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Dietary pattern among staff members and its relation to depression, Minia University, Egypt

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***Abstract*---**Background: Depression is a worldwide common mental disorder. According to the WHO reports, the total number of people with depression was more than 300 million in 2015, which was corresponding to 4·4% of the world's population. The aim of the study is to explore the associations of dietary pattern and depressive symptoms. This cross-sectional study used data of staff members and their assistants in Minia University. Dietary pattern was obtained from three days food records and average was taken. Depressive symptoms were assessed by center of epidemiological studies for

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depression (CES-D) scale. Logistic regression models were used to estimate the associations of dietary pattern with the risk of depressive symptoms. A total of 210 individuals aged 25 years and older were included in this study. Low fiber intake was the most important factor associated with presence of depressive symptoms (CES-D ≥16); OR= 12.130, C.I.95%= 2.718- 54.139, P= 0.001. The present study demonstrated that dietary fibers might reduce the risk of depressive symptoms in adults.

***Keywords*---**Dietary, pattern, Depressive symptoms, Cross-sectional study.

Introduction

Depression is a multifaceted condition with diverse biological and environmental causes and has therefore been bi-directionally associated with a 1.5 to 6 fold risk to develop cardiovascular diseases, diabetes, epilepsy, stroke, Alzheimer`s dementia and cancer (Lang et al., 2013). At its worst, depression can eventually lead to disability (Orsolini et al., 2020). The precise etiology of depression is unknown, but many psychological, social, and biological underpinnings are thought to contribute to its development. The latter includes genetic, hormonal, immunological, biochemical, and neurodegenerative factors. Concurrently, research has shown that these physiological aspects can be modulated by diet and nutrition (Patsalos et al., 2021).

The available evidence from observational studies suggests that diets higher in plant foods, such as vegetables, fruits, legumes and whole grains, and lean proteins, including fish, are associated with a reduced risk for depression, whilst dietary patterns that include more processed food and sugary products are associated with an increased risk of depression (Lai et al., 2013).

In several prospective partly large studies an unhealthy western dietary pattern was associated with an increased prevalence of depression. Moreover, the consumption of sweetened beverage, refined food, fried food, processed meat, refined grain, and high fat intake, biscuit snacking and pastries have been shown to be associated with an increased risk of depression in longitudinal studies . On the other hand healthy foods such as the Japanese diet (fruit, soy products, vegetables, green tea) or Mediterranean diet or other healthy diets containing high amounts of olive oil, fish, fruits, vegetables, nuts, legumes, poultry, dairy, unprocessed meat have been inversely associated with depression risk (Agarwal et al., 2015). In recapitulation, in a recent large study with about 4500 healthy controls, specific dietary patterns (healthy; unhealthy; sweets; 'Mexican' style; breakfast) predicted 39.8% of the total variance of depression incidence (Dipnall et al., 2015).

A recent study indicated that patients with a major depressive episode show increased levels of LDL cholesterol, and the severity of depressive symptoms correlates positively with LDL cholesterol levels (Wagner et al., 2019). In addition, adjuvant atorvastatin (Haghighi et al., 2014) or low-dose omega-3 fatty acids could significantly improve depressive symptoms in patients with major depressive disorder. Taken together, glucose and lipid related pathways may play a critical role for the development of depressive symptoms (Fang et al., 2019).

Urinary sodium excretion has been established as a reliable marker of sodium consumption (Moore et al., 2017) and thus may reflect the consumption of processed, unhealthy foods which are high in sodium content (Allemandi et al., 2015). In one intervention trial, low sodium intake specifically was associated with better mental health (Torres and Nowson, 2012).

Objective: to explore the association of dietary pattern and the risk of depressive symptoms.

Subjects and Methods

A cross-sectional study among university staff and their assistants, was conducted from November 2020 to January 2022 in Minia city. Before starting to collect the data, a pilot study was carried out on thirty staff members to fulfill the following purposes. The target population is staff members and their assistants in Minia University. The number of staff members and their assistants in Minia University are about four thousand persons; prevalence of depression is 22.9 among staff members as recorded by *(Yeshaw and Mossie, 2017).*

Using epi info, population size (for finite population correction factor or fpc) (N): 4000, Hypothesized % frequency of outcome factor in the population (p): 22.9% -/+ 5%, Confidence limits as % of 100(absolute +/- %)
(d): 5%, Design effect (for cluster surveys-DEFF): 1
Sample size n = [DEFF*Np (1-p)]/ [(d^2/Z$^2_{1-\alpha/2}$*(N-1)+p*(1-p)]
At 95% confidence level, 194 subjects were required to establish the study.
In this study, we randomly recruited 210 staff members and assistants, 31 from Faculty of Medicine, 64 from Faculty of Arts, 25 from Faculty of Nursing, 25 from Faculty of Tourism and Hotels, 31 form Faculty of Specific Education who agreed to participate in the study and give they were interviewed, and answered the study questionnaire.
In this study, we randomly recruited 210 staff members and assistants.

The questionnaire included:

Socio demographic data: gender, age, marital status, personal income, number of children, residence; cigarette smoking, weight, waist circumference, residence, physical activity, caffeine intake and multivitamin use.

Center for Epidemiologic Studies – Depression (CES–D) scale
Depression was measured by the Center for Epidemiologic Studies Depression Scale (CES-D). The CES-D has been widely used with good reliability and validity. This scale consists of 20 items related to characteristic symptoms and behaviors of depression, with each item rated from 0 to 3. The items (example item: “I was bothered by things that usually don’t bother me”) had a 4-point response option ranging from rarely or none of the time (less than 1 day) to most or all of the time (5-7 days). The total score ranges from 0 to 60, with a higher score indicating

greater depressive symptoms. The standard cut point 16 or more indicates clinically relevant depressive symptoms.

Three days food record

Food consumption data were collected by three-day food record and average was taken for one day.
Standardized food serving size was used to determine the quantity (in grams) of each portion.
The number of servings consumed of each food type was calculated by weight or volume
Participants were recruited on campus by face to face interview. Also, online form was forwarded on social media and in private.
According to Institute of Medicine (US) Dietary Reference Intakes , the recommended daily amount of vitamin A is 900 micrograms for adult men and 700 mcg for adult women, vitamin B1 for adults is 1.2 mg/day for men and 1.1 mg/day for women, riboflavin for adults is 1.3 mg/day for men and 1.1 mg/day for women, vitamin B6 for young adults is 1.3 mg, of zinc for adults is 8 mg/ day for women and 11 mg/day for men and for phosphorous is 700 mg/day.
No recommendations regarding carotenoid intake or desired blood or tissue concentrations have been issued by the majority of health authorities; no dietary reference intake recommendations (DRIs) exist, to our knowledge. whereas the German Nutrition Society recommended 2 mg/day total dietary carotenoid intake (Müller, 1996).

The RDA of vitamin E is 10mg of for men and 8 mg for women (Pryor, 2003). The average intake of potassium is 4700 (Suitor and Murphy, 2013).
The RDA for males and nonpregnant and nonlactating females age 15 years and older is 400 µg (Miller, 2013). RDA for vitamin C is 60 mg per day for adults (Ball, 2003). Sodium intake is recommended at <2.3 g (Mente et al., 2021).
According to FDA, the Recommended Dietary Allowance of magnesium for adults 19-51+ years is 400-420 mg daily for men and 310-320 mg for women
The National Research Council's Committee on Dietary Allowances recommended calcium intakes of 800 mg/ day for adults ages 19 and older and an iron intake of 10 mg/day for males 19 and older and intake of 18 mg/day for females ages 11 to 50 **(National Research Council, 1980)**.
Data were revised, coded and entered to personal computer and analyzed using SPSS version 20. Suitable analysis was done according to the type of data. Ethical committee and administrative approvals were obtained before conducting the study.

Results

This study included 210 staff members and their assistants in Minia University. The age of the subjects ranged between 25-68 years (mean age 37.7±9.6). Males construct 31% of the studied sample, while females construct 69%.

Table (1): Dietary pattern (macronutrients) of the studied participants of staff members and their assistants in Minia University (October 2020 to January 2022)

Variables		Frequency	Percentage (%)
Total energy	Low	121	57.6
	Normal 2000-2500 kcal	34	16.2
	High	55	26.2
Protein intake	Low	52	24.8
	Normal 10-35% of total calories	158	75.2
Fat intake	Low	15	7.1
	Normal 20-35% of total calories	128	61.0
	High	67	31.9
Carbohydrates intake	Low	26	12.4
	Normal 45-65% of total calories	115	54.8
	High	69	32.9
Dietary fiber intake	Low	168	80.0
	Norma l 21-38gram per day	22	10.5
	High	20	9.5
PUFA intake	Normal<10% of total calories	109	51.9
	High	101	48.1
Cholesterol intake	Normal</ =300 mg/day	106	50.5
	High	104	49.5
Vit. A intake	Low	119	56.7
	Normal700-900 µg/day	35	16.7
	High	56	26.7
Carotene intake	Low	115	54.8
	High>2 mg/day	95	45.2
Vit. E intake	Low	104	49.5
	Normal 8-10 mg/day	28	13.3
	High	78	37.1
Vit. B1 intake	Low	131	62.4
	Normal 1.1-1.2 mg/day	4	1.9
	High	75	35.7
Vit. B2 intake	Low	102	48.6
	Normal 1.1-1.3 mg/day	18	8.6
	High	90	42.9
Vit. B6 intake	Low	91	43.3
	Normal =1.3 mg/day	4	1.9
	High	115	54.8
Total Folic acid intake	Low	139	66.2
	High	71	33.8
Vit. C intake	Low	103	49.0

	High	107	51.0
Sodium intake	Low	119	56.7
	High>2300	91	43.3
Potassium intake	Low	210	100.0
Calcium intake	Low<800	143	68.1
	High>800 mg/day	67	31.9
Magnesium intake	Low	103	49.0
	Normal 310-420 mg/day	36	17.1
	High	71	33.8
Phosphorus intake	Low	28	13.3
	High >700 mg/day	182	86.7
Iron intake	Low	80	38.1
	Normal10-18 mg/day	87	41.4
	High	43	20.5
Zinc intake	Low	40	19.0
	Normal 8-11 mg/day	28	13.3
	High	142	67.6

PUFA= polyunsaturated fatty acids, mg=milligram, µg=microgram, mg= milligram
This table showed that about one quarter (24.8%) of the studied participants consumes low protein, one third (31.9%) of them consumes high fat, four fifths (80%) consume low fiber, one half (48.1%) consumes high PUFA, one half (49.5%) consumes high cholesterol in their diet.

Also, it was revealed that more than one half of the studied participants consumes low vitamin A (56.7%), one half (48.6%) consumes low riboflavin, more than two fifths (43.3%) consumes high sodium in their diet.

Table (2): Relation of dietary intake (low, normal and high) of macronutrients and CES-D score among studied staff members and their assistants in Minia University (October 2020 to January 2022)

Variables		Group I Score <16 N=24	Group II Score ≥16 N=186	Test statistic (x^2)	p-value
Total energy	Low	15(62.5%)	106(57%)	Fischer exact=1.464	0.494
	Normal 2000-2500 kcal	5(20.8%)	29(15.6%)		
	High	4(16.7%)	51(27.4%)		
Protein intake	Low	1(4.2%)	51(27.4%)	6.169	0.013*
	Normal 10-35	23(95.8%)	135(72.6%)		
Fat intake	Low	4(16.7%)	11(5.9%)	Fischer exact =4.595	0.081
	Normal 20-35	11(45.8%)	117(62.9%)		
	High	9(37.5%)	58(31.2%)		
Carbohydrates intake	Low	4(16.7%)	22(11.8%)	2.160	0.304
	Normal 45-	10(41.7%)	105(56.5%)		

	65				
	High	10(41.7%)	59(31.7%)		
Dietary fiber intake	Low	12(50%)	156(83.9%)	Fischer exact =18.462	<0.001*
	Normal 21-38	3(12.5%)	19(10.2%)		
	High	9(37.5%)	11(5.9%)		
PUFA intake	Normal<10%	4(16.7%)	105(56.5%)	13.478	<0.001*
	High	20(83.3%)	81(43.5%)		
Cholesterol intake	Normal</ =300mg	24(100%)	82(44.1%)	26.586	<0.001*
	High	0(0%)	104(55.9%)		

X^2= chi-squared, PUFA= polyunsaturated fatty acids, *= significant difference at <0.05

This table showed that participants with CES-D score more than or equal to 16 consumed significant lower intake of protein than those with CES-D score less than 16 (27.4% vs 4.2% p=0.013) respectively. Also, there was significant difference between participants with CES-D score more than or equal to 16 and those with score less than 16 regarding dietary fiber daily intake where participants with low intake constructed 83.9% vs 50% (p<0.001) respectively. There was significant difference (p <0.001) between two studied groups regarding PUFA intake where participants with high intake constructed 43.5% vs 83.3% among those with CES-D score more than or equal to 16 and those with score less than 16 respectively.

None of the studied participants with CES-D score less than 16 consumed high cholesterol in their dietary intake. However more than fifty percent (55.9%) of participants with CES-D score more than or equal to 16 consumed high cholesterol in their daily intake, which made significant difference at p<0.001

Table (3): Relation of dietary intake (low, normal and high) of micronutrients and CES-D score among studied staff members and their assistants in Minia University (October 2020 to January 2022)

Variables		Group I Score <16 N=24	Group II Score ≥16 N=186	Test statistic (x^2)	p-value
Vit. A intake	Low	15(62.5%)	107(57.5%)	Fischer exact =5.141	0.066
	Normal700-900 microgram	7(62.5%)	30(16.1%)		
	High	2(8.3%)	49(26.3%)		
Carotene intake	Low	13(54.2%)	102(54.8%)	0.004	0.950
	High>2	11(45.8%)	84(45.2%)		
Vit. E intake	Low	11(45.8%)	93(50%)	Fischer exact =0.291	0.911
	Normal 8-10	3(12.5%)	25(13.4%)		
	High	10(41.7%)	68(36.6%)		
Vit. B1 intake	Low	17(70.8%)	114(61.3%)	Fischer exact =0.638	0.696
	Normal 1.1-1.2	0(0%)	4(2.2%)		

	High	7(29.2%)	68(36.6%)		
Vit. B2 intake	Low	7(29.2%)	104(55.9%)	Fischer exact =6.535	0.031*
	Normal 1.1-1.3	3(12.5%)	13(7%)		
	High	14(58.3%)	69(37.1%)		
Vit. B6 intake	Low	12(50%)	79(42.5%)	Fischer exact =2.029	0.344
	Normal 1.3	1(4.2%)	3(1.6%)		
	High>1.3	11(45.8%)	104(55.9%)		
Total Folic acid intake	Low	18(75%)	121(65.1%)	0.940	0.332
	High >400	6(25%)	65(34.9%)		
Vit. C intake	Low <60	10(41.7%)	93(50%)	0.591	0.442
	High >60	14(58.3%)	93(50%)		
Sodium intake	Low	22(91.7%)	97(52.2%)	13.518	<0.001*
	High>2300	2(8.3%)	89(47.8%)		
Potassium intake	Low	24(100%)	186(100%)	-	-
Calcium intake	Low<800	18(75%)	125(67.2%)	0.595	0.441
	High>800	6(25%)	61(32.8%)		
Magnesium intake	Low	12(50%)	91(48.9%)	Fischer exact =0.507	0.771
	Normal 310-420	5(20.8%)	31(16.7%)		
	High	7(29.2%)	64(34.4%)		
Phosphorus intake	Low	6(25%)	22(11.8%)	3.192	0.074
	High >700 mg	18(75%)	164(88.2%)		
Iron intake	Low	9(37.5%)	71(38.2%)	Fischer exact =0.290	0.887
	Normal10-18	11(45.8%)	76(40.9%)		
	High	4(16.7%)	39(21%)		
Zinc intake	Low	7(29.2%)	33(17.7%)	Fischer exact =3.001	0.212
	Normal 8-11	1(4.2%)	27(14.5%)		
	High	16(66.7%)	126(67.7%)		

Vit=Vitamin, *= significant difference at <0.05

This table showed that participants with CES-D score more than or equal to 16 consumed significant lower intake of vitamin B2 than those with CES-D score less than 16 (55.9% vs 29.2% p=0.031) respectively.

Also, there was significant difference between participants with CES-D score more than or equal to 16 and those with score less than 16 regarding dietary sodium intake where participants with low intake constructed 52.2% vs 91.7% (p<0.001) respectively.

Table (4): Relation of dietary intake (low, normal and high) of macronutrients and CES-D score among studied staff members and their assistants in Minia University regarding sex (October 2020 to January 2022):

		Males			Females			
Variables		Group I Score <16 N=24	Group II Score ≥16 N=186	p-value		Group I Score <16 N=24	Group II Score ≥16 N=186	p-value
Total energy	Low	8(88.9%)	42(75%)	0.359	Low	10(66.7%)	71(54.6%)	0.373
	High	1(11.1%)	14(25%)		High	5(33.3%)	59(54.4%)	
Protein intake	Low	1(11.1%)	15(26.8%)	0.311	Low	0(0%)	36(27.7%)	0.019*
	Normal 10-35	8(88.9%)	41(73.2%)		Normal 10-35	15(100%)	94(72.3%)	
Fat intake	Low	2(22.2%)	2(3.6%)	0.067	Low	2(13.3%)	9(6.9%)	0.108
	Normal 20-35	6(66.7%)	37(66.1%)		Normal 20-35	5(33.3%)	80(61.5%)	
	High	1(11.1%)	17(30.4%)		High	8(53.3%)	41(31.5%)	
Carbohydrates intake	Low	0(0%)	7(12.5%)	0.520	Low	4(26.7%)	15(11.5%)	0.116
	Normal 45-65	5(55.6%)	29(51.8%)		Normal 45-65	5(33.3%)	76(58.5%)	
	High	4(44.4%)	20(35.7%)		High	6(40%)	39(30%)	
Dietary fiber intake	Low	4(44.4%)	54(96.4%)	<0.001*	Low	9(60%)	107(82.3%)	0.041*
	High	5(55.6%)	2(3.6%)		High	6(40%)	23(17.7%)	
PUFA intake	Normal< 10	1(11.1%)	37(66.1%)	0.003*	Normal< 10	3(20%)	68(52.3%)	0.018*
	High	8(88.9%)	19(33.9%)		High	12(80%)	62(47.7%)	
Cholesterol intake	Normal</=300mg	9(100%)	25(44.6%)	0.002*	Normal</=300mg	15(100%)	57(43.8%)	<0.001*
	High	0(0%)	31(55.4%)		High	0(0%)	73(56.2%)	

X^2= chi-squared, PUFA= polyunsaturated fatty acids *= significant difference at <0.05

This table showed that participants with CES-D score more than or equal to 16 consumed significant lower intake of protein than those with CES-D score less than 16 among females but not in males (27.7% vs zero, p= 0.019). Also, there was significant difference between two studied groups regarding dietary fiber daily intake where male and female participants with low intake constructed 96.4 vs 44.4% and 82.3%vs 60% (p<0.001, 0.041) among participants with CES-D score more than or equal to 16 and those with score less than 16 respectively.

There was significant difference between two studied groups regarding PUFA intake where male and female participants with high intake constructed 33.9% vs 88.9% and 47.7% vs 80% among those with CES-D score more than or equal to 16 and those with score less than 16 (p=0.003, 0.018) respectively.

None of the studied male and female participants with CES-D score less than 16 consumed high cholesterol in their dietary intake. However more than fifty percent (55.4% and 56.2%) of participants with CES-D score more than or equal to 16 consumed high cholesterol in their daily intake, which made significant difference at p=0.002 and <0.001 respectively.

Table (5): Relation of dietary intake (low, normal and high) of micronutrients and CES-D score among studied staff members and their assistants in Minia University regarding sex (October 2020 to January 2022)

		Males			Females			
Variables		Group I Score <16 N=24	Group II Score ≥16 N=186	p-value		Group I Score <16 N=24	Group II Score ≥16 N=186	p-value
Vit. A intake	Normal=900 microgram	8(88.9%)	38(67.9%)	0.198	Normal=700microgram	13(86.7%)	75(57.7%)	0.055
	High	1(11.1%)	18(32.1%)		High	2(13.3%)	55(42.3%)	
Carotene intake	Low	3(33.3%)	26(46.4%)	0.463	Low	10(66.7%)	76(58.5%)	0.540
	High>2	6(66.7%)	30(53.6%)		High>2	5(33.3%)	54(41.5%)	
Vit. E intake	Low	6(66.7%)	38(67.9%)	0.943	Low	7(46.7%)	64(49.2%)	0.851
	High	3(33.3%)	18(32.1%)		High	8(53.3%)	66(50.8%)	
Vit. B1 intake	Low	6(66.7%)	35(62.5%)	0.810	Low	11(73.3%)	82(63.1%)	0.433
	High	3(33.3%)	21(37.5%)		High	4(26.7%)	48(36.9%)	
Vit. B2 intake	Low	2(22.2%)	26(46.4%)	0.042*	Low	6(40%)	72(55.4%)	0.119
	Normal =1.3	0(0%)	4(7.1%)		Normal =1.1	1(6.7%)	1(0.8%)	
	High	7(77.8%)	26(46.4%)		High	8(53.3%)	57(43.8%)	
Vit. B6 intake	Low	4(44.4%)	22(39.3%)	0.282	Low	8(53.3%)	57(43.8%)	0.719
	Normal =1.3	1(11.1%)	1(1.8%)		Normal 1.3	0(0%)	2(1.5%)	
	High>1.3	4(44.4%)	33(58.9%)		High>1.3	7(46.7%)	71(54.6%)	
Tot. Fol.acid intake	Low	6(66.7%)	35(62.5%)	0.810	Low	12(80%)	86(66.2%)	0.278
	High >400	3(33.3%)	21(37.5%)		High >400	3(20%)	44(33.8%)	
Vit. C intake	Low <60	3(33.3%)	29(51.8%)	0.304	Low <60	7(46.7%)	64(49.2%)	0.851
	High >60	6(66.7%)	27(48.2%)		High >60	8(53.3%)	66(50.8%)	
Sodium intake	Low	8(88.9%)	25(44.6%)	0.014*	Low	14(93.3%)	72(55.4%)	0.005*
	High>2300	1(11.1%)	31(55.4%)		High>2300	1(6.7%)	58(44.6%)	
Potassium intake	Low	9(100%)	56(100%)	-	Low	15(100%)	130(100%)	-
Calcium intake	Low<800	7(77.8%)	37(66.1%)	0.486	Low<800	11(73.3%)	88(67.7%)	0.657
	High>800	2(22.2%)	19(33.9%)		High>800	4(26.7%)	42(32.3%)	
Magnesium intake	Low	6(66.7%)	36(64.3%)	0.890	Low	7(46.7%)	64(49.2%)	0.851
	High	3(33.3%)	20(35.7%)		High	8(53.3%)	66(50.8%)	
Phosphorus intake	Low	3(33.3%)	5(8.9%)	0.073	Low	3(20%)	17(13.1%)	0.462
	High >700 mg	6(66.7%)	51(91.1%)		High >700 mg	12(80%)	113(86.9%)	
Iron intake	Low	5(55.6%)	19(33.9%)	0.212	Low	13(86.7%)	105(80.8%)	0.579
	High	4(44.4%)	37(66.1%)		High	2(13.3%)	25(19.2%)	
Zinc intake	Low	4(44.6%)	17(30.4%)	0.402	Low	3(20%)	(%)	0.825
	High	5(55.6%)	39(69.6%)		High	12(80%)	107(82.3%)	

This table showed that male participants with CES-D score more than or equal to 16 consumed significant lower intake of vitamin B2 than those with CES-D score less than 16 (46.4% vs 22.2% p=0.042) respectively. Also, there was significant difference between male and female participants with CES-D score more than or equal to 16 and those with score less than 16 regarding dietary sodium intake where participants with low intake constructed 44.6% vs 88.9% and 55.4% vs 93.3% (p=0.014 and 0.005) respectively.

Table (6): Individualized binary logistic regression of dietary data (October 2020 to January 2022)

Variables	Odds ratio	95% C.I. for odds ratio		p-value
Protein intake per day (g)	0.949	0.927	0.972	<0.001*
Protein % of calories	0.889	0.820	0.965	0.005*
Protein grams per kilogram body weight	0.017	0.003	0.093	<0.001*
Dietary fiber intake (g/day)	0.928	0.900	0.958	<0.001*
PUFA	0.763	0.684	0.852	<0.001*
Cholesterol intake	1.010	1.005	1.015	<0.001*
Vitamin B2	0.251	0.116	0.544	<0.001*
Sodium	1.001	1.001	1.002	<0.001*

Univariate regression of dietary data showed that increasing protein intake (OR= 0.949, C.I.95%= 0.927-0.972, P<0.001), percent of protein from total caloric intake (OR= 0.889, C.I.95%= 0.820-0.965, P=0.005) , protein grams per kilogram body weight (OR= 0.017, C.I.95%= 0.003-0.093, P<0.001), dietary fiber (OR=0.928 , C.I.95%= 0.900-0.958, P<0.001), PUFA (OR=0.763 , C.I.95%= 0.684-0.852, P<0.001), and vitamin B2intake (OR= 0.251, C.I.95%= 0.116-0.544, P<0.001) are protective factors against depression measured by CES-D depression scale
Regarding cholesterol (OR=1.010, C.I.95%= 1.005-1.015, P<0.001) and sodium intake (OR=1.001, C.I.95%= 1.001-1.002, P<0.001), they were found to be as risk factors for presence of depressive symptoms.

Table (7): Multiple logistic regressions of predictors of total CES-D score (October 2020 to January 2022)

	OR	95% C.I. for OR		p-value
		Lower	Upper	
Protein intake				*
Low	13.800	1.044	182.384	0.046*
Normal	Ref			*
FIBER intake				0.005*
Low	12.130	2.718	54.139	0.001*
Normal	5.205	0.725	37.387	.101
PUFA intake				
Normal	Ref			
Low	7.937	2.116	29.780	0.002*
Sodium intake				
Low	0.100	0.020	0.504	0.005*
Normal	Ref			

OR= odds ratio, *= significant at <0.05

This table showed that low fiber intake was the most important factor associated with presence of depressive symptoms (CES-D ≥16); OR= 12.130, C.I.95%= 2.718-54.139, P=0.001

Discussion

This a cross-sectional study conducted among university staff and their assistants to explore the association of total protein intake and the risk of depressive symptoms. The majority of the studied staff members and their assistants were urban resident (78.6%), 66.7% married, 96.2% non-smokers, 83.8% free from chronic disease history, 62.9% did not consume fast food more than once per week, 64.3% did not take supplements, 94.3% did not have physical activity more than one hour per week.

Protein intake

In this study, the odds ratio for depression was associated with total protein intake (gram/day) (OR=0.989, P <0.001). As the intake from protein increase, the prevalence of depression decrease. These finding was consistent with a study by *Oh et al., 2020*. Also, protein intake was significantly different, negatively associated with depressive symptoms, which was consistent with some studies. A National Health and Nutrition Evaluation Follow-up Study observed that higher intake of protein was associated with decreased risk of severely depressed mood. Two cross-sectional studies separately conducted in Japanese male workers (Nanri et al., 2014) and Spanish Children (Rubio et al., 2016) both found an inverse association between protein intake and the risk of depressive symptoms.
One cross-sectional survey of Villanueva Older Health Study carried out by *Jimenez-Redondo et al., 2014* indicated that there was a negative association between protein and anxiety/depression in Spanish nonagenarians. *Guligowska et al., 2016* conducted a case–control study in Polish older adults and concluded that higher intake of protein was associated with better functional and cognitive status.

Additionally*, Ciarambino et al.* performed study (Ciarambino et al., 2012) about the association of a low protein diet and depressive symptomsinelderlywithtype2diabetes, and they found that the symptoms of depression were increased in individuals with low protein diet. However, the results of several studies were not in line with ours. In a Japanese cross-sectional study of 279 elderly people and a Polish cross-sectional study of sixty-four patients with obstructive sleep apnea (Stelmach-Mardas et al., 2016), the association of protein intake and depressive symptoms was insignificant. Moreover, a follow-up study found a positive association between protein intake and severely depressed mood among US female. In a Spanish cross-sectional study of 140 elderly people (Aparicio et al., 2013), protein intake was positively associated with depressive symptoms, but with no significance.

The mechanisms of the association between protein intake and depression are not well understood now. But it has been reported that amino acids from protein could influence mood state and cognitive functions. For example, tryptophan had an antidepressant-like effect that was due to its conversion to serotonin, which plays an important role in regulating mood (García-Montero et al., 2022). Tyrosine could have an effect on mood through being transformed into a neurotransmitter of dopamine. Moreover, small molecular peptides (e.g. creatine and carnosine) have been suggested to exert an impact on brain monoamine metabolism, which may further influence the development of depression (Nagasawa et al., 2012).

Although the high protein intake could increase the plasma concentration of tryptophan, other neural amino acids can compete with tryptophan for uptake into brain. Therefore, increasing protein intake does not necessarily increase the tryptophan level in the brain. Due to this conflicting effect of protein intake on the tryptophan concentration, there is a difficulty in interpreting the result that an increased intake of protein prevents depression by increasing serotonin in the brain (García-Montero et al., 2022).

Dietary fiber intake

In this study, we found that intakes of total fiber were inversely associated with depressive symptoms and was statistically significant for both men and women. *Yun et al., 2021* who used nationally representative samples of 10,106 subjects from the Korea National Health and Nutrition Examination Survey and found similar results. Our finding was consistent with the findings from previous studies (Kim et al., 2015; Gangwisch et al., 2015).

Similar to our findings, several studies have found an inverse association between dietary intake of fiber and severity of depressive symptoms (Xu et al., 2018; Miki et al., 2016). In a study on 1977 Japanese workers between ages 19 and 69 years, *Miki et al., 2016* found a significant inverse association between dietary fiber intake from vegetables and fruits and depressive symptoms. In another study on 16807 adults aged 20years or older, it was revealed that dietary intakes of total fiber, fruit fiber and vegetable fiber were inversely associated with depressive symptoms. Moreover, a Chinese study, which was conducted in 3394 community-dwelling older adults showed that total fiber intake was inversely associated with depression score (Xu et al., 2018).

The Women's Health Initiative Observational Study (Gangwisch et al., 2015) indicated that higher consumption of dietary fiber was associated with a decreased OR for depressive symptoms among postmenopausal women. A Korean study (Kim et al., 2015) performed among adolescent girls suggested that dietary fiber intake reduced the risk of depressive symptoms. A similar result was also found in an elderly Chinese population. In contrast, *Gopinath et al., 2016* found no statistically significant associations among total fiber intakes and depressive symptoms in older Australian adults.

The inconsistent results might be partly caused by the differences in age, sex, ethnic background, occupation, and intake level of dietary fiber of participants. In addition, different assessment methods of depressive symptoms, including PHQ-9, Burnam Scale (Gangwisch et al., 2015), Beck Depression Inventory (Kim et al., 2015), Center for Epidemiology Studies Depression Scale (Miki et al., 2016), and Mental Health Index Scale (Gopinath et al., 2016), might also contribute to the inconsistent results. Although the mechanism underlying the impact of dietary fiber on depression remains poorly understood, several possibilities have been suggested.

First, dietary fiber can alter the composition of intestinal microbiota (Albenberg and Wu 2014), and intestinal microbiota may regulate inflammation, oxidative stress (Selhub et al., 2014), serotonergic system (O'Mahony et al., 2015); thereby fiber consumption communicates with the central nervous system and influences brain function. Second, short-chain fatty acids, produced by fermentation of dietary fiber, have been suggested to regulate inflammatory response, which is an underlying mediating pathway in depression. Third, postprandial hyperglycemia may promote the overproduction of oxidative stress, and dietary fiber can lower postprandial plasma glucose, which may inhibit the inflammatory processes (Berk et al., 2013).

Cholesterol intake

We found that cholesterol was associated with depression like *Yun et al., 2021* who used nationally representative samples of 10,106 subjects from the Korea National Health and Nutrition Examination Survey and found similar results. *Cepeda et al., 2020*designed and conducted a large population-based study to assess the association of cholesterol with depression and found that having low total cholesterol (<129 mg/dl) was associated with a decreased risk of depression compared with higher levels.

Contrary to *Jia et al., 2020* who examined the relationship between lipid profile (total cholesterol, triglycerides, high-density lipoprotein cholesterol and low-density lipoprotein cholesterol) and cognition in adults with and without self-rated depression and found no significant association between cholesterol and depressive symptoms. Results from a larger sample in the Netherlands Study of Depression and Anxiety indicated higher total cholesterol level in 761 participants currently with major depressive disorder than 629 healthy controls (Jia et al., 2020).

The results of this study are also consistent with epidemiological evidence showing that obesity and depression are positively associated, and that total cholesterol levels are also positively associated with obesity (Cepeda et al., 2020).
A recent study that analyzed 9 Dutch clinical and population-based studies assessed the association of 230 metabolite measurements with depression found that high levels of triglycerides and total cholesterol were associated with increased risk of depression (Bot et al., 2020).

This inconsistency may reflect the complexity of cholesterol relationship with depression, although variations in methodology (different self-report scales, covariates or confounders considered) along with demographics and ethnicity of the sample studied, may also account for the discrepancy. Another reason for the inconsistent results might lie in the nature of the depressive spectrum. High cholesterol may also be associated with depression as it decreases membrane fluidity, which could negatively affect the activity of serotonin receptors in the central nervous system (Jo et al, 2022).

Polyunsaturated fatty acids intake

PUFA intake was significantly lower among CES-D scale above 16 and negatively associated with presence of depression by CES-D depression scale matching the results reported by *Huang et al., 2019* who concluded that dietary antioxidants such as green tea polyphenols or isoflavonoid intake have been negatively associated with depression or depressive symptoms. *Also, a study by Payne et al., 2012*done on a sample of older adults with depression against control group and found that the depression group reported a lower intake of antioxidant foods including PUFA. *Ciesielski et al., 2020* found that low circulating level of PUFAs based on their intakes have been linked to depressive disorders. *Yun et al., 2021* used nationally representative samples of 10,106 subjects from the Korea National Health and Nutrition Examination Survey and found similar results.

In a meta-analysis of 31 studies including 255076 individuals, higher intake of total PUFA was associated with lower risk of depression. Furthermore, a dose-response relationship was observed for total n-3 PUFA intake, and compared with 0, 0.5, 1, 1.5, and 1.8g/d, reduced the risk of depression by 31%, 52%, 67%, and 70%, respectively (Grosso et al., 2016; Kris-Etherton et al., 2021). There was a significant negative correlation between the incidence of depression and per-capita fish consumption (Yoshikawa et al., 2015; Smith et al., 2014). Although the data can provide the evidence for the negative relationship between depression and PUFA, the causal relationship between them cannot be determined. Due to PUFAs being closely related with depression, many clinical trials have been conducted to explore the effect of PUFA on depression.

Micronutrients and depression:

Riboflavin intake

We found that riboflavin was associated with depressive symptoms. This matched a cross sectional study by *Yun et al., 2021* who used nationally representative samples of 10,106 subjects from the Korea National Health and Nutrition Examination Survey and found similar results. *Moore, et al., 2019* studied B-vitamins in relation to depression assessed by CES-D score ≥16in older adults and found similar results.

Kim et al., 2018 studied the association of the anxiety/depression with nutrition intake and concluded that riboflavin intake was significantly higher in participants without depression than participants with depression. *Lin et al., 2019*investigated the association between the dietary intake of B vitamins and post partum depression (PPD) occurrence in a prospective cohort of 865 women, an inverse association was identified between vitamin B2intake and PPD.

Dietary sodium intake

This study provides evidence that depression is associated with sodium intake matching the results of a study by *Yun et al., 2021* who used nationally representative samples of 10,106 subjects from the Korea National Health and Nutrition Examination Survey.

Another study where results suggest that consumption of foods high in sodium contributes to the development of depressive symptoms in early adolescence and that diet is a modifiable risk factor for adolescent depression (Mrug et al., 2019). *Kaner* in Turkey evaluate nutritional intake of patients with depression and showed a higher amount of sodium intake in the group with depressive symptoms compared to the group without such symptoms (Kaner et al., 2015). Although only a handful of studies addressed the role of diet in the human brain, recent reviews of experimental animal studies (each citing over 100 papers) (Dash et al., 2015) convincingly demonstrated that diet – high in sodium has profound negative effects on behavior and cognition through impairments in frontal, limbic, and hippocampal areas of the brain.

Conclusion

Conclusion drawn from this study is that the protein, dietary fibers, vitamin B2 and PUFA high intake might reduce the risk of depressive symptoms in adults contrary to sodium nd cholesterol high intakes.

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