Full Length Research Paper

Relation between depression and Omega-3 fatty acids: A study in the Greek population

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The role of essential fatty acids in the human body and especially the decreased levels of it in patients with depression is a domain of interest for many researchers. The aim of the present study is to investigate the correlation between consumption of food rich in omega-3 fatty acids and depressive symptoms in the general population at the area of Larissa, central Greece. The sample consisted of 300 individuals (mean age 41.01, 137 men (46%) and 163 women (54%), randomly selected by the method of stratified multistage sampling. The Food Frequency Questionnaire (FFQ) and the Beck Depression Inventory-II (BDI-II) were used in order to investigate the relationship between food consumption and depression. A statistically significant negative correlation was detected between fish consumption and score at the BDI-II (-0.451, p<0.01). As concern the kind of fish consumed by our sample, statistically significant negative correlation was also detected by Pearson's Correlation Test. Individuals with increased consumption of fatty fish (rich in omega-3 fatty acids) have reduced scores at the BDI-II (-0.453, p<0.01). The same statistical difference was found among the combined consumption of fish, seafood and food supplements (containing omega-3 fatty acids) and BDI-II score (-0.480, p<0.01). Finally, the combined consumption of fruit, vegetables and nuts was negatively correlated with BDI-II score (-0.260, p<0.01). The present study indicates that depressed mood in our sample is negatively associated with dietary intakes of food rich in omega-3 fatty acids. It is also clear that omega-3 fatty acids should be delivered in a dietary framework that includes and other important nutrients contained in fruits, vegetables and nuts.

Key words: Omega-3 fatty acids, eicosapentaenoic acid, docosahexaenoic acid, depression, nutrition, general population.

INTRODUCTION

An emerging research sector analyses the neurobehavioral aspects of omega-3 fatty acids (eicosapentaenoic acid, docosahexaenoic acid) and their important role in the function of the central nervous system. Many studies have reported a decrease in the levels of omega-3 fatty acids in patients with depression

(Adams et al., 1996, Maes et al., 1998). Fish contain high concentrations of omega-3 polyunsaturated fatty acids, especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). It has been suggested that the inadequate consumption of fish can increase the occurrence of depression, as EPA and DHA are crucial for the optimal function of neurons and come from the consumption of fish (Timonen et al., 2004).

Long chain omega-3 fatty acids are polyunsaturated fatty acids and have a vegetable or sea origin. As these important fatty acids cannot be created in the human

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body, they have to be taken in through dietary sources (Allport, 2006). Fish contain various quantities of omega-3 fatty acids, mainly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (Sargent et al., 1996).

During last years, researchers have investigated the role of these important fatty acids in humans. In contrast with the healthy population, people suffering from depression have lower concentrations of omega-3 fatty acids in the plasma and the membranes of the erythrocytes (Adams et al., 1996, Peet et al., 1998, Maes et al., 1998). Furthermore, in another study it has been found that people suffering from depression have an increased ratio of omega-6/omega-3 fatty acids (Adams et al., 1996).

Mood disorders, including depression, are repeatable and possibly threatening for the patient's life. During the last 100 years, the age at which the depression symptoms occur has decreased and the general impact has increased in the western countries. For example, serious depression forms have an impact of 5% in the population of USA, while 20% of the population has milder forms. Furthermore, 2% of the population has bipolar disorder (Blazer, 2000). In contrast with the nutrition 50 years ago, today people consume 34% less vegetables and 66% less fish (Allport, 2006). Fish is the main source of omega-3 fatty acids, which are important for the good function of the brain (Allport, 2006).

The food impact on the psychological health can be direct and long lasting, because of the way in which the structure and the function of the brain is influenced (Bourre et al., 1991). Depression has been connected with the lower intake of omega-3 fatty acids, which results from the inadequate consumption of fish. The majority of people (66%), who report that they do not suffer from psychological disorders, consume fresh fruits and vegetables every day as well as fish. In contrast, fewer than 50% of those with psychological problems report a relative consumption (Silvers and Scott, 2002).

Despite the progress of medicine, a large percentage of patients with depression do not improve with the use of medical treatment (Kornstein and Schneider, 2001). Poor compliance, side effects and lack of desirable results are not uncommon during the treatment with antidepressants. The treatment with selective serotonin reuptake inhibitors (SSRI) results in the improvement only of the 50% of the patients, while 30% of the people suffering from depression stop the use of medication before the completion of six weeks (Anderson, 2000).Bearing in mind the above facts, we tried to investigate whether there is a significant relationship between consumption of food with high concentrations of omega-3 fatty acids and the occurrence of depression in representative population at the area of Larissa, Central Greece.

MATERIALS AND METHODS

Study population

This study was conducted in the general population at the area of Larissa, Central Greece (ages 18+) (Figure 1). The information, which came from the processing of the file of the statistical office for the population census during 2001, was used as a sampling frame (Larissa prefecture). The referral population of the study was 272.966 people for the year 2001. The size of the sample was n=300 individuals.

A random sample of 300 households was selected with a systematic cluster sampling method. Then, from each household an adult aged between 18 and 70 years old was selected at random for the interview, using the Kish selection grid. The final sample included 266 individuals from urban and semi-urban areas and 34 individuals from rural areas. The mean age of the participants was 41 years (SD ±11.9).

The sample consisted of 163 women (54%) and 137 men (46%). 203 of the participants were: married, 56 were single, 25 were divorced and 16 were widowed. The majority of the participants (143) had a secondary education, 170 had tertiary education and 50 people had primary education (mainly aged participants). Table 1 shows the demographic features of the sample.

Methodology

The collection of the data was done with the use of questionnaires in the residence of the participants. The questionnaires were completed in an average of 7 min. The study was conducted in the period of October 18th 2008 to February 1st 2009. Each participant completed two questionnaires: Food Frequency Questionnaire (FFQ) (adjusted to the needs of the study) and Beck Depression Inventory. The Beck Depression Inventory-II (Cronbach's index a=0.86) was used in the form of 'Which statement expresses the way you feel during the last two weeks, including this day'. The answer in each question is scored by Linkert system with 0, 1, 2, and 3. A total score of 0 to 9 does not indicate depression, a total score of 10 to 18 indicate mild depression, a total score of 19 to 29 indicates serious depression and a total score of 30 to 63 indicates major depression.

The Food Frequency Questionnaire (FFQ) was used in order to investigate the dietary habits (or styles) of our sample. FFQ includes 8 questions (adjusted to the needs of the study) with the following form: 'How often do you consume… what kind…' The answers, which have to do with the consumption of fish, seafood and red meat, are scored with the following way: 3 to 4 times a week (score 2), 2 times a week (score 1), once a week (score 0.8), 2 to 3 times a month (score 0.4), once a month (score 0.2). The answers that have to do with the type of fish, receive 1 to 0.2 points based on the concentration of the fish in omega-3 fatty acids. For example, salmon, which is a fish rich in omega-3 fatty acids, takes 1 point, while flounder, which has a poor concentration in omega-3 fatty acids, takes 0.2 points. The answers that have to do with the consumption of fruit, vegetables and nuts take the following points: 2 times a day (score 2), once a day (score 1), 3 to 4 times a week (score 0.8), 2 times a week (score 0.4), once a week (score 0.2).

Apart from the classic descriptive methods, the statistic analysis included the use of the parametric Pearson's Correlation Test, Kendall's Tau_b Test and Spearman's Test for the evaluation of the relation between depression and consumption of seafood, depression and the consumption of fish, depression and consumption of seafood, fish and nutritional supplements combined, depression and fish type, depression and consumption of red meat, depression and consumption of fruits, depression and consumption of vegetables, depression and consumption of nuts and depression and consumption of fruit, vegetables and nuts combined.

An impression of the linear regression that describes the above correlations was also made. The statistical analysis of the data was done with the use of SPSS program (version 16.0.1).
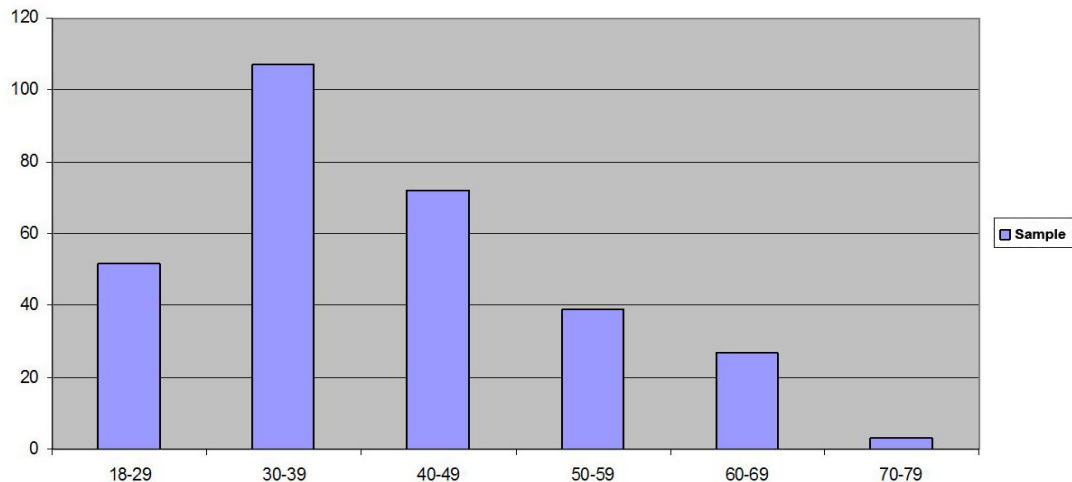
Figure 1. Age of sample.

Table 1. Dietary habits of participants in our study.

Variable	N	Minimum	Maximum	Mean	Std. deviation
Age	300	18.00	70.00	41.0133	11.98800
BDI-II Score	300	0.00	37.00	9.6100	6.83327
Fish Consumption	300	0.20	2.00	0.8853	0.47002
Kind of Fish	300	0.20	1.00	0.5976	0.17207
Seafood	300	0.20	2.00	0.5580	0.48520
Fish Seafood Suppl.	300	0.20	4.00	1.0937	0.74393
Nuts	300	0.20	2.00	0.6453	0.44113
Fruit	300	0.20	2.00	0.9287	0.54014
Vegetables	300	0.20	2.00	0.8960	0.49841
Fruit Veget. Nuts	300	0.20	5.00	2.4410	1.05422
Red Meat	300	0.20	2.00	1.2353	0.62454
Valid N (listwise)	300				

RESULTS

Dietary habits

Table 1 indicates the dietary habits of our sample. It is important to note that the mean value of the consumption of red meat was 1.2353, which means that a large percentage of the population consumes red meat with a high frequency (over 2 times a week). The mean value of the consumption of fish is 0.8853 (once per week). The consumption of fatty fish, which are rich in omega-3 fatty acid is medium with a mean value of 0.5976. The consumption of seafood is relatively low with a mean value of 0.5580 (average consumption of seafood 3 times a month). The consumption of fruit and vegetables is satisfactory with a mean value for the consumption of fruit of 0.9287, which means that the average of the sample consumes fruit once per day, and a mean value for

vegetables of 0.8960 (average consumption of vegetables 3 to 4 times a week). The consumption of nuts is relatively low with a mean value of 0.6453 (average consumption of nuts 2 times per week) (Table 1).

Finally, the mean value of depression is 9.61, which is at the higher levels of the healthy spectrum in Beck Depression Inventory-II. Figure 2 shows the percentage of fish consumption by our sample. Twenty nine individuals report that they consume fish 3 to 4 times per week, 104 people report that they consume fish 2 times per week, 60 people report that they consume fish once per week, 57 people report that they consume fish 2 to 3 times a month and 50 people report that they consume fish one per month (Figure 2).

The percentage of seafood consumption in the sample is: 6% report that they consume seafood 3 to 4 times per week, 15% report that they consume seafood 2 times per week, 12% report that they consume seafood once per
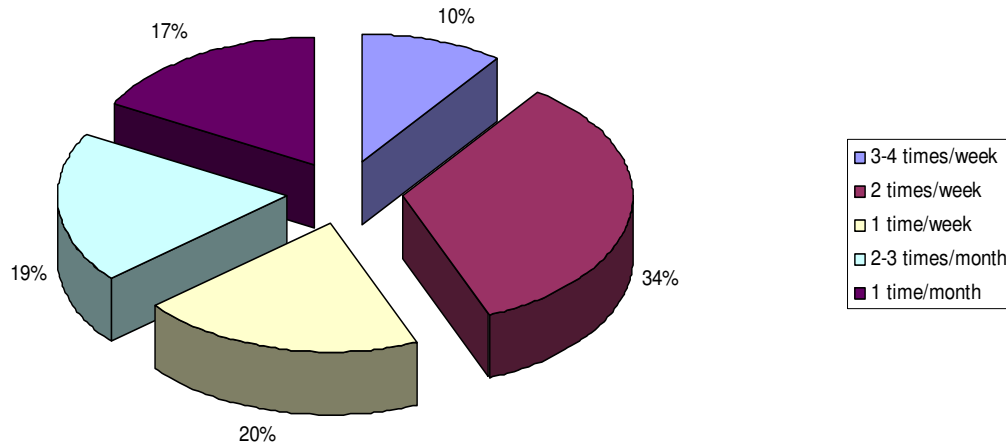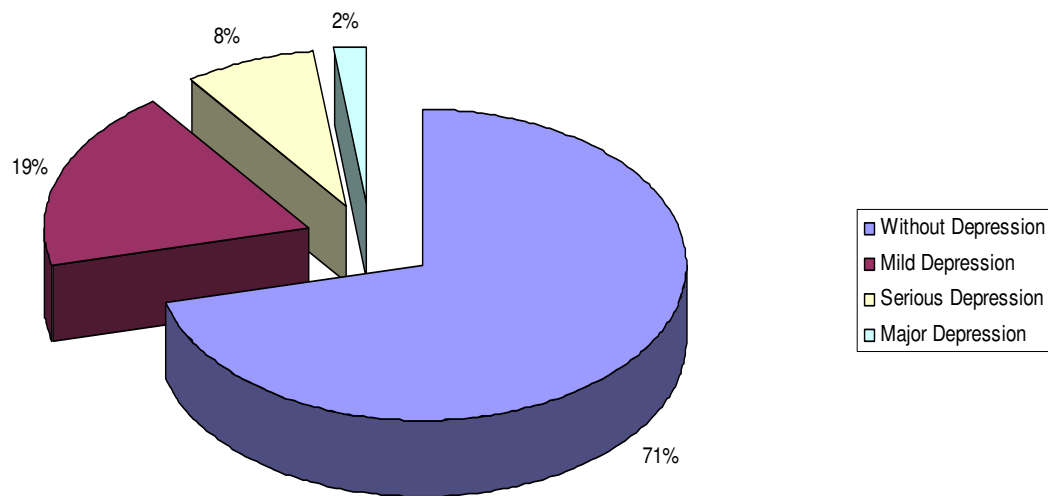
Figure 2. Fish consumption.

Legend:
- 3-4 times/week
- 2 times/week
- 1 time/week
- 2-3 times/month
- 1 time/month

Figure 3. Beck Depression Inventory-II results.

Legend:
- Without Depression
- Mild Depression
- Serious Depression
- Major Depression

week, 27% report that they consume seafood 2 to 3 times per month and 40% report that they consume seafood once per month. If we analyze the consumption of red meat in the sample we can see that 110 people report that they consume red meat 3 to 4 times per week (37%), 33% report that they consume red meat 2 times per week, 16% report that they consume red meat once per week, 7% report that they consume red meat 2 to 3 times per month and 7% report that they consume red meat once per month.

The consumption of fruit is considered satisfactory with a large proportion of the sample (32%) reporting that they consume fruit 3 to 4 times per week and 27% reporting that they consume fruit once a day. 13% of the sample report that they consume vegetables 2 times a day, 27% report that they consume vegetables once a day, 35% report that they consume vegetables 3 to 4 times per week, 16% report that they consume vegetables 2 times

per week and 9% report that they consume vegetables once per week. The consumption of nuts is relatively low in the sample. 5% report that they consume nuts 2 times a day, 17% report that they consume nuts once a day, 30% report that they consume nuts 3 to 4 times per week, 15% report that they consume nuts 2 times per week and 33% report that they consume nuts once per week.

Depression

The majority of the sample (212 individuals, 71%) belongs in the healthy spectrum of Beck Depression Inventory-II. According to BDI-II results, 57 people (19%) suffer from mild depression. 25 people (8%) suffer from serious depression and 6 suffer (2%) from major depression (Figure 3).
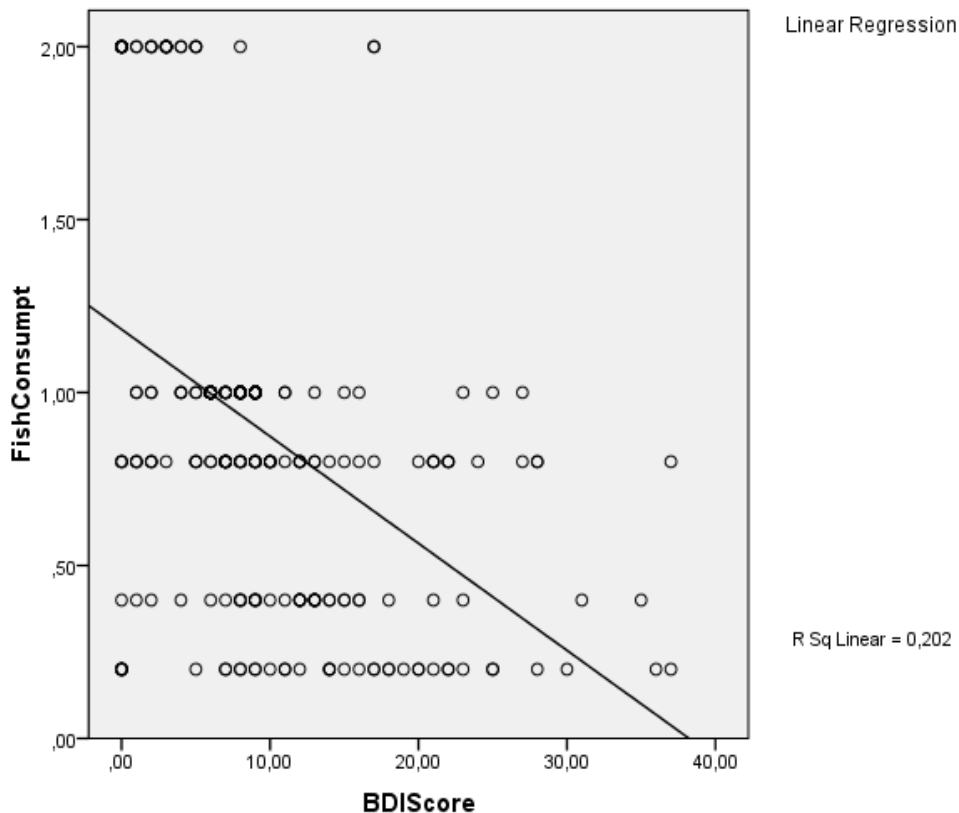
Figure 4. Linear regression line, which describes the relationship between the two variables (Beck Depression Inventory-II score and fish consumption).

Table 2. Beck Depression Inventory-II score and fish consumption correlations.

		BDI-II Score	Fish consumption
BDI-II Score	Pearson correlation	1,000	-.451**
	Sig. (2-tailed)		.000
	N	300,000	300
Fish consumption	Pearson correlation	-.451**	1,000
	Sig. (2-tailed)	.000	
	N	300	300,000

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

A correlation was found between the consumption of fish and depression. We noticed that when the consumption of fish increases, the levels of depression in BDI-II decrease (Figure 4). The result of Pearson's Correlation Test is -0.451 with p<0.01, the result of Kendall's Tau_b Test is -0.390 with p<0.01 and the result of Spearman's Rho is -0.469 with p<0.01 (Table 2). A very low negative correlation between the consumption of seafood and depression was found (practically there is no correlation). The result of Pearson's Correlation Test is -0.164 with p<0.01, the result of Kendall's Tau_b Test is -0.255 with p<0.01 and the result of Spearman's Rho test is -0.295 with p<0.01.

There is also a correlation between the type of fish, which was consumed by the sample and depression. We notice that as the consumption of fatty fish (rich in omega-3 fatty acids) is increased, the levels of depression in BDI-II decrease. The result of Pearson's

Table 3. Combined consumption of fish, seafood, supplements and Beck Depression Inventory-II score correlations.

		BDI-II Score	Fish seafood suppl.
BDI-II Score	Pearson Correlation	1,000	-,480[**]
	Sig. (2-tailed)		,000
	N	300,000	300
Fish seafood suppl.	Pearson Correlation	-,480[**]	1,000
	Sig. (2-tailed)	,000	
	N	300	300,000

[**]. Correlation is significant at the 0.01 level (2-tailed).

Correlation test is -0.453 with p<0.01, the result of Kendall's Tau_b Test is -0.405 with p<0.01) and the result of Spearman Rho test is -0.513 with p<0.01. Another correlation was found between the combined consumption of fish, seafood and nutritional supplements (which contain omega-3 fatty acids). The result of Pearson's Correlation Test is -0.480 with p<0.01, the result of Kendall's Tau_b Test is -0.475 with p<0.01 and the result of Spearman's Rho Test is -0,558 with p<0.01 (Table 3) Correlation between red meat consumption and depression was not found. The result of Pearson's Correlation Test is -0.059 with p=0.305, the result of Kendall's Tau_b Test is -0.027 with p=0.546 and the result of Spearman's Rho Test is -0.034 with p=0.557.

A correlation between the consumption of fruit, vegetables and nuts, and depression was found. The result of Pearson's Correlation Test for fruit was -0.193 with p<0.01, the result of Pearson's Correlation Test for vegetables was -0.183 with p<0.01 and the result of Pearson's Correlation Test for nuts was -0.193 with p<0.01. A correlation was found between the combined consumption of fruit, vegetables, nuts and depression. The result of Pearson's Correlation Test is -0.260 with p<0.01, the result of Kendall's Tau_b Test is -0.272 with p<0.01 and the result of Spearman's Rho Test is -0.326 with p<0.01.

DISCUSSION

Depression is a serious problem for the modern society and has an increasing impact on the western world. Bearing in mind the fact that it is underestimated for various reasons, for example the fact that it coexists with other diseases or with old age, it is not exaggerated to characterize it as one of the diseases of the future. The purpose of this study is to evaluate the relationship between dietary habits as far as the consumption of food rich in omega-3 fatty acids is concerned and depression in the general population at the area of Larissa, central Greece. Based on the results of BDI-II spectrum of depression, 19% of the people in the study (n=57) exhibit

mild depression, 8% (n=25) exhibit serious depression and 2% (n=6) exhibit major depression. 10% (n=29) of the sample report that they consume fish 3 to 4 times per week, nearly the half (54%, n=164) report that they consume fish once or two times per week and 36% (n=107) report that they consume fish 2 to 3 times per month or less. The consumption of seafood is relatively low with the 67% of the sample consuming seafood 2 to 3 times per month or less. The consumption of red meat is very high with the 37% of the sample (n =110) consuming red meat 3 to 4 times per week and the 33% (n=100) consuming red meat 2 times per week. The consumption of fruit and vegetables is satisfactory with the 43% of the sample consuming fruit one time per day and the 40% of the sample consuming vegetables once per day.

The results show a negative correlation between the consumption of fish and depression in the population of the sample (300 individuals residing at the area of Larissa, central Greece). Important is also the relationship between the type of fish that is being consumed and depression. A negative correlation was found between the combined consumption of fish, seafood and nutritional supplements (which contain omega-3 fatty acids). This kind of relationship between the low consumption of fish and the high levels of depression has been reported in other studies as well (Silvers and Scott, 2002, Tanskanen et al., 2001, Timonen et al., 2004). Fish and seafood are the main source of omega-3 fatty acids in the human diet. Thus, a small consumption of fish may mean low intake of omega-3 fatty acids and increased danger of depression.

A correlation between the consumption of red meat and depression was not found (Pearson's Correlation Test = -0.059 with p=0.305). An insignificant negative correlation was found between the consumption of seafood and depression (practically there is no correlation). Finally, an insignificant negative correlation was found between the consumption of fruit, vegetables and dried fruit and depression, but the consumption of all the above in combination shows that there is a small negative cor-relation. A small number of studies (or research) depict the beneficial impact of folic acid, which is contained in

fruit and vegetables, on depression and its potential to strengthen the effectiveness of antidepressants with the use of doses of 500 mg (Paul et al., 2004; Coppen and Bailey, 2000). We must note that folic acid is proven to increase the levels of omega-3 when it is administered as a nutritional supplement, while decreased omega-3 levels are noticed when there is inefficiency of folic acid (Pita and Delgado, 2000). Furthermore, a poor in folic acid diet can strengthen lipid peroxidation (Durand et al., 1996).

The study did not include structured diagnostic interviews, like the Structured Clinical Interview for DSM or the objective evaluation of depression symptoms. The use of this measure could probably strengthen the findings. The evaluation of fish consumption was done with the use of the Food Frequency Questionnaire, which is not a food-recording questionnaire, a fact that limits the research. However, the value for the use of a frequency questionnaire (FFQ) for the estimation of fish and seafood consumption in the everyday diet has been proven (Hu et al., 1999). Another limitation of this study is the relative small sample number. The present study is one of the very few that have been conducted in Greece and the results indicate that depression has a negative relationship with the dietary consumption of fish. It is clear that the intake of omega-3 fatty acids must be conducted in a way so as it will include other important nutrients.

Nutritional therapy, which is unregarded by the main stream of doctors, appears justified in psychiatry and neurology. While it is not essential for the professionals of mental health to be clinical nutritionists, the introduction of a diet rich in omega-3 fatty acids may be important for their patients. The basic conclusions, which must be taken into account, are two: a) A diet rich in omega-3 fatty acids may contribute in the decrease of the danger of depression and, b) the same diet can offer positive results in other situations (e.g. cardiovascular disorders), which may relate in a small or big degree to the occurrence of depression (e.g. a patient with coronary disease may present depression because of his fear for his health) (Holub, 2002).

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