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Is there any Relationship between Acne Vulgaris and Diet Inflammatory Index in Women?

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ABSTRACT

Background: Acne vulgaris (AV) is a chronic inflammatory disease that can be seen at any stage of life. Diet is thought to be effective in AV formation. The dietary inflammatory index (DII) determines how inflammatory a diet is. We hypothesized that DII is associated with AV and a biochemical parameter in women.

Methods: In the study performed on 68 women (34 cases and 34 controls) between the ages of 19-35 at Erciyes University Faculty of Medicine Dermatology Polyclinic, AV severity was determined by the responsible dermatologist and blood samples were taken from the individuals. Three-day food consumption records from women were used in the DII calculation. DII scores were divided into tertiles according to women with and without AV. The socio-demographic information and anthropometric measurements of the women were recorded face-to-face with a questionnaire.

Results: Cases had higher DII scores than controls. When DII scores were divided into tertiles, the most proinflammatory group was found to be tertile 3^{+}. It was determined that the women in the most proinflammatory group had higher body weight and body mass index (BMI) values compared to other tertiles.

Conclusion: The study's results suggest that as the DII score increases, the diet has a pro-inflammatory effect associated with AV. Including sufficient anti-inflammatory foods in their diets to decrease DII of individuals will help prevent AV formation and/or reduce lesions.

KEYWORDS

Acne vulgaris; Nutrition; Diet inflammatory index; Inflammation; C-reactive protein.

INTRODUCTION

Acne vulgaris (AV) is a chronic inflammatory disease of the pilosebaceous unit that affects all age groups, although it usually appears in adolescence[1]. The mechanisms under the initial and later developmental stages of AV formation have not been fully explained[2]. However, four basic factors are known to play a role in its etiogenesis: Follicular hyper keratinization, increased sebum secretion, *Propionibacterium acnes*, microbial colonization, and inflammation[1]. In addition, factors that contribute to AV include genetics, stress, premenstrual cycle, ultraviolet radiation, smoking, body mass index (BMI), and diet[3].

The effect of diet on AV is highly controversial[4]. The lower incidence of AV in industrially backward societies compared to industrialized societies supports that genetic factors and environmental and especially nutritional habits can affect AV[5]. Along with the hormonal and genetic structure, the diet pattern turned out to be an essential factor in the development of AV. It has been reported that the diet can change the amount and content of sebum secretion in the skin[6]. The most effective foods in the development of AV are chocolate, sugared foods, foods with high glycemic index, fermented products, dairy products, fatty foods, and multivitamin supplements. These foods may cause increased lesions in some AV individuals[7]. A positive relationship was found in the bio-

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chemical parameters of individuals who consumed a diet containing red meat, dairy products, processed meats, refined grains, dessert, and sugar-sweetened soft drinks, and a negative relationship was found in the biochemical parameters of individuals who consumed a diet containing fruits, vegetables and whole grains[8]. In an epidemiological study, the diet was found to mediate inflammation and oxidative stress in AV; in this regard, it is thought that these foods increase lesions in individuals with AV[9]. Studies on the relationship between AV and diet have been conducted on the glycemic index, glycemic load, milk, and dairy products[4,10]. Today, it is believed that the diet is involved in the pathogenesis of acne, and some foods can affect this dermatosis[11].

The relationship between diet and inflammation was determined by the Diet Inflammatory Index (DII) developed by Cavicchia et al.[12], after a literature review and later revised by Shivappa et al., DII is a new and practical index in terms of the relationship between diet and inflammation[13]. In the study of Tabung et al.[14], high DII scores were significantly associated with inflammatory biomarkers such as C-reactive protein (CRP), tumor necrotic factor-α (TNF-α), interleukin-8 (IL-8).

Although research has been conducted on nutritional issues such as AV and BMI, obesity, body composition, premenstrual syndrome, glycemic index, glycemic load, and insulin resistance, no national or international publication has shown the diet's inflammatory burden and the relationship between AV[15-16]. Hence, this study is the first study planned to establish the relationship between the nutritional status of women with and without AV and the CRP, an indicator of inflammation.

MATERIALS AND METHODS

Participants

Acne vulgaris cases were from Erciyes University Medical Faculty Gevher Nesibe Hospital Dermatology Polyclinic. In total, 34 AV patients who were referred to the polyclinic between March 2019 and March 2020 and 34 age and sex matched healthy volunteers as control group were included in the study. The researcher interviewed all participants face-to-face to gather the necessary information, and informed volunteer consent was obtained from women before the study. The study protocol was approved by the Ethical Committee of Erciyes University (2018/548: 07.11.2018). Written informed consent was obtained from all patients and the study was conducted in accordance with the Helsinki Declaration.

The study included cases (n=34) of women over the age of 19, who have not previously received systemic treatment for AV, had AV problems for at least three months, are not in pregnancy or lactation, and can understand and answer the questions. Likewise, controls (n=34) consist of women over the age of 19, who have never had acne problems, are not in pregnancy or lactation, and can understand and answer the questions. Women during pregnancy or lactation, under the age of 19, having cancer, cardiovascular disease, liver, kidney, or lung disease, diabetes mellitus, thyroid diseases, other chronic skin diseases, metabolic diseases, polycystic ovary syndrome, menstrual irregularities, using oral contraceptives and had received hirsutism, vitamin supplements or anti-inflammatory drugs or oral antibiotics within three months, who had previously received systemic AV therapy, and had hormone replacement therapy were excluded.

Global Acne Grading System Calculation and C-Reactive Protein Level

The responsible doctor evaluated the AV duration and severity of the cases in the study. The Global Acne Grading System (GAGS) considers six regions based on up-down area, distribution, and pilosebaceous unit density with a factor in each area on the face, upper, and back of the chest. The acne classification according to GAGS is mild, moderate, severe, and very severe AV[17].

The CRP levels of women were analyzed in laboratory with 2 ccs of venous blood taken. The Human (CRP) ELISA Kit was used for serum CRP analysis.

Anthropometric Measurements

Bioelectronic impedance analysis (BIA) was used to determine body weights. The researcher did not request women to perform any heavy physical activity before measuring them. Still, it was stated that they should not have eaten at least two hours before, should not drink much water before the analysis, should not drink tea and coffee four hours earlier, and should not carry any kind of metal objects, etc. The height of the women was measured with a height meter, without shoes, head upright and in Frankfort plane (eye and auricle aligned, feet adjacent). After measuring body weight and height, BMI (kg/m^2) was calculated. BMI was then classified according to the World Health Organization (WHO) as weak (< 18.50 kg/m^2), normal (18.5-24.99 kg/m^2), overweight (25.0-29.99 kg/m^2, and obese (≥ 30.0 kg/m^2) categories[18]. Waist circumference was determined by measuring the midpoint between the lowest rib and the crista iliaca. Waist circumference measurement according to WHO's classification was normal (< 80 cm), risk group (≥ 80 cm), and high-risk group (≥ 88 cm). According to WHO's waist/hip ratio assessment classification, normal (< 0.85) and risk group (≥ 0.85)[19]. According to the evaluation criteria determined for the waist circumference/height ratio of women; normal (≥ 0.4-0.5), risk (≥ 0.5-0.6), and high-risk group (≥ 0.6)[20].

The Food Consumption and Diet Inflammatory Index Calculation

Food consumption was evaluated by recording their food and drinks on three consecutive days (two days on weekdays

and one day on weekends). Original DII consists of 45 nutrients. However, computer programs used by countries do not include all nutrients. For this reason, not all items are calculated in the diet evaluation of DII[21]. In this study, a three-day dietary record of women who received the specified energy, macro, and micronutrients of the DII was used in the calculation of 29 food, and the average was developed for daily uptake values in Turkiye from Nutrition Information Systems Package Program (BeBIS). Nutrients obtained with BeBIS and DII levels of women were calculated.

In the DII, nutrients' inflammatory effects are divided into anti-inflammatory or pro-inflammatory groups. In this study, the components that cause high DII and show pro-inflammatory effects are energy, protein, total fat, saturated fatty acids (SFA), cholesterol, carbohydrate, vitamin B_{12}, and iron. Among the components that cause low DII and have anti-inflammatory effects are monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), omega-3 PUFA (ω-3), omega-6 PUFA (ω-6), fiber, caffeine, vitamin A, β-carotene, vitamin D, vitamin E, thiamine, riboflavin, niacin, vitamin B_6, folic acid, vitamin C, magnesium, zinc, selenium, alcohol, green/black tea. While calculating the DII, after calculating the DII for each nutrient item from the amounts of the nutrients taken Daily (Daily consumption of nutrients-average global daily consumption / standard deviation of that food or nutrient item X overall inflammatory effect score), the total DII-score that determined the inflammatory burden of the diet was determined by collecting all the points. A high DII-score defines that the diet has pro-inflammatory properties that increase inflammation, and a low diet defines that the diet has anti-inflammatory properties[13].

Statistical Analysis

The statistical Package for Social Sciences (SPSS 24) statistical package program was used for the statistical evaluation of the data. In qualitative variables, number (S) in percent (%); in quantitative variables are mean (X), standard deviation (SD), minimum and maximum levels (min-max) were evaluated. While evaluating qualitative variables, Pearson Chi-Square (χ^2) was used when it was normally distributed, and Fisher Exact Chi-Square (χ^2) was used when it was not provided. Whether quantitative data have normal distribution or not was evaluated with the Kolmogorov-Smirnov test. While comparing three or more groups for quantitative variables, One-Way Analysis of Variance (ANOVA) was used for normally distributed ones, and Kruskal-Wallis Test was used for non-normally distributed ones. In order to determine the source of the difference, Post-hoc Tukey, one of the multiple comparison tests, was used for data with normal distribution, and Bonferroni Test was used for data that did not fit normal distribution. When the relationship between diet inflammatory index and quantitative variables showed normal distribution, the Spearman Correlation Test was used. 95% confidence intervals (95% CI) were calculated, and significance was considered at a *p*-value < 0.05.

Tertiles were used to determine the DII. Controls were selected as the tertile$^-$ (T^-) group. They were grouped from the lowest DII to the highest DII, and the DII groups were named tertile 1^- ($T1^-$, n = 11), tertile 2^- ($T2^-$, n = 12), tertile 3^- ($T3^-$, n = 11). Cases were determined as the tertile$^+$ (T^+) group. They were grouped from the lowest DII to the highest DII, and the DII groups were named tertile 1^+ ($T1^+$, n = 11), tertile 2^+ ($T2^+$, n = 12), tertile 3^+ ($T3^+$, n = 11). While the anti-inflammatory effect of the group with the lowest DII increases, as the DII level increases, the pro-inflammatory effect of the diet increases. Tertiles of DII scores were calculated based on the distribution of DII among controls according to the following ranges: $T1^- \leq -1.89$, $T2^-$ -1.88-1.03, $T3^- \geq 1.04$ in the controls, and $T1^+ \leq -0.49$, $T2^+$ -0.48-3.50, $T3^+ \geq 3.51$ in the cases.

RESULTS

The distribution of sociodemographic characteristics according to DII tertiles was determined in groups cases and controls. It was found that those in the most pro-inflammatory group (i.e., $T3^+$) were more overweight (58,27 ± 6,63 kg), and BMI (21,94 ± 2,80 kg/m^2) was higher. In the controls, there were only overweight women in $T2^-$, while in the cases, there were overweight women in all tertiles (Shown in Table 1).

Classification of women's anthropometric measurements according to DII tertiles is shown in Table 2. A linear decrease in BMI and waist/hip ratio was observed as tertiles increased in controls. All women at $T1^-$ have normal weight. It was determined that there were more overweight women in the tertiles of the women with AV, and the mean BMI values of cases were higher than controls.

The distribution of energy and nutrient intakes for cases and controls is shown in Figure 1 and Figure 2. From energy and macronutrients; energy, carbohydrate, fat, and SFA intakes were found to be statistically significantly higher in the control group ($P < 0.05$) (Shown in Figure 1).

From micronutrients; niacin intake was found to be statistically significantly higher in the case group and vitamin C in the control group ($P < 0.05$) (Shown in Figure 2).

The distribution of nutrients and food groups' intake of DII tertiles for cases and controls are shown in Table 3. Most anti-inflammatory nutrient groups such as fiber, PUFA, ω-6, thiamine, and niacin decreased linearly during their tertiles. In both groups, while pro-inflammatory components consumed in higher amounts in T1 tertiles (in T1- and $T1^+$) were energy, protein, carbohydrates, fat, and iron; the anti-inflammatory components consumed in higher amounts were fiber, PUFA, ω-6, thiamin, niacin, vitamin B_6, vitamin C, vitamin D, vitamin E, folic acid, vitamin A, β-carotene, magnesium.

Table 1. Socio-demographic characteristics of cases and controls across the tertiles of DII

	Controls			Cases		
	T1⁻	**T2⁻**	**T3⁻**	**T1⁺**	**T2⁺**	**T3⁺**
Continuous variables (mean±SD)						
Age (year)	25.46 ± 5.24	25 ± 2.22	24.27 ± 2.80	23 ± 2.45	23.58 ± 5.49	22.91 ± 2.98
Weight (kg)	57.24 ± 6.94	55.67 ± 11.95	54.17 ± 5.26	56.24 ± 5.36	57.28 ± 5.10	58.27 ± 6.63
Height (cm)	162.55 ± 5.07	160.50 ± 10.61	163.64 ± 4.50	159.64 ± 6.68	162.75 ± 5.55	163.27 ± 7.50
BMI (kg/m^2)	21.60 ± 1.92	21.47 ± 2.85	20.28 ± 2.25	22.17 ± 2.76	21.66 ± 2.10	2194 ± 280
Categorical variables						
GAGS classification (n (%))						
No-AV	11 (100)	12 (100)	11 (100)	-	-	-
Mild	-	-	-	7 (63.6)	9 (75.0)	9 (81.8)
Moderate	-	-	-	3 (27.3)	3 (25.0)	2 (18.2)
Severe	-	-	-	1 (9.1)	-	-
BMI category (%)						
Underweight	-	-	18.2	9.1	-	18.2
Normal	100	83.3	81.8	81.8	91.7	72.7
Overweight	-	16.7	-	9.1	8.3	9.1
Educational level (%)						
Primary or less	-	-	-	-	8.3	-
Secondary	-	-	-	18.2	-	9.1
Tertiary	100	100	100	81.8	91.7	90.9
Job (%)						
Employed	36.4	58.3	27.3	27.3	16.7	9.1
Unemployed / Student	63.6	41.7	72.7	72.7	83.3	90.9
Marital status (%)						
Married	18.2	-	9.1	9.1	8.3	-
Single	81.8	100	90.9	90.9	91.7	100
Smoking (%)						
Non-smoker	90.9	75	90.9	100	75	100
Smoker	9.1	25	9.1	-	25	-
Alcohol consumption (mL/d)	-	10.77 ± 6.25	6.25 ± 2.94	6.25 ± 2.94	8.80 ± 7.65	4.17 ± 0.00

GAGS, global acne grating system; BMI, body mass index; SD, standard deviation.

Table 2. Classification of women's anthropometric measurements according to DII

	Controls			Cases			*P*-value
	T1⁻	**T2⁻**	**T3⁻**	**T1⁺**	**T2⁺**	**T3⁺**	
BMI category (%)							
Underweight	-	-	18.2	9.1	-	18.2	0.454
Normal	100	83.3	81.8	81.8	91.7	72.7	
Overweight	-	16.7	-	9.1	8.3	9.1	
mean±SD	21.60 ± 1.92	21.47 ± 2.85	20.28 ± 2.25	22.17 ± 2.76	21.66 ± 2.10	21.94 ± 2.80	0.571
Waist circumference (%)							
Normal	90.9	83.4	81.8	90.9	91.7	72.7	0.843
Risk	9.1	8.3	18.2	9.1	8.3	27.3	
High risk	-	8.3	-	-	-	-	
mean±SD	71.18 ± 6.01	73.42 ± 9.73	70.64 ± 6.86	71.82 ± 6.35	73.08 ± 4.30	73.91 ± 7.06	0.844
Waist/hip ratio (%)							
Normal	90.9	91.7	90.9	100	91.7	100	0.843
Risk	9.1	8.3	9.1	-	8.3	-	
mean±SD	0.77 ± 0.08	0.77 ± 0.06	0.74 ± 0.05	0.73 ± 0.04	0.76 ± 0.05	0.75 ± 0.05	0.451
Waist/height ratio (%)							
Normal	90.9	83.3	81.8	72.7	91.7	72.7	0.749
Risk	9.1	16.7	18.2	27.3	8.3	27.3	
mean±SD	0.44 ± 0.03	0.46 ± 0.05	0.43 ± 0.04	0.45 ± 0.05	0.45 ± 0.05	0.45 ± 0.05	0.737

BMI, body mass index; SD, standard deviation.
Tertiles were significantly different from each other at P < 0.05; Comparisons were made between all tertiles (6 tertiles) of the case and control groups.

DII-score and CRP parameters according to DII tertiles are shown in Table 4. While the group with the lowest mean score of DII and the most anti-inflammatory group was $T1^-$, the group with the highest mean DII and the most proinflammatory group is $T3^+$.

Serum CRP levels increase linearly as the pro-inflammatory feature increases in tertiles ($P < 0.001$). With the Post-hoc tests performed, the mean serum CRP level in $T3^+$ was determined from the mean of $T1^-$, $T2^-$, $T3^-$, $T1^+$ serum CRP; the mean serum CRP level in $T2^+$ was found to be statistically significantly higher than the mean of $T1^-$, $T2^-$, $T3^-$ serum CRP ($P < 0.001$).

When the correlation between DII and serum CRP levels was examined, positive correlations were found between DII and CRP levels of controls (r = 0.203, $P = 0.246$) and cases (r = 0.463, $P = 0.006$) (not shown in Table).

DISCUSSION

The impact of diet on AV is one of the most debated topics[4]. Today, it has been determined that diet can play an effective role in the pathogenesis of AV, but it had been reported in studies before 2005 that diet does not play a significant role in AV[22]. In the present study, the relationship between acne, nutrition, and inflammation has been studied. The inflammation potential of participants' cases was compared with the inflammation potential of participants' control. As a result of this study, the relationship between AV, nutrition, and inflammation supports the study's hypothesis.

According to the available literature and the best of our knowledge, studies on AV have investigated various aspects of the nutrition-AV relationship, so this study is an important case-control study examining the relationship between acne

Figure 1. Distribution of energy and macronutrients according to AV status

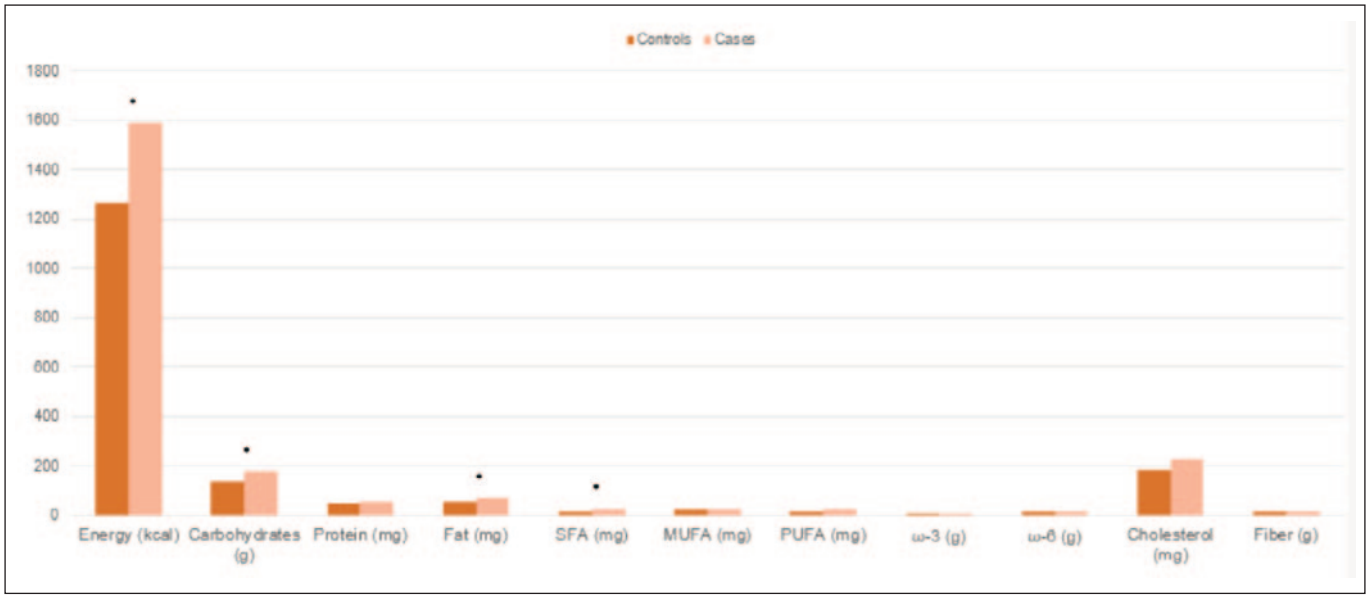
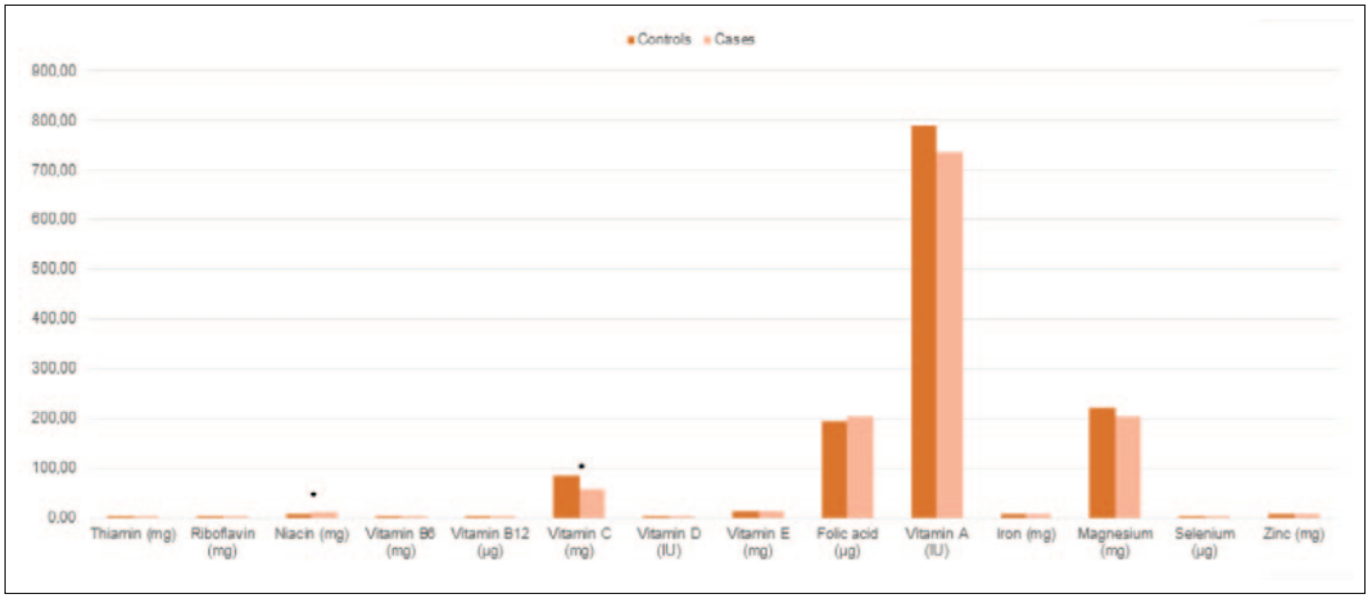


Figure 2. Distribution of micronutrients according to AV status



and dietary inflammation. In an epidemiological study, the diet was found to mediate inflammation and oxidative stress in AV. In this respect, it was thought that foods increased lesions in individuals with AV[9].

Adipose tissue is associated with increased BMI and inflammation in individuals with AV. It has been reported that individuals with low BMI have less risk of A[23]. Clinical and laboratory findings of the study with AV in women participating in a study conducted in Turkiye were examined. Overweight or obese women were statistically significantly higher in the group with AV, and a positive correlation was found between AV and BMI[24]. In this study, the mean BMI of cases was higher than controls. These results are consistent with the results of other studies, confirming the relationship between AV and BMI.

CRP and IL-6 levels were found to be high in the Western diet and low in the Mediterranean diet[25]. The fat and glucose content of the diet causes increased inflammation, while the low-fat content causes the inflammation to decrease[26]. Increasing the amount of unsaturated fatty acids can reduce inflammation[27]. ω-3 PUFAs inhibit the inflammatory signaling pathways of TNF-α and possibly increase anti-inflammatory

Table 3. Distribution of nutrients and food groups across tertiles of DII

	Controls			Cases			*P*-value
	T1⁻	T2⁻	T3⁻	T1⁺	T2⁺	T3⁺	
Nutrient or Food Group/Day (Mean ± SD)							
Energy (kcal)	1574.94 ± 281.40$^{\eta}$	1243.27 ± 290.98$^{\mu}$	963.43 ± 278.82$^{\eta\alpha\beta}$	1812.56 ± 291.95$^{\mu\alpha\Omega}$	1603.92 ± 294.09$^{\beta}$	1340.03 ± 517.39$^{\Omega}$	**<0.001**
Protein (g)	55.14 ± 11.85$^{\eta}$	48.17 ± 11.15	36.66 ± 8.90$^{\eta\mu\alpha}$	57.46 ± 16.57$^{\mu}$	56.21 ± 13.59$^{\alpha}$	45.72 ± 11.86	0.001
Carbohydrates (g)	178.72 ± 33.54$^{\eta}$	133.88 ± 30.90$^{\mu}$	95.54 ± 43.56$^{\eta\alpha\beta\Omega}$	207.39 ± 45.60$^{\mu\alpha}$	172.53 ± 37.23$^{\beta}$	159.50 ± 66.11$^{\Omega}$	**<0.001**
Fiber (g)	20.71 ± 3.49$^{\eta\mu\alpha}$	17.63 ± 4.29$^{\beta}$	10.90 ± 3.77$^{\eta\beta\Omega}$	16.70$^{\alpha\Omega}$(12.40-36.60)	14.54 ± 3.94	13.91 ± 5.03$^{\mu}$	**<0.001**
Fat (g)	69.78 ± 17.90	55.73 ± 21.48$^{\eta}$	46.95 ± 11.53$^{\mu\alpha}$	82.42 ± 13.48$^{\eta\mu\beta}$	74.93 ± 16.28$^{\alpha}$	52.90$^{\beta}$ (20.60-133.30)	**<0.001**
SFA (g)	12.22 ± 9.27	16.93 ± 7.45$^{\eta}$	15.13 ± 5.16$^{\mu\alpha}$	25.32 ± 6.05$^{\mu}$	25.30$^{\eta\alpha}$ (19.20-40.80)	20.41 ± 10.40	**0.004**
MUFA (g)	22.06 ± 5.70	19.32 ± 9.22	18.80 (9.80-21.40)	23.82 ± 7.10	24.45 ± 5.98	16.40 (7.70-39.40)	0.108
PUFA (g)	21.34 ± 6.06$^{\eta\mu\alpha}$	15.65 ± 6.36$^{\beta\Omega}$	12.51 ± 3.99$^{\eta}$	26.39 ± 4.67$^{\beta\Omega}$	18.01 ± 6.43$^{\mu}$	11.80$^{\alpha}$(2.40-39)	**<0.001**
Cholesterol (mg)	199.29 ± 84.53	177.28 ± 91.50	187.04 ± 112.4	243.69 ± 122.73	256.78 ± 95.78	178.81 ± 65.11	0.215
ω-3 (g)	203 ± 1.08	1.54 ± 0.82	1.28 ± 0.58$^{\eta}$	1.90$^{\eta}$(1.40-6.80)	2.01 ± 0.94	1.20 (0.50-4.20)	**0.017**
ω-6 (g)	18.98 ± 6.32	14.10 ± 5.72$^{\eta}$	11.20 ± 3.81$^{\mu\alpha}$	23.66 ± 4.63$^{\eta\mu\beta}$	15.71 ± 5.93	10.90$^{\alpha\beta}$(2-34.80)	**<0.001**
Thiamin (mg)	0.67 ± 0.14$^{\eta}$	0.63 ± 0.19	0.43 ± 0.12$^{\eta\mu}$	0.60$^{\mu}$ (0.40-1.30)	0.56 ± 0.12	0.50 (0.30-1.20)	**0.010**
Riboflavin (mg)	1.05 ± 0.30	0.98 ± 0.2	0.74 ± 0.19	0.96 ± 0.27	1 ± 0.20	0.87 ± 0.26	0.054
Niacin (mg)	9.52 ± 2.32	8.03 ± 3.04	5.88 ± 1.45$^{\eta}$	10.70 ± 4.46$^{\eta}$	9.82 ± 4.09	6.30 (3.70-15.60)	**0.010**
Vitamin B_6 (mg)	1.08 ± 0.16$^{\eta}$	1.03 ± 0.29	0.73 ± 0.23$^{\eta\mu}$	1.20 ± 0.39$^{\mu}$	1 (0.50-1.20)	0.87 ± 0.32	**0.003**
Vitamin B_{12} (µg)	2.83 ± 0.96	2.93 ± 1.29	2.58 ± 1.26	2.77 ± 1.27	2.88 ± 1.05	2.16 ± 1.35	0.665
Vitamin C (mg)	93.42 ± 46.11$^{\eta}$	90.01 ± 46.87	67.59 ± 30.33	76.10 (27.90-204)	51.71 ± 20.05	40.80$^{\eta}$(18.80-111.50)	**0.014**
Vitamin D (IU)	2.16 ± 1.93	1 (0.20-10.20)	1.31 ± 0.78	1.78 ± 1.32	1.45 (0.40-15.70)	0.92 ± 0.34	0.665
Vitamin E (mg)	17.04 ± 5.25$^{\eta\mu}$	12.93 ± 4.80$^{\alpha}$	10.29 ± 3.44$^{\eta\beta}$	19.66 ± 5.14$^{\alpha\beta\Omega\omega}$	13.37 ± 4$^{\omega}$	7.80$^{\mu\Omega}$ (3.70-24.60)	**<0.001**
Folic acid (µg)	237.46 ± 41.69$^{\eta}$	198.81 ± 44.54	151.18 ± 53.41$^{\eta\mu}$	222.60$^{\mu}$ (164.70-490.30)	199.83 ± 41.40	171.99 ± 45.18	**0.001**
Vitamin A (IU)	994.06 ± 497.87	603.20 (379-1933.10)	590.95 ± 272.67	850.96 ± 486.89	784.21 ± 402.69	417.80(295.30-1095)	0.171
β-carotene (µg)	2300 ± 1039.23	1650 (800-1200)	1336.36 ± 637.61	1481.82 ± 762.65	1300 (800-3200)	900 (400-3300)	0.070
Iron (mg)	10.90 ± 2.34$^{\eta\mu\alpha\beta}$	7.93 ± 1.82$^{\eta}$	5.93 ± 1.69$^{\mu\Omega}$	8.70$^{\Omega}$ (5.50-15.50)	8.24 ± 1.83$^{\alpha}$	7.20 ± 2.04$^{\beta}$	**<0.001**
Magnesium (mg)	283.06 ± 76.45$^{\eta\mu\alpha}$	215.48 ± 58.75	162.14 ± 42.76$^{\eta}$	207.20 (158.0-421.20)	203.28 ± 36.46$^{\mu}$	186.33 ± 73.97$^{\alpha}$	**0.001**
Selenium (µg)	0 (0-0.60)	-	0 (0-0.20)	0 (0-0.60)	0 (0-0.60)	-	0.051
Zinc (mg)	8.72 ± 2.03$^{\eta\mu}$	7.20 ± 1.44	5.41 ± 1.81$^{\eta\alpha}$	7.70 ± 2.12$^{\alpha}$	7.51 ± 1.37	6.38 ± 1.91$^{\mu}$	**0.002**
Alcohol (g)	0 (0-0.40)	-	0 (0.00-0.20)	-	-	0 (0-0.80)	0.657
Caffeine (mg)	58,70 (26.70-200)	44.84 ± 32.49	68.25 ± 43.57	39.60 ± 24.70	56.54 ± 24.19	38.88 ± 29.08	0.162
Green/Black tea (g)	7.05 ± 2.41	4.80 ± 4.18	7.54 ± 2.81	4.59 ± 3	4.82 ± 2.28	4.02 ± 2.80	0.071

DII, dietary inflamatory index; AV, acne vulgaris; SFA, saturated fatty acids; MUFA, mono-unsaturaated fatty acids; PUFA, polly-unsaturated fatty acids; ω, omega.

Median (min-max) was used for data that did not show normal distribution; Groups with the same symbol and word on the same row are groups that make the difference.

Table 4. DII-score and serum CRP parameter according to DII tertiles

	Controls			Cases		
	T1⁻(≤ -1.89)	**T2⁻(-1.88-1.03)**	**T3⁻(≥ 1.04)**	**T1⁺(≤ -0.49)**	**T2⁺(-0.48-3.50)**	**T3⁺(≥ 3.51)**
DII-score(mean±SD)	-3.84 ± 1.02^{abcde}	-0.06 ± 1.04^{afgh}	1.88 ± 0.46^{bfij}	-2.23 ± 1.68^{cgikl}	1.33 ± 1.09^{dkm}	4.93 ± 1.37^{ehjlm}
CRP (mg/dL) **(mean±SD)***	0.30 ± 0.16$^{\alpha\mu}$	0.43 ± 0.19$^{\beta\infty}$	0.38 ± 0.26$^{\Omega\times}$	0.62 ± 0.31$^{\pi}$	1.12 ± 0.82$^{\alpha\beta\Omega}$	1.59 ± 0.91$^{\pi\mu\infty\times}$

DII, dietary inflamatory index; CRP, C-reactive protein; SD, standard deviation.
One-way ANOVA; Post-Hoc Test-Tukey; *P < 0.001; Groups with the same symbol and word on the same row are groups that make the difference.

genes[28]. Dietary fiber has an anti-inflammatory effect, and a negative relationship has been found between fiber intake and CRP. Low dietary fiber intake causes hyperglycemia and thus an increase in IL-6, IL-18, and TNF-α levels[29]. In this study, the fact that the daily intake levels of nutrients with anti-inflammatory effects (MUFA, PUFA, ω-3, ω-6, fiber, vitamin A, vitamin D, vitamin E, thiamine, riboflavin, niacin, vitamin B_6, folic acid, magnesium, and zinc) are lower in cases and those with pro-inflammatory effects (energy, carbohydrate, protein, SFA, cholesterol) are higher support the findings of other studies. This study provides evidence that AV is associated with exposure to pro-inflammatory nutrients and a diet poor in anti-inflammatory nutrients, which are associated with the DII. Dietary components in the DII calculation have a very important effect on inflammation.

The DII is associated with six inflammatory markers (CRP, interleukin-1β, interleukin-4, IL-6, interleukin-10 and TNF-α)[21]. The DII results calculated from the data of the study Seasonal Variation of Blood Cholesterol Study (SEASONS) participants found that increased DII was associated with increased serum CRP levels[13]. In a postmenopausal women study, the quartile with the highest DII was found to have the most elevated CRP and TNF-α levels[14]. This study found a positive and statistically significant relationship between women's DII and serum CRP (r = 0.463, $p< 0.05$). The results of this study conducted cases and controls support other studies investigating the relationship between CRP and DII. In line with these results, the fact that the diet of individuals is pro-inflammatory supports the hypothesis that AV formation and/or exacerbation of lesions are affected by increasing inflammation.

The limitations of the study include insufficient sampling and the inclusion of only female participants. The reason for this can be shown to be that women apply to the hospital because they have more beauty anxiety and care more about AV complaints than men[30]. However, since there is no gender-related difference in acne formation in the age group we receive[1], our study results will give the same results for both genders. In addition, not all the nutrients and nutrients used in DII calculation are included in the BEBIS program. In the studies, the use of the nutrients we take in the calculation of DII was found to be sufficient[16]. On the other hand, the study's strength was that the DII-score was calculated by taking the 3-day food intake record. Generally, the food consumption frequency questionnaire is used in studies on the DII[21].

CONCLUSION

This study shows that cases consume a more pro-inflammatory diet with fewer anti-inflammatory ingredients than controls. This result shows that healthcare professionals should also consider the components that cause inflammation in the diet, rather than just changing individuals' energy intake or the diet's quality. A diet with a low DII is effective in preventing AV formation and progression. Therefore, the preference for nutrients such as MUFA, PUFA, ω-3, ω-6, fiber, caffeine, vitamin A, β-carotene, vitamin D, vitamin E, thiamine, riboflavin, niacin, vitamin B_6, folic acid, vitamin C, magnesium, zinc, selenium, alcohol, green tea/black tea, which has a more anti-inflammatory effect in the diet, will prevent the formation and exacerbation of AV lesions. Based on this, excessive intake of nutrient and nutritional parameters such as energy, carbohydrate, protein, total fat, saturated fat, cholesterol, vitamin B_{12}, and iron, which have pro-inflammatory effects, should be limited.

This study opens a new field in the literature investigating the relationship between nutrition and AV using the DII as a guide for future studies. Therefore, more scientific studies on larger populations are needed to fully reveal these relationships in the future.

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