depression symptoms.

MATERIALS AND METHOD

The study was conducted according to the guidelines of the Declaration of Helsinki and approve by the University Ethics Committee for Scientific Research with the Participation of People of the University of Life Sciences in Lublin, eastern Poland (Resolution No. UKE/01/2023).

Study group. To select a group of subjects using a vegetarian diet, an advertisement was published via a forum of people using plant-based diets on a popular social networking site between February – April 2023. 50 women and 7 men applied for the study. Due to such a significant disproportion in the number of representatives of both genders, men were excluded from the research, leaving a group of women aged 17–50 as participants. To maintain gender homogeneity, 50 women following a conventional diet were also selected via a social networking site. This group consisted of women aged 18–50. Participation in the study was voluntary and anonymous.

Research tools. Beck's Depression Inventory II (BDI-II, a questionnaire consisting of 21 items, on which answers are scored on a 4-point scale ranging from 0, indicating no symptoms, to 3, indicating severe symptoms [37]. BDI-II questions concern, e.g., sadness, pessimism, loss of pleasure, failures, energy loss, sleep rhythm changes, irritability, difficulty concentrating, fatigue, suicidal thoughts, etc. [38]. The result is obtained by summing-up the points for all 21 items. Severe depression is considered to be >29, moderate depression – 20–28, mild depression – 14–19 points, and lack of depressive symptoms – <14 points [4].

An original survey questionnaire containing questions about the respondents› age, gender, education, body weight and height, and use of supplementation, was also used in the survey. Additional questions concerned the type of plant-based diet used and the length of use of a given plant-based diet. Body mass index (BMI) was calculated based on weight and height.

Food diary. Each respondent filled in a 3-day diary with a quantitative indication of food products consumed. The logs were analyzed using the Aliant 2.0 software (Anmarsoft, Poland). This made it possible to obtain information on the diet of the surveyed women, compare it with the Dietary Reference Value of EFSA (European Food Safety Authority) [39], and to indicate nutritional deficiencies of given nutrients which affect the severity of depression symptoms.

Statistical analysis. Statistical analysis was performed using Statistica software (v13.3, StatSoft, Poland). Data expressed on a qualitative scale were presented as the number and percentage of the sample. The Chi-squared test ($\chi 2$) was used to compare the relationships between variables expressed in the qualitative scale. Data expressed on a quantitative scale were presented as mean with standard deviation (SD). Depending on the result of the Shapiro-Wilk test (assessment of compliance with the normal distribution), the student›s t test or Mann-Whitney test were used. Results were considered statistically significant when $p<0.05$.

RESULTS

The study involved 50 women following one of the types of a vegetarian diet (lacto-ovo-vegetarian, lactovegetarian, ovovegetarian, vegan) and 50 women on a conventional diet. Table 2 presents the characteristics of the studied groups. Both groups differed significantly in terms of age and level of education ($p<0.001$). The age of the subjects differed significantly, with the group of vegetarians being dominated by younger participants aged 17–30 years, while among those following a conventional diet, the majority were women aged 18–50 years. BMI (Body Mass Index) was calculated for each subject, determining the body weight ratio to height. The vast majority of both vegetarians and omnivores were characterized by proper body weight. The two groups had no significant differences regarding BMI ($p>0.05$).

Table 2. Characteristics of the studied sample according to dietary pattern

	Vegetarians N = 50	Omnivores N = 50	P Value
Age groups, N (%)			
17 years	13 (26)	0 (0)	0.00002**
18-30 years	31 (62)	3 (66)	
31-50 years	5 (10)	16 (32)	
51-60 years	1 (2)	1 (2)	
BMI category, N (%)			
Underweight	11 (22)	4 (8)	0.15103
Correct weight	34 (68)	36 (72)	
Overweight	3 (6)	7 (14)	
Obesity	2 (4)	3 (6)	

Note: Data are presented as number (percentage) of participants; ** $p<0.001$, level of significance assessed by Chi-Square test

The research results obtained by using the Beck-II Inventory show the division of vegetarians and those using a conventional diet with women who were not characterized by symptoms of depression, and those who had symptoms of mild, moderate, and severe depression. The results of this analysis are statistically significant ($p<0.001$) (Tab. 3). In the group of vegetarians, only 12 subjects were not characterized by symptoms of depression, and 28 in the group of meat eaters. Due to the small number of respondents in each category of depression, which made it impossible to conduct a detailed analysis of the differences between them, it was decided that in the other part of the results, all women with symptoms of depression should be grouped into one category of 'subjects with depression', i.e. vegetarians with depression (VWD).

Table 3. Level of depression according to the Beck's Depression Inventory II (BDI-II) and type of dietary pattern

	BDI-II				
Dietary pattern, N (%)	No depression N= 40	Depression N= 60			P Value
		Mild depression N= 18	Moderate depression N= 18	Severe Depression N=24	
Vegetarians	12 (30)	12 (67)	7 (39)	19 (79)	0.00040**
Omnivores	28 (70)	6 (33)	11 (61)	5 (21)	

Note: Data are presented as number (percentage) of participants; ** $p<0.001$, level of significance assessed by Chi-Square test

When surveying the respondents, a question was asked about the diet period to indicate the relationship between the length of the diet and the occurrence of depression. In the case of women on a conventional diet, all subjects had followed this diet since birth. The duration of their use of a plant-based diet varied among vegetarians (Tab. 4). Those who had been vegetarian for less than a year suffered from depressive symptoms. The highest percentage of vegetarians used a plant-based diet from 1–4 years, and the most significant percentage of this group was characterized by depression. However, statistical analysis showed no important (p>0.05) relationship between the duration of the vegetarian diet and the occurrence of depression.

Table 4. Association between length of the vegetarian diet and occurrence of depression in the vegetarian group N=50)

Length of vegetarian diet, N (%)	Vegetarians with no depression N= 12	Vegetarians with depression N= 38	P Value
<1 year	0 (0)	6.0 (16)	0.14005
1-4 year	6 (50)	22.0 (58)	
5-9 years	3 (25)	7.0 (18)	
≥10 years	3 (25)	3.0 (8)	

Note: Data are presented as number (percentage) of participants, level of significance assessed by Chi-Square test

Due to the scientific confirmation that body image perception measurements are strongly related to depression [40], it was decided to check whether the level of BMI and the perception of one's body weight by the respondents were associate in them with depression symptoms. Table 5 shows the number of subjects in each BMI category and the incidence of depression, broken down into the group of vegetarians and those using a conventional diet. The highest percentage of women with symptoms of depression was characterized by proper body weight. Statistical analysis of the relationship between BMI and the occurrence of depression among the respondents indicates no significant relationship (p>0.05).

Table 5. Association between BMI and occurrence of depression in vegetarian and omnivores groups

	Vegetarians N=50			Omnivores N= 50		
BMI, N (%)	No depression N= 12	Depression N= 38	P Value	No depression N= 28	Depression N=22	P Value
Underweight	4 (33)	7 (19)	0.51372	3 (11)	1 (5)	0.19201
Correct weight	7 (59)	27 (71)		19 (67)	17 (77)	
Overweight	1 (8)	2 (5)		3 (11)	4 (18)	
Obesity	0 (0.0)	2 (5)		3 (11)	0 (0)	

Note: Data are presented as number (percentage) of participants, level of significance assessed by Chi-Square test

Another examined relationship was the supplementation of some nutrients and the occurrence of depression symptoms. VWD were the most significant percentage of women using supplementation (Tab. 6). More than 60% of the VWD group used supplementation, the most frequently used were vitamin D, B_{12}, and magnesium. Other ingredients that were not listed in the survey were omega-3 acids and multivitamin preparations. Among omnivores, vitamin D was the most frequently supplemented ingredient, and none

Table 6. Supplementation and occurrence of depression among vegetarians and omnivores

	Vegetarians N=50			Omnivores N= 50		
Supplementation, N (%)	No depression N= 12	Depression N= 38	P Value	No depression N= 28	Depression N=22	P Value
Yes	8 (67)	25 (66)	0.76907	19 (68)	14 (64)	0.75470
No	4 (33)	13 (34)		9 (32)	8 (36)	
Supplemented nutrient n (%)						
Iron	5 (42)	8 (21)	0.29751	5 (18)	2 (9)	0.63392
Calcium	1 (8)	2 (5)	0.75903	2 (7)	2 (9)	0.78482
Zinc	1 (8)	3 (8)	0.57448	3 (11)	1 (5)	0.78482
Vitamin D	5 (42)	17 (45)	0.88332	13 (46)	10 (45)	0.94531
Vitamin B_{12}	6 (50)	21 (55)	0.98940	3 (11)	0 (0)	0.32526
Vitamin B_6	1 (8)	2 (5)	0.75903	2 (7)	0 (0)	0.58062
Biotin	0 (0)	5 (13)	0.43973	3 (11)	1 (5)	0.78482
Magnesium	4 (33)	9 (24)	0.77421	8 (29)	1 (5)	0.06811
Others	1 (8)	4 (11)	0.74054	6 (21)	5 (23)	0.81511

Note: Data are presented as number (percentage) of participants, level of significance assessed by Chi-Square test

of the respondents used vitamin B_{12}. Other supplemented ingredients included omega-3, collagen, folic acid, iodine, and vitamin C. Statistical analysis showed no significant relationship between supplementation and the occurrence of depression in both groups.

The results of comparing the relationship between the quality of nutrition and the occurrence of depressive symptoms among vegetarians and meat eaters are presented in Table 7. Their average 3-day consumption was compared to the EFSA nutritional standards for individual ingredients. The results are shown in the AR (according to references) and BR (below references) columns.

When analyzing the consumption of nutrients by VWD, it can be seen that vegetarians provided adequate amounts of fibre, magnesium, copper, folic acid, and zinc, compared to women on a conventional diet. These results were statistically significant (p<0.05). They provided significantly less vitamin K and vitamin B_{12}, which was also statistically significant (p<0.05). A greater number of VWD were also deficient in iodine and vitamin D, but these results were not statistically significant (p>0.05). Vegetarians without symptoms of depression (VWND) provided adequate amounts of phosphorus, vitamin A, vitamin D, folic acid, and vitamin C. Nevertheless, the results were statistically insignificant (p>0.05). Among VWND, adequate amounts of potassium (p<0.05), vitamin E (p<0.05), and vitamin B_2 (p<0.05) were provided by omnivore, compared to vegetarians. Statistically, significantly less vitamin B_6 was provided by VWND.

The study also compared the average intake of energy, macro-nutrients, minerals, vitamins, selected amino acids, alcohol, and caffeine over three days among vegetarians and non-vegetarians with and without symptoms of depression (Tab. 8). Compared to vegetarians, non-vegetarians expended significantly more energy, resulting in a high fat and protein intake in women with and without depression. Omnivores with symptoms of depression (OWD) and omnivores with no symptoms of depression (OWND) consumed slightly more carbohydrates. Despite this, VWD consumed statistically significant more fibre compared to OWD. Fibre intake among VWND and OWND was at a similar level.

Table 7. Adherence to EFSA standards for nutrient intake between vegetarians and omnivores with and without depression.

Nutrients [PRI or AI], N (%)	Depression N=60					No Depression N= 40				
	Vegetarians N= 38		Omnivores N= 22		P Value	Vegetarians N= 12		Omnivores N= 28		P Value
	AR	BR	AR	BR		AR	BR	AR	BR	
Fibre [≥25]	33 (87)	5 (13)	11 (50)	11 (50)	0.00500*	8 (67)	4 (33)	20 (71)	8 (29)	0.93998
Potassium [≥3500 mg]	7 (18)	31 (82)	9 (41)	13 (59)	0.06078	0 (0.0)	12 (100)	16 (57)	12 (43)	0.00246**
Phosphorus [≥550 mg]	36 (95)	2 (5)	21 (95)	1 (5)	0.62294	12 (100)	0 (0)	28 (100)	0 (0)	1.0000
Magnesium [≥300 mg]	33 (87)	5 (13)	13 (59)	9 (41)	0.03297*	7 (58)	5 (42)	19 (68)	9 (32)	0.82820
Copper [≥1.3 mg]	36 (95)	2 (5)	13 (59)	9 (41)	0.00198*	9 (75)	3 (25)	19 (68)	9 (32)	0.93998
Iodine [≥150 µg]	6 (16)	32 (84)	1 (5)	21 (95)	0.37338	0 (0.0)	12 (100)	2 (7)	26 (93)	0.87421
Vitamin A [≥650 µg]	34 (89)	4 (11)	19 (86)	3 (14)	0.95563	12 (100)	0 (0)	23 (82)	5 (18)	0.29682
Vitamin D [≥15 µg]	0 (0)	38 (100)	1 (5)	21 (95)	0.78023	12 (100)	0 (0)	0 (0)	28 (100)	1.0000
Vitamin E [≥11 mg]	19 (50)	19 (50)	12 (55)	10 (45)	0.73421	5 (42)	7 (58)	21 (75)	7 (25)	0.04538*
Vitamin K [≥70 µg]	14 (37)	24 (63)	2 (9)	20 (91)	0.04139*	6 (50)	6 (50)	10 (36)	18 (64)	0.40043
Vitamin B_2 [≥1.6 mg]	9 (24)	29 (76)	10 (45)	12 (55)	0.08326	4 (33)	8 (67)	23 (82)	5 (18)	0.00800**
Vitamin B_6 [≥1.6 mg]	23 (61)	15 (39)	16 (73)	6 (27)	0.33503	5 (42)	7 (58)	22 (79)	6 (21)	0.02463*
Folic [≥330 µg]	32 (84)	6 (16)	11 (50)	11 (50)	0.00499*	8 (67)	4 (33)	20 (71)	8 (29)	0.93998
Vitamin B_{12} [≥4 µg]	0 (0)	38 (100)	7 (32)	15 (68)	0.00103*	0 (0)	12 (100)	9 (32)	19 (68)	0.06910
Vitamin C [≥95 mg]	33 (87)	5 (13)	15 (68)	7 (32)	0.08673	10 (83)	2 (17)	21 (75)	7 (25)	0.86875
Zinc [7.5- ≥12.7 mg]	24 (63)	14 (37)	16 (73)	6.0 (27)	0.00440*	7 (58)	5 (42)	25 (89)	3 (11)	0.09652

Note: Data presented as number (percentage) of participants; *p<0.05; ** p<0.001, level of significance assessed by Chi-Square test; AR - According to References; BR - Below References

Consumption levels of both omega-3 fatty acids were lower among VWD and VWND; in particular, VWD consumed the least. In the case of omega-6 fatty acids, OWD had the lowest consumption; in the case of VWD they consumed more omega-6 fatty acids compared to VWND. However, these differences were not statistically significant.

Salt and sodium intake among both VWD and VWND was statistically significantly lower compared to omnivores.

Table 8. Three-day average intake of energy, macronutrients, minerals, vitamins, selected amino acids, alcohol, and caffeine among vegetarians and omnivores, with and without depressive symptoms

Nutrients [$\bar{x}$ ± SD]	Vegetarians		Omnivores	
	Depression	No Depression	Depression	No Depression
Energy, kcal	1516 ± 311 *	1533 ± 358 #	1836 ± 470 *	1921 ± 400 #
Total protein, g	55.6 ± 16.9 *	60.8 ± 19.1 #	82 ± 29.6 *	86.1 ± 29.5 #
Fat, g	51.5 ± 16.2 *	54.3 ± 16.1 #	66 ± 24.3 *	78.1 ± 29.5 #
Carbohydrates, g	212 ± 37.7	211 ± 49.5	241.7 ± 66.2	235 ± 61.8
Fiber, g	32.6 ± 7.56 *	28.8 ± 8.1	25.2 ± 9.11 *	28.5 ± 11.2
Vegetable protein, g	41.1 ± 12.6 *	33.8 ± 10.3	30.8 ± 10.1 *	30.9 ± 14
Animal protein, g	11.5 ± 10.8 $*	19.9 ± 11.7 $#	45.2 ± 23.6 *	44.5 ± 18.2 #
Omega-3 fatty acids, g	1.48 ± 0.6	1.6 ± 0.7	2.05 ± 1.49	2.46 ± 1.88
Omega-6 fatty acids, g	11.6 ± 4.23	10.9 ± 5.3	10.4 ± 5.8	12.6 ± 8.2
Trans fatty acids, g	0.06 ± 0.1	0.1 ± 0.2	0.08 ± 0.09	0.08 ± 0.11
Sodium, mg	1703 ± 674 *	1776 ± 525 #	2736 ± 1698 *	2569 ± 1119 #
Salt, g	4.4 ± 1.73 *	4.58 ± 1.34 #	7.06 ± 4.39 *	6.64 ± 2.88 #
Potassium, mg	3082 ± 558	2761 ± 575 #	3112 ± 1016	3581 ± 1132 #
Calcium, mg	750 ± 381	831 ± 287	728 ± 364	913 ± 472
Phosphorus, mg	1089 ± 243	1129 ± 285	1269 ± 472	1328 ± 510
Magnesium, mg	387 ± 98.8	347 ± 121	332 ± 132	374 ± 135
Iron, mg	14.05 ± 3.48 *	12.3 ± 3.53	11.4 ± 3.7 £*	13.9 ± 4.9 £
Zinc, mg	8.72 ± 1.92	8.74 ± 2.51	10.3 ± 4.3	10.9 ± 3.7
Copper, mg	1.98 ± 0.5 *	1.74 ± 0.67	1.45 ± 0.61 *	1.77 ± 0.89
Manganese, mg	6.44 ± 2.32 *	5.41 ± 2.49	4.59 ± 2.48 *	4.97 ± 2.52
Selenium, µg	21.1 ± 13.3	14.4 ± 6.07	17.5 ± 21.09	20.5 ± 23.7
Iodine, µg	67.4 ± 53.3	52.8 ± 29.3	59.4 ± 35.6	66.5 ± 41
Vitamin A, µg	1147 ± 592	1620 ± 1140	1507 ± 107	1832 ± 1031
Vitamin D, µg	1.59 ± 1.43	1.58 ± 1.39 #	2.83 ± 3.38	3.36 ± 2.94 #
Vitamin E, mg	12.5 ± 5.56	12.9 ± 7.07	14.6 ± 10.1	17 ± 8.76
Vitamin K, µg	59.8 ± 55.7 *	118 ± 129	60.5 ± 144 £*	270 ± 391 £
Vitamin B_1, mg	1.36 ± 0.48	1.13 ± 0.44 #	1.48 ± 0.7	1.49 ± 0.46 #
Vitamin B_2, mg	1.3 ± 0.41 *	1.38 ± 0.4 #	1.72 ± 0.65 *	1.93 ± 0.52 #
Vitamin B_3, mg	10.8 ± 2.6 *	9.75 ± 2.87 #	18.3 ± 11.3 *	19.5 ± 9.57 #
Vitamin B_6, mg	1.59 ± 0.36 *	1.51 ± 0.39 #	2.38 ± 1.77 *	2.53 ± 1.5 #
Folates, µg	396 ± 77	389 ± 98	373 ± 174	452 ± 221
Vitamin B_{12}, µg	1.1 ± 0.94 *	1.67 ± 1.09 #	3.5 ± 2.64 *	3.57 ± 1.95 #
Vitamin C, mg	162 ± 59	147 ± 48	172 ± 143	198 ± 138
Tyrosine, mg	1625 ± 597 *	1904 ± 668 #	2630 ± 1224 *	2639 ± 920 #
Tryptophan, mg	579 ± 19 *	675± 246 #	982 ± 435 *	981 ± 351 #
Alcohol, g	6.98 ± 11.7	2.21 ± 5.71	0.13 ± 0.46	0 ± 0
Caffeine, mg	71.9 ± 83.8	29.2 ± 61.2	30.4 ± 59.3	59.1 ± 57.7

$ statistically significant difference (p<0.05) between vegetarians with and without symptoms of depression;
£ statistically significant difference (p<0.05) between omnivores with and without symptoms of depression;
* statistically significant difference (p<0.05) between omnivores and vegetarians with symptoms of depression;
# statistically significant difference (p<0.05) between omnivores with vegetarians without symptoms of depression, level of significance assessed by the student's t test and U Mann-Whitney test.

OWND supplied the most potassium with food compared to the other groups studied. Compared to VWND, this difference was statistically more significant.

VWD provided significantly more iron ($p<0.05$), copper ($p<0.05$), and manganese ($p<0.05$) compared to OWD. In the case of VWND, the intake of these minerals was lower compared to VWD, but these values were statistically insignificant ($p>0.05$). The consumption of other minerals was not statistically significant in any of the variants ($p>0.05$).

Vitamin D intake was higher for omnivores and statistically significantly higher for OWND compared to VWND ($p<0.05$). Both VWND and OWND, consumed significantly more vitamin K than women with symptoms of depression – in the case of omnivores, this difference was statistically significant, while in the case of vegetarians it was not statistically significant.

Vitamin B_2 intake of vegetarians and omnivores was statistically significantly higher among women without symptoms of depression. VWD provided statistically significantly less vitamin B_3 compared to OWD. The most vitamin B_3 was consumed by OWND and this amount was statistically significantly higher compared to VWND. In the case of vitamin B_6 intake, statistically significantly more was consumed by VWD, compared to the same group among omnivores. Among women without symptoms of depression, the intake of vitamin B_6 by vegetarians was statistically significantly lower compared to omnivores. Similar differences in dietary intake were observed in the context of vitamin B_{12}. Depressed vegetarians provided statistically significantly less of it compared to OWD. Among women without symptoms of depression, significantly more omnivores consumed vitamin B_{12}.

Tyrosine intake was significantly higher among omnivores, both with and without depressive symptoms, compared to VWD and VWND. The differences in tyrosine consumption between VWD and OWD, and between VWND and OWND, were statistically significant ($p<0.05$). Of all subgroups, VWD consumed the least tyrosine with food.

As with tyrosine, tryptophan intake was greater among women without depression symptoms than women with depression symptoms. Statistically significantly more tryptophan was consumed by OWD compared to VWD. A similar relationship occurred among OWND and VWND. Statistically significantly more tryptophan along with the diet was consumed by omnivores compared to vegetarians.

Vegetarians consumed more alcohol, especially VWD. OWND did not drink alcohol. VWD and OWND consumed the highest amount of caffeine; however, the comparison of alcohol and caffeine consumption was statistically insignificant ($p>0.05$).

DISCUSSION

The study aimed to compare the occurrence of depressive symptoms among Polish vegetarians and meat eaters and to assess the correlation between its occurrence and the quality of nutrition of both groups. Despite various validated screening tools for detecting depressive symptoms, the Beck Depression Inventory Second Edition (BDI-II) was selected for use in the study. The BDI-II is used to screen for the symptoms of depression and is very useful in the initial diagnosis of the disease. As a self-report tool, it allows for a quantitative assessment of the severity of depression. According to Wiglusz et al. [41], the BDI-II is an important psychometric measure of depressive disorders, maintaining appropriate sensitivity and specificity, high negative predictive value (NPV), acceptable predictive value (PPV), with an optimal cut-off point of 18 for the diagnosis of depression.

This study is the first to be conducted on a group of Polish participants which included vegetarians. Similar studies have been conducted in other European countries, e.g. in Germany [35] and France. In the French study, a similar analysis was made of the relationship between the occurrence of depression and the type of diet – vegetarian and conventional. Over 6,500 people participated in the study, of whom over 70% were women. The group of vegetarians numbered over 800 subjects. The results showed that those on a vegetarian diet had no increased risk of anxiety or depression. The difference between this and the current study is that the latter study did not measure some significant potential covariates that could have influenced the development of depressive symptoms – such as alcohol. The researchers in the French study indicated that their measurements were based solely on the information reported by the participants. Therefore they did not exclude the possibility that some participants who answered that they rejected easting meat or fish, did not completely abstain from their consumption [42].

In the current study, each participant was asked to keep a 3-day food diary, specifying the exact dishes and food products consumed on those days, along with weight and home measurements. This allowed for a thorough check of the meals consumed and obtaining the most accurate results from the nutritional analysis in the Aliant programme. This may be why the results in the current study differ slightly, and the group of vegetarians had a higher percentage of depressive symptoms (N=12) compared to non-vegetarians (N=28).

The study analyzed whether the level of BMI had an impact on the appearance of depressive symptoms among the participants. Based on a survey by Stolińska et al. [43], it was assumed that the BMI among vegetarians would be appropriate. The Stolińska study also involved dividing the women into two groups according to their diet – conventional (omnivores) or vegetarian. BMI in the group of omnivores indicated obesity, which was significantly higher in this group compared to vegetarians, whose BMI was normal. In the current study, most vegetarians and omnivores were characterized by an average body weight; a few were overweight or obese. Therefore, the BMI had no significant effect on the occurrence of depressive symptoms.

Dietary supplements are top-rated in many social groups. Their use in some cases seems appropriate and sometimes necessary due to nutritional deficiencies [44]. It is justified to use supplementation in restrictive diets, including vegetarian diets, which may increase the risk of deficiencies, especially vitamin B_{12}, vitamin D, omega-3 fatty acids, calcium, iron, and zinc [45]. In the study carried out by Grzelak et al. [44], out of 47 vegetarians and 207 omnivores, supplementation was used by 72% and 46%, respectively, of the participants. Both, in the above-mentioned and the current study, vegetarians most often used the supplemented vitamin B_{12} and vitamin D. Magnesium, zinc, and iron were next in order in both studies. In the current study, vegetarians also supplemented their diet with biotin, vitamin B_6 and omega-3 fatty acids, collagen, folic acid, and vitamin C. There was no statistically significant correlation between supplementation and the appearance or absence of depression symptoms. This

is particularly perplexing because the beneficial effects of supplementation have been demonstrated, including a significant reduction in symptoms of depression through the use of magnesium. In a randomized clinical trial, Tarleton et al. [46] showed that using magnesium supplementation in the amount of 248 mg for 6 weeks resulted in a significant reduction of depressive symptoms in adults, compared to the placebo group. There is also a study on the impact of daily magnesium intake on preventing depression, and a correlation has been reported between using this element with a lower risk of depressive symptoms in the future [47]. It is all the more interesting that in the current study, vegetarians with symptoms of depression consumed adequate amounts of magnesium, results that were statistically significant. It is probable that other factors unrelated to the supply of magnesium with diet influenced the occurrence of depressive symptoms.

The use of any diet, whether conventional diet or a more restrictive diet, can involve nutritional deficiencies which contribute to various diseases, including depression. Studies indicate several mechanisms between mental health and dietary deficiencies of critical nutrients, including vitamin B_{12}, folic acid, omega-3 fatty acids, or increased intake of omega-6 fatty acids, fiber, vitamin C, vitamin E, and vitamin A [33, 48].

In the current study, the quality of nutrition of both groups – vegetarians and omnivores – was analyzed, with the participants divided into women showing symptoms of depression and without symptoms, based on EFSA nutrition standards. Most vegetarians consume adequate amounts of fibre compared to omnivores. Typical for the vegetarian group of women, excluding meat and limiting products of animal origin, vitamin B_{12} deficiencies, were noted in the diet. This concerned both women with and without symptoms of depression. Currently, researchers are trying to determine the link between vitamin B_{12} and depression and the fact that its supplementation can slow down the progression of depression or prevent it. Some clinical studies have shown that higher levels of vitamin B_{12} in the body result in better outcomes in patients with depression, reducing its symptoms over time [49–52]. However, a meta-analysis, carried out in 2021 which aimed to assess the effects of vitamin B_{12} supplementation on cognitive functions, depressive symptoms, and idiopathic fatigue, showed that vitamin B_{12} supplementation probably does not improve cognitive functions and depressive symptoms in people without advanced neurological disorders [53]. Due to inconsistent scientific reports, it is still worth considering the relationship between the level of vitamin B_{12} in the diet and the occurrence or reduction of depressive symptoms, not only among vegetarians.

Among the ingredients involved in building neurotransmitters and showing positive effects on the brain and mental health, omega-3 fatty acids deserve attention. Their reduced concentration in the brain may cause changes in its functioning, including changes in the size of neurons and deterioration of learning and memory [54]. Omega-3 fatty acids increase dopamine levels in the frontal cortex and bind to dopamine receptors, improving mood [55]. In addition, they have anti-inflammatory effects and thus may reduce pro-inflammatory cytokines, characteristic of people with depression [56].

In clinical trials performed as early as the 1990s in which the participants suffered from mood disorders, it was shown that those with symptoms of depression had a lower concentration of omega-3 fatty acids in the plasma and erythrocyte cell membrane, compared to people without such symptoms [57, 58]. One of the studies conducted on young adults (average age 33 years) described the effects of omega-3 fatty acids supplementation on mood, cognitive and physiological functioning. After supplementation with omega-3 fatty acids in the amount of 4 g by the participants, this was associated with significant mood changes. A statistically significantly higher level of vigour and lower levels of anger, anxiety, fatigue, and even depression, were demonstrated compared to the placebo group [59]. However, different results were reported in a study conducted by a British team of scientists [60]. They used a double-blind, placebo-controlled trial to determine the effect of taking EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) at 1.5 g/d on mood and cognition in people with mild to moderate depressive symptoms. No statistically significant differences were observed in terms of the DAAS depression scale, while in terms of the Beck Depression Scale, a slight dependence on the intervention was shown.

In the current study, omega-3 fatty acids intake was not measured by blood chemistry and serum omega-3 levels, but only by food diary analysis. The consumption of omega-3 fatty acids was slightly higher among non-depressives in both vegetarians and omnivores. However, these results were not statistically significant. It is therefore worth considering the continuation of research on the consumption of omega-3 fatty acids and their correlation with the occurrence or prevention of depression symptoms.

Tyrosine is an endogenous amino acid that is also involved in the production of neurotransmitters. Its reduced concentration in the body may cause a deficiency of norepinephrine and dopamine and lead to symptoms of depression [61]. In the current study, vegetarians with symptoms of depression were characterized by low tyrosine intake. More tyrosine was found mainly in the diet of women without symptoms of depression; despite this, these differences were not statistically significant. It cannot be said that in the case of the studied group of vegetarians, a low consumption of these ingredients could have contributed to the occurrence of depression symptoms.

In turn, tryptophan is an exogenous amino acid, i.e., one that must be supplied to humans with food [62]. Clinical studies by Maes et al. [63] showed that disorders of tryptophan metabolism contribute to the pathogenesis of depression. It was found that reduced concentrations of tryptophan and kynurenic acid with neuroprotective properties, characterize patients with depression. In the same subjects, an increased concentration of non-urotoxic by-products of tryptophan metabolism, i.e., quinolinic acid and 3-hydroxy-kynurenine, was observed. In the current study, the level of tryptophan supplied with food was significantly lower among women with depressive symptoms, particularly vegetarians with such symptoms. This may be because tryptophan is found mainly in products of animal origin – pork and fish – which excludes herbivores [9]. Differences in tryptophan intake between vegetarians with symptoms of depression and vegetarians without symptoms of depression were not statistically significant. Thus, it can be concluded that in the case of the study group, the level of tryptophan was not significant in terms of the occurrence of depression.

The ingredients mentioned above are crucial for the proper functioning of the brain. Nevertheless, their effect of

preventing or reducing the symptoms of depression, which has been supported by many scientific studies described above, did not translate into the current study. Consumption of most substances was insignificant in the appearance of depressive symptoms in the vegetarian group.

Still searching for a nutritional cause for the symptoms of depression, the level of consumption of stimulants – caffeine and alcohol – was analyzed in this study. Caffeine is the most commonly used stimulant in the world and is consumed in the most significant amounts with coffee and, to a lesser extent, with black tea [63, 64]. Many studies confirm the positive role of caffeine in preventing or reducing the symptoms of depression. In their meta-analysis, Lucas et al. [65] found that consuming coffee with caffeine up to 600 ml per day decreased the risk of depression among the surveyed American women [63]. Another study showed that consuming 4 or more cups of coffee a day significantly reduced the risk of depressive symptoms, compared to people who drank one or fewer cups of coffee a day [65]. Also, Asil et al. [64] compared black tea and caffeine consumption with depression in a study conducted on 491 adults, of whom 322 were women. The average daily caffeine intake was calculated based on the volume of caffeine-containing beverages and their content in each as also used in the current study. Among the surveyed people, over 30% were depressed. Multivariate regression analysis showed that providing 450–600 mg of caffeine per day significantly reduced the risk of depression. In the current study, it was observed that higher caffeine consumption was reported among omnivores without depressive symptoms and vegetarians with depressive symptoms. These results are not statistically significant. This discrepancy may be related to the relatively small number of participants, or to the fact that some participants in the study did not report in the food diary the exact amounts consumed of caffeinated beverages.

In the current study, it was also decided to check whether the consumption of alcohol by the examined subjects could contribute to the occurrence of depressive symptoms. In the literature, the problem of depression with long-term use of stimulants, including alcohol, is most often described, but there is a lack of information on occasional alcohol consumption and the severity of depressive symptoms [66]. Among the subjects in this study, vegetarians with depression were most likely to consume alcohol. However, when analyzing the food diaries, it was noticed that the doses of alcohol were consumed sporadically, in small portions, and usually around dinner. This may also be due to the fact that only women participated in the study. According to the report on alcohol consumption patterns in Poland in 2020, women consumed alcohol much less frequently (on average 21 days a year) compared to men (on average 98 days a year) [67].

Limitations of the study. Some limitations of this study need to be taken into account when interpreting the obtained results. Although the study makes an important contribution by comparing the occurrence of depressive symptoms among vegetarians and omnivores, and assessing the quality of their diet, there are some factors that may affect the confidence about the generalisability of the results. One of the main limitations is the small size of both the study and control groups. Due to financial and logistical constraints, the number of female participants in the study was relatively small. The small group size may also have affected the representativeness of the results and reduce statistical power, meaning that some differences or effects may not be detected or have less statistical significance. The study did not take into account whether the participants had previously been diagnosed/treated for mood disorders. The aim was to obtain data on depressive symptoms based only on the Beck Scale Inventory-II. Another factor is the varying age of the participants, which could have affected the results because age can be a factor in the dependent variables. Specifically, age can affect the body›s response to the diet and the difference in dietary requirements of the study subjects. It is additionally worth noting that the study was based on the use of questionnaires and dietary analysis as research material, based on data reported by the participants themselves. No biochemical tests were carried out on the blood levels of individual dietary components, which would have yielded far more accurate results. Also, the aspect of using qualitatively different supplements for different lengths of time may have yielded different target results in the study groups.

In addition, it must be emphasised that the study analysed the quality of the diet of the study subjects on the basis of a 3-day menu. Such a menu may not take into account fluctuations in nutrient intake, and may not reflect the full picture of dietary habits not covered during the 3 days analysed. These limitations should be a taken as a guide for further studies which could provide a more comprehensive picture of the issues dealt with above.

CONCLUSIONS

The present study showed that, based on the BDI-II, depressive symptoms were more common among women following a vegetarian diet. The analysis shows that it is impossible to find a nutritional cause that would significantly impact the development of depressive symptoms. In the studied group of vegetarians, nutrition was not a significant factor n the presence or absence of depressive symptoms. Due to the complexity of depression, the depressive symptoms in the study group were certainly not caused by the diet. Despite this, there is a belief that consuming a plant-based diet abundant in vegetables and fruits which contain anti-oxidants, can help alleviate symptoms of depression. Nevertheless, the ambiguous results suggest the need for additional research and directing the interest of researchers toward the impact of a plant-based diet on the mental health of the vegetarian community, men as well as women.

Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could in any way have influence the study.

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REFERENCES

1. Światowy Dzień Walki z Depresją 2021 – Wojewódzka Stacja Sanitarno-Epidemiologiczna w Krakowie – Portal Gov.pl. Wojewódzka Stacja Sanitarno-Epidemiologiczna w Krakowie. Accessed May 14, 2023. https://www.gov.pl/web/wsse-krakow/swiatowy-dzien-walki-z--depresja-2021
2. Kuehner C. Why is depression more common among women than among men? Lancet Psychiatry. 2017;4(2):146–158. doi:10.1016/S2215-0366(16)30263-2
3. Rondón Bernard JE. Depression: A Review of its Definition. MOJAMT. 2018;5(1). doi:10.15406/mojamt.2018.05.00082
4. Suchowiak S, Wszołek K, Suwalska J, et al. Screening for perinatal depression: a review of tools and barriers. Neuropsychiatria i Neuropsychologia/Neuropsychiatry and Neuropsychology. 2020;15(1):60–69. doi:10.5114/nan.2020.97402
5. Glibowski P, Misztal A. Wpływ diety na samopoczucie psychiczne. Bromatol Chem Toksykol. 2016;49(1):1–9.
6. Sánchez-Villegas A, Delgado-Rodríguez M, Alonso A, et al. Association of the Mediterranean dietary pattern with the incidence of depression: the Seguimiento Universidad de Navarra/University of Navarra follow-up (SUN) cohort. Arch Gen Psychiatry. 2009;66(10):1090–1098. doi:10.1001/archgenpsychiatry.2009.129
7. Banyś K, Knopczyk M, Bobrowska-Korczak B. The importance of folic acid for the health of the human body. Farm Pol. 2020;76(2):79–87. doi:10.32383/farmpol/118863
8. Kühn S, Düzel S, Colzato L, et al. Food for thought: association between dietary tyrosine and cognitive performance in younger and older adults. Psychol Res. 2019;83(6):1097–1106. doi:10.1007/s00426-017-0957-4
9. Stępień A, Walecka-Kapica E, Błońska A, et al. Rola tryptofanu i serotoniny w patogenezie i leczeniu zespołu jelita nadwrażliwego. Fol Med Lodz. 2014;41(2):139–154.
10. National Institutes of Health. Office of Dietary Supplements.: Vitamin B6: Health Professional Fact Sheet. 2022. Accessed May 14, 2023. http://ods. od.nih.gov/factsheets/vitaminb6/
11. National Institutes of Health. Office of Dietary Supplements.: Vitamin B12: Health Professional Fact Sheet. 2022. Accessed May 14, 2023. https://ods.od.nih.gov/factsheets/VitaminB12-HealthProfessional/
12. Jedut P, Szwajgier D, Glibowski P, et al. Some Plant Food Products Present on the Polish Market Are a Source of Vitamin B12. Applied Sci. 2021;11(8):3601. doi:10.3390/app11083601
13. National Institutes of Health. Office of Dietary Supplements.: Folate: Health Professional Fact Sheet. 2022. Accessed May 14, 2023. https://ods.od.nih.gov/factsheets/Folate-HealthProfessional/
14. National Institutes of Health. Office of Dietary Supplements.: Zinc: Health Professional Fact Sheet. 2022. Accessed May 14, 2023. https://ods.od.nih.gov/factsheets/Zinc-HealthProfessional/
15. National Institutes of Health. Office of Dietary Supplements.: Copper: Health Professional Fact Sheet. 2022. Accessed May 14, 2023. https://ods.od.nih.gov/factsheets/Copper-HealthProfessional/
16. National Institutes of Health. Office of Dietary Supplements.: Health Professional Fact Sheet. 2022. Accessed May 14, 2023. https://ods.od.nih.gov/factsheets/Iron-HealthProfessional/
17. National Institutes of Health. Office of Dietary Supplements.: Magnesium: Health Professional Fact Sheet. 2022. Accessed May 14, 2023. https://ods.od.nih.gov/factsheets/Magnesium-HealthProfessional/
18. National Institutes of Health. Office of Dietary Supplements. Omega-3 Fatty Acids: Health Professional Fact Sheet. 2023. Accessed May 14, 2023. https://ods.od.nih.gov/factsheets/Omega3FattyAcids-HealthProfessional/
19. Aquili L. The Role of Tryptophan and Tyrosine in Executive Function and Reward Processing. Int J Tryptophan Res. 2020;13:1–13. doi:10.1177/1178646920964825
20. McNamara RK. Role of Omega-3 fatty acids in the etiology, treatment, and prevention of depression: Current status and future directions. J Nutr Intermed Metab. 2016;5:96–106. doi:10.1016/j.jnim.2016.04.004
21. Berkins S, Schiöth HB, Rukh G. Depression and Vegetarians: Association between Dietary Vitamin B6, B12 and Folate Intake and Global and Subcortical Brain Volumes. Nutr. 2021;13(6):1790. doi:10.3390/nu13061790
22. Li Z, Wang W, Xin X, Song X, Zhang D. Association of total zinc, iron, copper and selenium intakes with depression in the US adults. J Affect Disord. 2018;228:68–74. doi:10.1016/j.jad.2017.12.004
23. Pickering G, Mazur A, Trousselard M, et al. Magnesium Status and Stress: The Vicious Circle Concept Revisited. Nutr. 2020;12(12):3672. doi:10.3390/nu12123672
24. Martínez-González MA, Sánchez-Villegas A. Food patterns and the prevention of depression. Proc Nutr Soc. 2016;75(2):139–146. doi:10.1017/S0029665116000045
25. Dagnelie PC, Mariotti F. 1 – Vegetarian Diets: Definitions and Pitfalls in Interpreting Literature on Health Effects of Vegetarianism. In: Mariotti F, ed. Vegetarian and Plant-Based Diets in Health and Disease Prevention. Academic Press; 2017:3–10. doi:10.1016/B978-0-12-803968-7.00001-0
26. Marrone G, Guerriero C, Palazzetti D, et al. Vegan Diet Health Benefits in Metabolic Syndrome. Nutrients. 2021;13(3):817. doi:10.3390/nu13030817
27. Baş M, Karabudak E, Kiziltan G. Vegetarianism and eating disorders: association between eating attitudes and other psychological factors among Turkish adolescents. Appetite. 2005;44(3):309–315. doi:10.1016/j.appet.2005.02.002
28. Jin Y, Kandula NR, Kanaya AM, et al. Vegetarian diet is inversely associated with prevalence of depression in middle-older aged South Asians in the United States. Ethn Health. 2021;26(4):504–511. doi:10.1080/13557858.2019.1606166
29. Hibbeln JR, Northstone K, Evans J, et al. Vegetarian diets and depressive symptoms among men. J Affective Dis. 2018;225:13–17. doi:10.1016/j.jad.2017.07.051
30. Li Y, Lv MR, Wei YJ, et al. Dietary patterns and depression risk: A meta-analysis. Psychiatry Res. 2017;253:373–382. doi:10.1016/j.psychres.2017.04.020
31. Owen L, Corfe B. The role of diet and nutrition on mental health and wellbeing. Proc Nutr Soc. 2017;76(4):425–426. doi:10.1017/S0029665117001057
32. Beezhold B, Radnitz C, Rinne A, et al. Vegans report less stress and anxiety than omnivores. Nutr Neurosci. 2015;18(7):289–296. doi:10.1179/1476830514Y.0000000164
33. Askari M, Daneshzad E, Darooghegi Mofrad M, et al. Vegetarian diet and the risk of depression, anxiety, and stress symptoms: a systematic review and meta-analysis of observational studies. Crit Rev Food Sci Nutr. 2022;62(1):261–271. doi:10.1080/10408398.2020.1814991
34. Iguacel I, Huybrechts I, Moreno LA, et al. Vegetarianism and veganism compared with mental health and cognitive outcomes: a systematic review and meta-analysis. Nutr Rev. 2021;79(4):361–381. doi:10.1093/nutrit/nuaa030
35. Goldberg M, Carton M, Descatha A, et al. CONSTANCES: a general prospective population-based cohort for occupational and environmental epidemiology: cohort profile. Occup Environ Med. 2017;74(1):66–71. doi:10.1136/oemed-2016-103678
36. Lee MF, Eather R, Best T. Plant-based dietary quality and depressive symptoms in Australian vegans and vegetarians: a cross-sectional study. BMJ Nutr Prev Health. 2021;4(2):479–486. doi:10.1136/bmjnph-2021-000332
37. Kendall PC, Hollon SD, Beck AT, et al. Issues and recommendations regarding use of the Beck Depression Inventory. Cogn Ther Res. 1987;11(3):289–299. doi:10.1007/BF01186280
38. Zawadzki B, Popiel A, Pragłowska E. Charakterystyka psychometryczna polskiej adaptacji Kwestionariusza Depresji BDI-II Aarona T. Becka (Psychometric Properties of the Polish Version of the Aaron T. Beck's Depression Inventory BDI-II). PSYCHOLOGIA – ETOLOGIA – GENETYKA. 2009;2009:71–95.
39. Dietary reference values | EFSA. Published April 24, 2023. Accessed May 14, 2023. https://www.efsa.europa.eu/en/topics/topic/dietary-reference-values
40. Darimont T, Karavasiloglou N, Hysaj O, et al. Body weight and self-perception are associated with depression: Results from the National Health and Nutrition Examination Survey (NHANES) 2005–2016. J Affect Disord. 2020;274:929–934. doi:10.1016/j.jad.2020.05.130
41. Wiglusz MS, Landowski J, Michalak L, et al. Validation of the Polish version of the Beck Depression Inventory in patients with epilepsy. Epilepsy Behav. 2017;77:58–61. doi:10.1016/j.yebeh.2017.09.023
42. Bègue L, Shankland R. Is vegetarianism related to anxiety and depression? A cross-sectional survey in a French sample. Journal of Health, Population and Nutrition. 2022;41(1):18. doi:10.1186/s41043-022-00300-2
43. Stolińska H, Wolańska D. Analiza składu ciała kobiet na diecie tradycyjnej i wegetariańskiej. Żyw Czł Met. 2015;42(2):13–22.
44. Grzelak T, Suliga K, Pelczyńska M, et al. Ocena częstości stosowania suplementów diety wśród wegetarian oraz osób odżywiających się tradycyjnie. Probl Hig Epidemiol. 2017;98(2):170–176.
45. Schüpbach R, Wegmüller R, Berguerand C, et al. Micronutrient status and intake in omnivores, vegetarians and vegans in Switzerland. Eur J Nutr. 2017;56(1):283–293. doi:10.1007/s00394-015-1079-7

46. Tarleton EK, Littenberg B, MacLean CD, et al. Role of magnesium supplementation in the treatment of depression: A randomized clinical trial. PLoS One. 2017;12(6):e0180067. doi:10.1371/journal.pone.0180067
47. Kirkland AE, Sarlo GL, Holton KF. The Role of Magnesium in Neurological Disorders. Nutrients. 2018;10(6):730. doi:10.3390/nu10060730
48. Daneshzad E, Keshavarz SA, Qorbani M, et al. Dietary total antioxidant capacity and its association with sleep, stress, anxiety, and depression score: A cross-sectional study among diabetic women. Clin Nutr ESPEN. 2020;37:187–194. doi:10.1016/j.clnesp.2020.03.002
49. Sangle P, Sandhu O, Aftab Z, et al. Vitamin B12 Supplementation: Preventing Onset and Improving Prognosis of Depression. Cureus. 2020;12(10). doi:10.7759/cureus.11169
50. Wu Y, Zhang L, Li S, Zhang D. Associations of dietary vitamin B1, vitamin B2, vitamin B6, and vitamin B12 with the risk of depression: a systematic review and meta-analysis. Nutrition Rev. 2022;80(3):351–366. doi:10.1093/nutrit/nuab014
51. Todorov AA, Chumpalova-Tumbeva PG, Stoimenova-Popova MY, et al. Correlation between Depression and Anxiety and the Level of Vitamin B12 in Patients with Depression and Anxiety and Healthy Controls. J Biomedical Clin Res. 2017;10(2):140–145. doi:10.1515/jbcr-2017-0023
52. Klettner A, Perez E. 0166 The Role of Vitamin B12 Supplementation in the Association between Depression Symptoms and Daytime Sleepiness. Sleep. 2022;45(Supplement_1):A77. doi:10.1093/sleep/zsac079.164
53. Markun S, Gravestock I, Jäger L, et al. Effects of Vitamin B12 Supplementation on Cognitive Function, Depressive Symptoms, and Fatigue: A Systematic Review, Meta-Analysis, and Meta-Regression. Nutrients. 2021;13(3):923. doi:10.3390/nu13030923
54. Mehdi S, Manohar K, Shariff A, et al. Omega-3 Fatty Acids Supplementation in the Treatment of Depression: An Observational Study. J Personalized Med. 2023;13(2):224. doi:10.3390/jpm13020224
55. Healy-Stoffel M, Levant B. N-3 (Omega-3) Fatty Acids: Effects on Brain Dopamine Systems and Potential Role in the Etiology and Treatment of Neuropsychiatric Disorders. CNS Neurol Disord Drug Targets. 2018;17(3):216–232. doi:10.2174/1871527317666180412153612
56. Kopschina Feltes P, Doorduin J, Klein HC, et al. Anti-inflammatory treatment for major depressive disorder: implications for patients with an elevated immune profile and non-responders to standard antidepressant therapy. J Psychopharmacol. 2017;31(9):1149–1165. doi:10.1177/0269881117711708
57. Edwards R, Peet M, Shay J, et al. Depletion of docosahexaenoic acid in red blood cell membranes of depressive patients. Biochem Soc Trans. 1998;26(2):S142. doi:10.1042/bst026s142
58. Peet M, Murphy B, Shay J, et al. Depletion of omega-3 fatty acid levels in red blood cell membranes of depressive patients. Biol Psychiatry. 1998;43(5):315–319. doi:10.1016/s0006-3223(97)00206-0
59. Fontani G, Corradeschi F, Felici A, et al. Cognitive and physiological effects of Omega-3 polyunsaturated fatty acid supplementation in healthy subjects. Eur J Clin Invest. 2005;35(11):691–699. doi:10.1111/j.1365-2362.2005.01570.x
60. Rogers PJ, Appleton KM, Kessler D, et al. No effect of n-3 long-chain polyunsaturated fatty acid (EPA and DHA) supplementation on depressed mood and cognitive function: a randomised controlled trial. Br J Nutr. 2008;99(2):421–431. doi:10.1017/S0007114507801097
61. Peplińska-Miąskowska J, Wichowicz H, Waśkow M. Potencjalny wpływ wybranych składników diety na stan psychiczny: Neuropsychiatria Przegląd kliniczny. 2017;9(3):101–107.
62. Maes M, Leonard BE, Myint AM, et al. The new "5-HT" hypothesis of depression: cell-mediated immune activation induces indoleamine 2,3-dioxygenase, which leads to lower plasma tryptophan and an increased synthesis of detrimental tryptophan catabolites (TRYCATs), both of which contribute to the onset of depression. Prog Neuropsychopharmacol Biol Psychiatry. 2011;35(3):702–721. doi:10.1016/j.pnpbp.2010.12.017
63. Lucas M, Mirzaei F, Pan A, et al. Coffee, caffeine, and risk of depression among women. Arch Intern Med. 2011;171(17):1571–1578. doi:10.1001/archinternmed.2011.393
64. Asil E, Yılmaz MV, Yardimci H. Effects of black tea consumption and caffeine intake on depression risk in black tea consumers. Afr Health Sci. 2021;21(2):858–865. doi:10.4314/ahs.v21i2.47
65. Guo X, Park Y, Freedman ND, et al. Sweetened beverages, coffee, and tea and depression risk among older US adults. PLoS One. 2014;9(4):e94715. doi:10.1371/journal.pone.0094715
66. McHugh RK, Weiss RD. Alcohol Use Disorder and Depressive Disorders. Alcohol Res. 2019;40(1):arcr.v40.1.01. doi:10.35946/arcr.v40.1.01
67. Rowicka M, Postek S, Zin-Sędek M. Wzory konsumpcji alkoholu w Polsce: Raport z badań kwestionariuszowych 2020 r. 2021: 12–20.