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The association between polyunsaturated fatty acids and depression among Iranian postgraduate students in Malaysia

Teymoor Yary* and Sanaz Aazami

Abstract

Background: The incidence of depression is expected to increase over the next 20 years, and many people will have to deal with it. It has been reported that up to 40% of university students experience levels of depression. Several negative consequences are associated with depression symptoms, such as memory impairment, suicide, and substance abuse. Recently, researchers have been studying possible associations between depression and polyunsaturated fatty acids (PUFAs), which may modify depression symptoms. The aim of the present study was to find an association between PUFA levels and depression among Iranian postgraduate students in Malaysia.

Methods: This cross-sectional study was conducted in 2011 with 402 Iranian postgraduate students who were studying in Malaysia. The participants included 173 (43%) women and 229 (57%) men, and the mean age of the participants was 32.54 ± 6.22 years.

Results: After adjustment for several potential confounders including sex, age, BMI, PUFAs, MUFAs, and SFAs, monthly expenses, close friends, living in campus, smoking, education, and marital status in a logistic regression model, an inverse relationship was found between depression symptoms and the dietary intake of PUFAs.

Conclusion: We found an inverse association between PUFA intake and depression symptoms in Iranian postgraduate students in Malaysia. We, therefore, concluded that long-term intake of PUFAs may modify or prevent depression symptoms.

Keywords: Polyunsaturated fatty acids (PUFAs), depression, inflammation, neurotransmitter

Introduction

One of the most important health problems of the last century was depression [1]. The incidence of depression is expected to increase over the next 20 years, and many people will have to deal with it [2]. It has been reported that up to 40% of university students experience levels of depression [3]. Several negative consequences are associated with depression symptoms [4], such as memory impairment [5], suicide [6], and substance abuse [7]. Furthermore, it has been demonstrated that depression elevates the risks of several diseases such as coronary heart disease [8]; therefore, preventing and treating

depression are necessary to protect students from its negative consequences.

Recently, researchers have been studying possible associations between depression and nutrient intake, which may modify depression symptoms. Based on the recommendations of several observational, epidemiological, and clinical studies, psychiatric disorders such as depression may be modified or amended by the intake of essential fatty acids [9]. These studies demonstrated that increased levels of polyunsaturated fatty acids (PUFAs) could enhance brain function and therefore stabilize depression symptoms [10].

Current treatments for depression cannot be targeted at the general population because depression is a silent disease that is difficult to diagnose. Thus, other treatments that may be applicable to the general population, such as nutritional assessments and interventions, are needed to

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prevent/modify depression. However, the results from previous studies are inclusive, and more investigations are needed. The aim of the present study was to find an association between PUFA levels and depression among Iranian postgraduate students in Malaysia.

Materials and methods

Study design and study subjects

This cross-sectional study in 2011 was conducted on a convenience sample of 425 Iranian postgraduate students, who were studying in Malaysia. The participants included 173 (43%) women and 229 (57%) men, and the mean age of the participants was 32.54 ± 6.22 years. Individuals with serious diseases such as hyperthyroidism, hypertension, diabetes, and heart disease were excluded from the study, as such conditions may change lifestyle factors or modify the risk factors for depression. Students who had histories of mental illnesses or those taking antipsychotic drugs were excluded. Therefore, 23 students who did not meet the eligibility criteria were excluded from the study. This study was approved by the Scientific Counselor and Director of Iranian Students Affairs in South East Asia in Malaysia, and informed consent was obtained from all participants before enrollment.

Determination of nutrient intake

A semi-quantitative food frequency questionnaire (FFQ) that was developed by Willet et al. [11], was used to measure typical and long-term food intake. The questionnaire has been validated and used to calculate dietary nutrient intake. Nutritionist IV software version 3.5.2 was used to analyze the levels of saturated fatty acids, mono-unsaturated fatty acids, and polyunsaturated fatty acids. The saturated and unsaturated fatty acids data were merged with sociodemographic and other variables for statistical analysis using SPSS version 18.

Depression questionnaire

To measure depression symptoms, the self-administrated Center for Epidemiologic Studies (CES-D) questionnaire was employed [12]. The 20-item CES-D questionnaire measures the current level of depressive symptoms including appetite loss, sleep disorders, sadness, crying, feelings of loneliness, and fear. In the CES-D questionnaire, each question is answered using a 4-point Likert-type scale that ranges from 0 (rarely or none of the time (less than 1 day)) to 3 (most or all the time (5-7 days)), producing a total score of 0-60. The scoring is continuous, and a higher score indicates greater depressive symptoms. The cutoff score for depressive symptoms was 16.

Statistical analysis

SPSS version 18 was used for the statistical analyses via parametric and nonparametric tests. Chi-square and

ANOVA tests were run to analyze the data. A logistic regression analysis was performed to find an association between PUFA levels and depression symptoms, and the association was reported after adjustment for sex, age, body mass index (BMI), PUFAs, monounsaturated fatty acids (MUFAs), saturated fatty acids (SFAs), monthly expenses, close friends, living in campus, smoking, education, and marital status.

Results

Table 1 shows the continuous and categorical variables of the participants based on the tertiles of PUFA intake. SFA and MUFA levels were significantly different among the tertiles of PUFA intake; SFA and MUFA levels were lower in tertile 1 than in tertiles 2 and 3. BMI values were not significantly different among the PUFA tertiles. Monthly expenses were significantly associated with PUFA intake; the mean monthly expenses were higher in the second and third tertiles than in the first tertile. Sex was not significantly different among the tertiles of PUFA intake. Several variables, including living in campus, years of studying, close friends, age, and smoking (current and former), were not associated with PUFA intake. Furthermore, there was no relationship between marital status and PUFA intake, although the first tertile featured fewer married subjects than did the other tertiles. Lastly, the results demonstrated that a high level of depression symptoms was associated with low levels of dietary PUFA intake; the prevalences of depression symptoms in the first, second, and third tertiles were 29.1%, 23.9%, and 38.1%, respectively.

Further statistical analyses in this study were conducted regarding the association between PUFA intake and depression symptoms. After adjustment for all other variables in a logistic regression model, including sex, age, BMI, PUFAs, MUFAs, SFAs, monthly expenses, close friends, living in campus, smoking (current and former), education, and marital status, there was an inverse association between depression symptoms and the second tertile of PUFA intake (Table 2).

Discussion

To the best of our knowledge, this was the first study to investigate an association between depression and PUFA intake among Iranian students in Malaysia. After adjustment for several potential confounders including sex, age, BMI, PUFAs, MUFAs, and SFAs, monthly expenses, close friends, living in campus, smoking, education, and marital status in a logistic regression model, an inverse relationship was found between depression symptoms and the dietary intake of PUFAs.

Our findings extend the results of several studies that investigated a relationship between PUFAs and depression [13-15]. A study conducted in a population above

Table 1 Characteristics of the subjects based on the tertile of PUFAs intake (N = 402)

| Variables | T ₁ (N = 134) | T ₂ (N = 134) | T ₃ (N = 134) | P |
|--------------------------|-----------------------------|-----------------------------|-----------------------------|-------|
| Depression Symptoms, % | 38.1 | 23.9 | 29.1 | 0.038 |
| Living in Campus, % | 41.0 | 47.0 | 38.8 | 0.372 |
| Current Smoking, % | 7.5 | 10.4 | 9.0 | 0.693 |
| Former Smoking, % | 4.5 | 4.5 | 3.0 | 0.771 |
| Married, % | 44.0 | 56.7 | 54.5 | 0.085 |
| Close Friends | 6.00 (4.50) | 7.00 (5.00) | 7.86 (5.5) | 0.124 |
| PUFAs (g/day) | 7.18 ± 2.12 | 12.67 ± 1.73 | 27.84 ± 10.85 | 0.000 |
| SFAs (g/day) | 12.03 ± 6.20 | 17.92 ± 7.49 | 32.51 ± 17.72 | 0.000 |
| MUFAs (g/day) | 10.86 ± 4.09 | 17.43 ± 6.15 | 34.00 ± 19.95 | 0.000 |
| Age (y) | 32.32 ± 6.00 | 32.69 ± 6.44 | 32.60 ± 6.17 | 0.879 |
| BMI (kg/m ²) | 24.06 ± 3.77 | 24.52 ± 4.72 | 24.40 ± 4.23 | 0.669 |
| Sex, Female/Male | 45.0/54.5 | 36.6/63.4 | 47.0/53.0 | 0.175 |
| Studying (y) | 20.12 ± 2.11 | 20.45 ± 2.35 | 20.53 ± 2.50 | 0.311 |
| Monthly Expenses (\$) | 761.10 ± 500.60 | 922.04 ± 447.94 | 970.67 ± 489 ± 61 | 0.001 |

T = Tertile; y = Year; SFAs = Saturated fatty acids; MUFAs = Monounsaturated fatty acids; PUFAs = Polyunsaturated fatty acids; BMI = Body mass index.

15 years of age reported that the consumption of fish, which is rich in PUFAs, was protective against mental health disease [16]. Researchers in Australia also indicated that a diet rich in omega-3 fatty acids improved mood and cognitive performance [17]. A recent meta-analysis reported that lower levels of both eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) were associated with depression [18].

Although the mechanism of the association between PUFA intake and depression is not completely clear, several neurophysiological mechanisms may explain how PUFAs control or modify depression symptoms. One of the mechanisms is that neurotransmission in patients with depression could improve with increased dietary intake or supplementation of PUFAs. It has been demonstrated that high PUFA intake, including DHA and EPA, was associated with increased levels of dopamine and dopamine D2 receptors in the frontal cortex of the rat brain [19]. In addition, Delion et al. reported that low intake of PUFAs increase the number of 5-hydroxytryptamine (5-HT₂) receptors [20]. It has been reported 5-HT₂ receptors may be involved in the pathophysiology of depression [18,21]. Researchers have emphasized a

relationship between dietary alpha-linolenic acid (ALA), in particular, and the control of depression, as they believe this nutrient can restart dopaminergic neurotransmission in the brain [22]. In addition, increased dietary intake of ALA stimulates both cholinergic and serotonergic neurotransmission [23,24].

Omega-3 fatty acid insufficiency reduces phosphatidylserine (PS) levels in the rat brain cortex, brain mitochondria, and olfactory bulb by at least 30% [25]; PS has antidepressant properties [26,27], and supplementation of this nutrient can improve depression [19]. Additionally, insufficient dietary intake of omega-3 fatty acids was associated with a reduction in glucose uptake by brain cells and cytochrome oxidase activity [28]; both glucose uptake and cytochrome oxidase activity are indicators of neuronal functional activity. Moreover, deregulation of blood-brain barrier may occur due to PUFA deficiency, which may lead to a decrease in the transport of amino acids and glucose to the brain [29].

Another mechanism by which PUFAs may influence depression is through inflammatory modulation [30], which is induced via glial cells [31]. A cluster of cytokines including interleukin-1 beta (IL-1β), IL-2, IL-6, interferon-gamma, and tumor necrosis factor alpha (TNFα) have been reported to correlate with depression symptoms [32-34]. These cytokines have been found to negatively affect the central nervous systems via several pathways such as downregulation of the hypothalamic-pituitary axis, neurotransmitter metabolism, and neurotransmitter mRNA levels as well as decreased neurotransmitter precursor availability [33,35,36].

It has been demonstrated that omega-3 fatty acids may modify depression symptoms by inhibiting proinflammatory cytokines [37], particularly IL-1β and TNFα

Table 2 The association between PUFAs intake and depression

| Variables | OR* | 95% CI | p |
|-----------|------|-----------|-------|
| PUFAs | | | |
| Tertile 1 | 1.0 | - | - |
| Tertile 2 | 0.51 | 0.29-0.90 | 0.014 |
| Tertile 3 | 0.75 | 0.38-1.48 | 0.407 |

*Adjusted for sex, age, BMI, PUFAs, MUFAs, SFAs, monthly expenses, close friends, living in campus, smoking, education, and marital status.

[38]. Although it is unclear how omega-3 fatty acids regulate these cytokines, omega-3 fatty acids may control some substances involved in inflammatory processes such as prostaglandin E2, thromboxane A2, and histamine [33,35]. Furthermore, omega-3 fatty acids influence the activities of the hypothalamic-pituitary-adrenal axis and corticosteroid hormones [33,35].

Limitation of the study

This study was a cross-sectional study, and thus, this design did not permit us to assess causal relationships. For example, depression symptoms may lead to a loss of appetite and result in reduced consumption of foods and PUFAs, or studying in a foreign country (Malaysia) away from family may have caused depression in our study population. The last potential limitation is that plasma PUFA level was not measured by the present study and which may suggest avenues for future studies.

Conclusion

We found an inverse association between PUFA intake and depression symptoms in Iranian postgraduate students in Malaysia. We, therefore, concluded that long-term intake of PUFAs may modify or prevent depression symptoms.

Abbreviations

ALA: Alpha-linolenic acid; BMI: Body mass index; CES-D: Center for Epidemiologic Studies; DHA: Docosahexaenoic acid; EPA: Eicosapentaenoic acid; FFQ: Food frequency questionnaire; IL-1 β : Interleukin-1 beta; MUFAs: Monounsaturated fatty acids; PUFAs: Polyunsaturated fatty acids; SFAs: Saturated fatty acids; TNF α : Tumor necrosis factor alpha

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Competing interests

The authors declare that they have no competing interests.

Authors' contributions

TY designed the study, collected data, interpreted the results, and helped draft the manuscript. SA assisted with collecting data, interpreting the results, and drafting the manuscript. All authors read and approved the final manuscript.

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