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The Association of Legume Consumption and Psychological Health among Women: A Cross-Sectional Study

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ABSTRACT

Background: Independent association between legume intake and psychological disorders is not well documented. This study was carried out to examine legume consumption in relation todepression, anxiety, and stress in women in Tehran city of Iran. **Methods:** In this cross-sectional study, 458 women aged 20-50 years who referred to the health centers of Tehran University of Medical Sciences were selected by multistage cluster sampling method. The usual dietary intake in the past year was evaluated using a 168-item semi-quantitative food frequency questionnaire with confirmed validity and reliability. Legume intake was calculated by summing up the consumption of lentils, peas, chickpeas, and different kinds of beans including broad beans and chickling vetch. Psychological disorders were assessed using a validated depression, anxiety, stress scales questionnaires with 21items. In the logistic regression analysis, the results were adjusted to the confounding factors. **Results:** The mean age of the study participants was 31.85 ± 7.67 years. The prevalence of depressive symptoms, anxiety, and psychological distress among study participants was 34.6%, 40.6%, and 42.4%, respectively. After adjustment of the confounding variables, legume consumption had no significant association with depression (P = 0.72), anxiety (P = 0.17), and stress (P = 0.89). However, a significant association was found between moderate legume consumption and depression (OR: 0.52; 95% CI: 0.30–0.90; P = 0.01). **Conclusion:** Higher legume consumption has no significant relationship with depression, anxiety, and anxiety in women. However, a significant association was observed between moderate legume consumption and depression. Prospective studies are needed to confirm these findings.

Keywords: *Legume; Depression; Anxiety; Stress; Women*

Introduction

The prevalence of psychotic disorders is increasing worldwide (Murphy *et al.*, 2004). Psychotic disorders are related to heavy economic costs, inability, and mortality (Olesen *et al.*, 2012). Depression and anxiety with prevalence rate of 10-20% are the most common

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psychological disorders in the general population (Davis *et al.*, 2003). Studies conducted in Iran show that about 21.0% and 20.8% of adults have anxiety and depression, respectively. On average, the prevalence of depression is 1.95 times higher in women than men (Sadeghirad *et al.*, 2010). The current treatments for depression may bring about a series of issues such as high economic costs, adverse side effects, and desirable treatment outcomes. Alternative approaches, specially nutritional factors, may have an important role in the prevention and treatment of mental disorders (Penckofer *et al.*, 2010).

Legumes, as low-glycemic-index and low-energy-dense foods, have high amounts of proteins, fiber, oligosaccharides, phenolic, and other bioactive compounds (Messina, 1999). Some nutrients such as zinc, magnesium, folate, and vitamin B12 are essential for the proper functioning of neurotransmitters and improvement of psychological health (Bjelland *et al.*, 2003, Młyniec *et al.*, 2014). Several studies showed that consumption of legumes was inversely associated with risk of cardiovascular disease, obesity, type 2 diabetes, and some types of cancers (Flight and Clifton, 2006, Kolonel *et al.*, 2000, Trinidad *et al.*, 2010, Villegas *et al.*, 2008).

A study by Azadbakht et al. on 486 Iranian women reported that legume consumption had an inverse relationship with serum concentrations of adhesion molecules and inflammatory biomarker (Esmaillzadeh and Azadbakht, 2012). In addition, legumes consumption had a significant association with cardiovascular events in elderly Iranian people (Nouri *et al.*, 2016). A review of randomized clinical trials (RCTs) showed that non-soy legume consumption may contribute to reductions in C-reactive protein (CRP) and hs-CRP concentrations (Salehi-Abargouei *et al.*, 2015).

Although earlier studies considered dietary fiber (Miki *et al.*, 2016), magnesium (Sun *et al.*, 2019), and glycemic index (Haghighatdoost *et al.*, 2015) in relation to psychological disorders, few data exist associating legume intake to these outcomes.

Observational studies that investigated intake of legume in relation to chronic diseases are limited. Current studies considered legume in combination with other foods such as grains or nuts and it is difficult to identify the effects of legume from other foods. Due to low consumption of legumes in populations, the single effect of legume had low importance in health and disease. The traditional Iranian diet contains high amounts of legume (almost 3 servings/wk) (Ghaemi-Hashemi *et al.*, 1998). These high dietary intakes provide the opportunity to investigate legume intake in relation to mental health. In this study, we evaluated legume consumption in relation to depression, anxiety, and stress among Iranian women.

Materials and Methods

Study design and participants: This cross-sectional study was conducted on 458 women referring to the health centers affiliated to Tehran University of Medical Sciences selected by multistage cluster sampling method in 2018. These centers were randomly selected from 29 health centers in the south of Tehran. In each selected health center, the number of participants was determined in proportion to the total number of persons attending the center. Women who were in the age range of 20-50 years, Iranian, healthy, not pregnant and lactating, not menopause, and not on any particular diet, filled the consent to participate in the study, had no history of diabetes, cardiovascular, cancer, depression, lung, thyroid, kidney, liver, hypertension, multiple sclerosis (MS), and epilepsy diseases, and did not use anti-anxiety and anti-depressant medications were included. A written informed consent was also received from each participant prior to the study. Those who did not complete consent forms, did not cooperate in completing the questionnaires, and consumed less than 500 or more than 3500 kilo calorie of energy were excluded from the study.

Assessment of dietary intake and legumes consumption: Dietary intake was evaluated using

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a semi-quantitative food frequency questionnaire (FFQ) containing 168 food items that had already been validated (Esfahani *et al.*, 2010). In our study, legume intake was calculated by summing up the consumption of lentils, peas, chickpeas, and different kinds of beans including broad beans and chickling vetch. We did not consider soy intake in the legume category because soy consumption is low among Iranians. All questionnaires were completed by trained dietitians. Participants were asked to report the frequency of each food during the past year on a daily, weekly, monthly, or annual basis. The amount of each food was converted to gram using household measures. Later, the gram of consumption of each food item was converted to daily intake. Each food item was coded and nutrients were analyzed using the NUTRITIONIST IV software for Iranian foods (version 7.0; N-Squared Computing, Salem, OR, USA).

Assessment of psychological profile: Psychiatric disorders were assessed using a questionnaire of Depression, Anxiety, and Stress Scale (DASS-21), the reliability of which was previously confirmed (Samani and Joukar, 2007). To complete the questionnaire, the respondent should identify the status of a symptom during the past week. Each of the three DASS subscales consists of 7 questions. And its final score was obtained by calculating the total score of the three subscales. The answers are divided into four categories of zero, low, medium, and high within the score range of 0–3, respectively. Since the DASS-21 is the short-form of the original scale (42 questions), the final score of each of these subscales should be doubled (Lovibond and Lovibond, 1995). Based on the total score, the participants were categorized into five groups of normal, mild, moderate, severe, and very severe for depression, anxiety, and stress. However, due to the limited number of participants in some groups, they were divided into two groups of normal and mild/moderate/ severe/very severe. Depressive, anxiety, and stress symptoms were defined as a score of equal or higher than 10, 8, and 15, respectively.

Assessment of other variables: The participants' general information were also collected that included: age, marital status, socioeconomic status (home and welfare status), frequency of travel abroad, occupational status, education status, head of family education status, number of family members, number of employed family members, number of children, head of family occupational status, number of deliveries, smoking, number of rooms, number of hours out of the home, satisfaction with the physical form, use of supplementation or medication, adherence specific diet, and a history and/or a family history of diabetes, cancer, cardiovascular, pulmonary, kidney, liver, high blood pressure, depression, thyroid, epilepsy, and MS.

The height was measured in the standing position without shoes by an inflexible meter with 0.5 cm accuracy. The weight was measured by a digital scale (SECA, Hamburg, Germany) without shoes in minimal clothing and with an accuracy of 0.1 kg. Body mass index (BMI) was calculated by dividing the weight (kg) by height squared (m^2). Physical activity was determined based on metabolic equivalents × h/d (Met.h/d) by recording physical activity over 24 hours and the level of physical activity of individuals was calculated as Met.h/d (Ainsworth *et al.*, 2000).

Ethical considerations: This study was approved by the Research Council and Ethics Committee of the School of Nutrition and Food Science, Tehran University of Medical Sciences, Tehran, Iran with 9511468003 cod number. All participants declared their consent to participate in the study by providing written informed consent forms.

Data analysis: The variables' distribution was checked for normality using the Kolmogorov-Smirnov test. General characteristics across tertiles of legumes intake were reported as means ± SDs for continuous variables using numbers and percentages for categorical variables. To examine the differences across

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tertiles, ANOVA was run for continuous variables and a Chi square test was performed for categorical variables. Dietary intakes of the study participants across tertiles of legumes were compared using ANCOVA and all values were adjusted for energy intake. Moreover, binary logistic regressions were used to estimate ORs and 95% CIs for psychological profile across tertiles of legumes in crude and multivariable-adjusted models. In these analyses, age and total energy intake were controlled in the first model. Further adjustment was made for age, energy intake, socio-economic status (low, medium and high), marital status, physical activity, supplement use (yes/no), drug use (yes/no) , family history of chronic disease (yes/no), sleep time, out of home time, and body size image (normal, abnormal). In the final model, BMI was added to the adjustment and P-value for trend was determined by considering tertiles of legumes as ordinal variables in the logistic regression analysis. All statistical analyses were performed using the Statistical Package for Social Sciences (version 21; SPSS Inc.) and P-value < 0.05 was considered as statistically significant.

Results

In this study, 482 women aged 20-50 years with a mean age of 31.85 ± 7.67 years were included. The mean BMI was 24.46 ± 4.10 kg/m^2. The prevalence of depression, anxiety, and psychological stress was 34, 40, and 42% among participants, respectively. In the third tertile of potato intake, women were older than the first tertile. Moreover, the number of women who consumed supplements in third tertile of legumes intake was lower than the first tertile. No significant difference was found about other demographic factors among legumes intake tertiles. The distribution of demographic variables among legumes tertiles can be seen in **Table 1**.

The mean dietary intakes in each potato tertile showed that energy intake, total fiber, protein, thiamine, vitamin B3, folate, vegetable, and whole grains were significantly higher in the third terile than the first tertile of legumes intake. In addition, consumption of fruits and processed meat was significantly reduced in the third tertile than first tertile of legumes. Dietary intakes of the study participants across tertiles of legumes are provided in **Table 2**.

Table 3 shows the odds ratio of depression, anxiety, and stress among legumes tertiles. After adjusting the confounding variables, consuming highest legumes intake had no significant association with depression (P = 0.72), anxiety (P = 0.17), and stress (P = 0.89). However, a significant association was observed between moderate legumes consumption and depression (OR: 0.52; 95% CI: 0.30–0.90; P = 0.01).

Table 1. General characteristics of participants across the tertiles of legumes

Variables	Total (N = 458)	legumes tertiles			P-value
		T1 ≤ 21 (n = 162)	T2 21< to 48 (n = 145)	T3 ≥48 (n = 151)	
Quantitative variables					
Age (year)	31.44 ± 7.52[a]	30.25 ± 7.51	32.21 ± 7.47	31.97 ± 7.47	0.04[b]
Body mass index (kg/m^2)	23.88 ± 3.84	23.66 ± 4.00	23.79 ± 3.80	24.20 ± 3.70	0.43[b]
Physical activity (METhr/d)	39.89 ± 6.62	39.05 ± 5.98	40.60 ± 7.53	40.09 ± 6.26	0.11[b]
Sleeping time (hrs)	7.78 ± 1.49	7.71 ± 1.44	7.97 ± 1.51	7.67 ± 1.50	0.16[b]
Out time (hrs)	6.22 ± 3.72	6.44 ± 3.64	6.31 ± 3.61	5.91 ± 3.91	0.42[b]
Qualitative variables					
Socio-economic status	N (%)	N (%)	N (%)	N (%)	
Low	142 (31)	41 (29)	58 (41)	43 (30)	0.29[c]
Medium	180 (40)	67 (37)	52 (29)	61 (34)	

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Table 1. General characteristics of participants across the tertiles of legumes

Variables	Total (N = 458)	legumes tertiles			P-value
		T1 ≤ 21 (n = 162)	T2 21< to 48 (n = 145)	T3 ≥48 (n = 151)	
High	136 (29)	54 (40)	40 (29)	42 (31)	
Overweight or obesity	157 (34)	52 (33)	51 (32)	54 (35)	0.76 [c]
Marital status					
Single	186 (40)	75 (40)	54 (29)	57 (31)	0.18 [c]
Married	272 (60)	87 (32)	91 (33)	94 (35)	
Supplement use	171 (37)	64 (37)	63 (37)	44 (26)	0.03 [c]
Drug use	34 (7)	14 (41)	13 (38)	7 (21)	0.27 [c]
Family history of chronic disease	246 (54)	83 (34)	79 (32)	84 (34)	0.72 [c]
Depression	157(34)	61(39)	41(26)	55(35)	0.17 [c]
Anxiety	181(39)	69(38)	53(29)	59(33)	0.55 [c]
Stress	192(42)	72(37)	56(29)	64(34)	0.58 [c]

[a]: Mean ± SD; [b]: One-way ANOVA test; [c]: Chi-square test

Table 2. Multivariable-adjusted dietary intakes across the tertiles of legumes

Variables	Legumes tertiles			P-value[b]
	T1 ≤21 (n = 162)	T2 21< to 48 (n = 145)	T3 ≥48 (n = 151)	
Energy intake (kcal/d)	1988.00 ± 42.01[a]	2083.37 ± 39.97	2151.77 ± 38.94	0.01
Total fiber (g/d)	15.70 ± 0.39	15.92 ± 0.41	18.82 ± 0.40	<0.001
Protein (g/day)	73.37 ± 1.15	74.38 ± 1.21	78.37 ± 1.19	0.007
Carbohydrate (g/d)	292.77 ± 2.50	286.60 ± 2.63	289.79 ± 2.59	0.108
Fat (g/d)	75.85 ± 1.07	76.53 ± 1.12	74.95 ± 1.11	0.604
Saturated fatty acids (g/d)	23.39 ± 0.45	23.46 ± 0.48	22.52 ± 0.47	0.293
W-3 fatty acids (g/d)	0.21 ± 0.01	0.19 ± 0.01	0.17 ± 0.01	0.345
Cholesterol (mg/d)	241.69 ± 6.28	221.95 ± 6.61	221.92 ± 6.50	0.652
Vitamin B1 (mg/d)	1.47 ± 0.01	1.53 ± 0.02	1.57 ± 0.01	0.001
Vitamin B3 (mg/d)	17.06 ± 0.21	17.55 ± 0.22	17.88 ± 0.21	0.027
Vitamin B6 (mg/d)	1.30 ± 0.02	1.34 ± 0.02	1.35 ± 0.02	0.436
Folate (µg /d)	276.48 ± 5.93	307.25 ± 6.24	371.05 ± 6.14	<0.001
Vitamin B12 (µg/d)	4.51 ± 0.19	4.51 ± 0.20	4.60 ± 0.20	0.928
Vitamin D (µg /d)	2.14 ± 0.12	2.12 ± 0.12	2.03 ± 0.12	0.810
Iron (mg/d)	23.80 ± 1.63	20.96 ± 1.72	21.26 ± 1.69	0.416
Zinc (mg/d)	9.05 ± 0.23	8.74 ± 0.24	9.20 ± 0.24	0.398
Fruit (g/d)	369.96 ± 15.68	278.45 ± 16.49	271.84 ± 16.22	<0.001
Vegetable (g/d)	321.38 ± 15.16	357.38 ± 15.95	386.47 ± 15.69	0.012
Nuts (g/d)	12.42 ± 0.98	11.75 ± 1.03	12.23 ± 1.02	0.890
Whole grains (g/d)	8.56 ± 0.98	9.53 ± 1.04	12.58 ± 1.02	0.015
Refined grains (g/d)	305.35 ± 8.15	310.66 ± 8.57	297.90 ± 8.43	0.566
Dairy (g/d)	472.31 ± 16.87	492.92 ± 17.75	445.32 ± 17.46	0.160
Red meat (g/d)	44.71 ± 2.66	39.33 ± 2.80	42.29 ± 2.76	0.382
Processed meat (g/d)	8.26 ± 0.69	6.69 ± 0.73	7.75 ± 0.71	0.041

[a]: Values are mean ± SE. All values are adjusted for energy intake, except for total energy; [b]: One-way ANCOVA test.

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Table 3. Multiple-adjusted odds ratio (OR) and 95% confidence intervals (CI) across the tertiles of legumes intake

Variables	legumes tertiles			P-trend
	T1 ≤21 (n = 162)	T2 21< to 48 (n = 145)	T3 ≥48 (n = 151)	
Depression				
Crude	1.00	0.65 (0.40, 1.05)	0.94(0.59, 1.50)	0.822
Model I[a]	1.00	0.57(0.35, 0.94)	0.85 (0.53, 1.37)	0.524
Model II[b]	1.00	0.56(0.33, 0.92)	0.87 (0.54, 1.42)	0.592
Model III[c]	1.00	0.52 (0.30, 0.90)	0.91 (0.53, 1.54)	0.728
Anxiety				
Crude	1.00	0.77 (0.49, 1.22)	0.86 (0.55, 1.35)	0.521
Model Ⅰ	1.00	0.72 (0.45, 1.15)	0.80 (0.50, 1.27)	0.348
Model Ⅱ	1.00	0.68 (0.42, 1.10)	0.79 (0.49, 1.28)	0.350
Model Ⅲ	1.00	0.60 (0.35, 1.00)	0.69 (0.41, 1.16)	0.171
Psychological distress				
Crude	1.00	0.78 (0.49, 1.24)	0.92 (0.58, 1.43)	0.713
Model Ⅰ	1.00	0.73 (0.46, 1.16)	0.85 (0.54, 1.34)	0.493
Model Ⅱ	1.00	0.71 (0.44, 1.16)	0.92 (0.57, 1.47)	0.727
Model Ⅲ	1.00	0.69 (0.41, 1.16)	0.95 (0.57, 1.61)	0.893

[a:] Adjusted for age and energy intake; [b]: Additionally, adjusted for socio economic status, physical activity, marriage status, supplement use, drug use, family history of chronic disease, body mass index; [c]: Further controlled for intake of fruit, vegetable, nuts, processed meat, red meat, whole grains, refined grains and dairy.

Discussion

This study was conducted to investigate the relationship of legumes intake with depression, anxiety, and stress in adult women. According to the findings, no significant relationship was found between legumes intake, depression, anxiety, and stress in women. However, women who consumed moderate legumes had significant decreased risk of depression.

The prevalence of common psychological disorders has been increasing in the world (Murphy *et al.*, 2004); therefore, identifying the modifiable risk factors of mental disorders, including dietary factors, is of great importance. Legumes are low in fat and rich in protein, fiber, minerals, and vitamins. Higher consumption of legumes may reduce blood cholesterol concentration and decrease the risk of coronary heart disease (Bazzano *et al.*, 2001).

Legumes intake had no significant association with depression, anxiety, and stress. Although no study has ever examined the association of legumes intake with depression, anxiety, and stress, several published studies reported the association of legumes components like fiber (Miki *et al.*, 2016), magnesium (Sun *et al.*, 2019), phytochemicals (Sureda and Tejada, 2015), and protein (Mitani *et al.*, 2006) with depression and anxiety. Boyle et al. (Boyle *et al.*, 2016) showed that magnesium supplementation had beneficial effects on anxiety symptoms among anxious individuals. In this regard, a meta-analysis reported that moderate magnesium intake may be inversely associated with the risk of depression (Barra *et al.*, 2007). In addition, epidemiological studies suggested that dietary polyphenols, such as flavonoids, phenolic acids, and lignans may reduce the risk of depression (Sureda and Tejada, 2015). Some studies showed that dietary protein intake was associated with mental status. Important neurotransmitters such as dopamine and serotonin are made from amino acids tyrosine and tryptophan, respectively (Bell *et al.*, 2001, Lehnert *et al.*, 1984).

Several possible mechanisms may explain the inverse association between legumes intake and

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mental health. Legumes contain vitamin B9, iron, zinc, and calcium (Messina, 1999) . Some nutrients such as zinc, magnesium, folate, and vitamin B12 are essential for proper functioning of neurotransmitters and improvement of psychological health (Bjelland *et al.*, 2003, Młyniec *et al.*, 2014). Magnesium deficiency can lead to abnormal penetration of calcium into the intracellular fluid that liberates glutamate in cells. Consequently, the presence of glutamate results in neuronal dysfunction and anxiety (Młyniec *et al.*, 2014). A deficiency in either folate or vitamin B12, which have a role in neurotransmitter synthesis, can increase homocysteine levels and elevate the risk of depression (Kim *et al.*, 2008). Zinc deficiency increase somatic symptoms and psychiatric symptoms are associated with depression disorders (Nowak, 2015). Our findings can be explained by the undetectable effects of legumes, interaction between components of legumes, lower amounts of these components in legumes compared to the dosages used in clinical trials, different cooking methods, and the effect of processing on these components. In addition, reverse causality in cross-sectional studies should be considered.

To the best of our knowledge, this is the first study investigating the association of legumes consumption with psychological disorders. Adjustment of the known confounders such as age, energy intake, physical activity, socioeconomic status, medication and supplement use, family history of chronic diseases, BMI, and dietary factors is one of the strengths of this study.

Due to the cross-sectional nature of this study, it was not possible to fully explain association of the exposure and outcome with the mechanism of this correlation; a prospective study will help to accurately study this mechanism. In this study, we also tried to control all the known confounders. However, it was not possible to exclude all confounders. The medical condition in exclusion criteria were self-reported and could have introduced some level of bias. Moreover, lack of recognizing the causes of depression, anxiety, and stress was one of the limitation of this study.

Conclusion

As a result of this study, no significant relationship was found between legumes intake, depression, anxiety, and stress in women. However, women who consumed legumes moderately had significant decreased risk of depression. Further prospective studies can help explain the physiological and psychological relationships in this field.

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Conflict of interest

The authors declared no conflict of interest.

Authors' contributions

Darooghegi Mofrad M, Siassi F, Guilani B, Azadbakht L. contributed to conception, design, data collection, statistical analyses, data interpretation, manuscript drafting, and approval of the final version of the manuscript and agreed for all aspects of the work.

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