Investigation of the Effect of Herbal Omega-3-Rich Food Consumption on Hematologic Parameters and Total Cholesterol Levels According to Physical Activity Status in Healthy Individuals

Fatih CESUR*

Abstract

Aim: It is known that walnut consumption has favorable effects on health. Walnuts are known to be food rich in unsaturated fatty acids and herbal omega-3 fatty acids. This study investigated the effects of walnut (plant omega-3) consumption on hematologic factors in healthy adults with a certain physical activity level.

Methods: Healthy participants in this study were offered thirty grams of walnuts per day for three weeks. Walnuts were consumed on an empty stomach or with breakfast every morning for three weeks. The blood values of people were measured at the beginning and the end of the study. Hematological parameters were measured in the routine blood test from blood taken.

Results: The effect of a consumption rich in vegetable omega-3 products on hematologic factor levels caused a significant difference in MCH (p=0.001), MCHC (p=0.001), and LENFOSIT (p=0.001) levels. A significant increase in HCT levels was found only in male subjects. No significant changes were observed in other hematologic parameters. In addition, although a decrease in TC levels (p=0.023) and an increase in MONOSITE levels (p=0.027) were observed after the consumption of plant omega-3 in active individuals, this difference was not observed in sedentary individuals. On the other hand, sedentary individuals showed an increase in LENFOSITE levels after consumption of plant-based omega-3 (p=0.016), whereas this difference was not observed in active individuals. There was also a statistically significant difference in carbohydrate, PUFA, and a-linolenic acid intake compared to TBSA. There were no significant differences in energy, cholesterol, monounsaturated fatty acid, and saturated fatty acid intakes.

Conclusion: In this study, the addition of plant omega-3 fatty acids to the diet of healthy volunteers affected some hematologic factors and is thought to have a stimulating effect against cells that defend the body. It was also observed that the effect on hematologic factors and cholesterol levels was higher when plant omega-3 supplements were given to individuals who engaged in regular physical activity. We think that the effect of plant omega-3 fatty acids on hematologic factors should be further investigated.

Özgün Araştırma Makalesi (Original Research Article)
Geliş / Received: 15.08.2023 & **Kabul / Accepted:** 16.07.2024
DOI: https://doi.org/10.38079/igusabder.1344041
* Corresponding Author: Asst. Prof. Dr., Istanbul Gedik University, Faculty of Health Sciences, Department of Nutrition and Dietetics, Istanbul, Türkiye. E-mail: fatihcesr@gmail.com, fatih.cesur@gedik.edu.tr
ORCID https://orcid.org/0000-0003-2062-098X

ETHICAL STATEMENT: The Clinical Research Ethics Committee of Avrasya University approved all human subjects' procedures. This trial is registered under award numbers 2022-32 date of 24.06.2023. The research was conducted per the ethical standards in the Declaration of Helsinki.

Keywords: Walnut consumption, herbal omega-3 fatty acids, a-linolenic acid, physical activity, hematological parameters.

Sağlıklı Bireylerde Bitkisel Omega-3 Ürününden Zengin Gıda Tüketiminin Fiziksel Aktivite Durumuna Göre Hematolojik Parametreler ve Total Kolesterol Düzeyleri Üzerine Etkisinin Araştırılması

Öz

Amaç: Ceviz tüketiminin sağlık üzerinde olumlu etkileri olduğu bilinmektedir. Cevizin doymamış yağ asitleri ve bitkisel omega-3 yağ asitleri açısından zengin bir besin olduğu bilinmektedir. Bu çalışmada, ceviz (bitkisel omega-3) tüketiminin fiziksel aktivite düzeyi belli sağlıklı yetişkinlerin hematolojik faktörleri üzerindeki etkileri araştırılmıştır.

Yöntem: Bu çalışmada sağlıklı katılımcılara üç hafta boyunca günde otuz gram ceviz sunulmuştur. Ceviz üç hafta boyunca her sabah aç karnına veya kahvaltı ile birlikte tüketildi. Çalışmanın başında ve sonunda kişilerin kan değerleri ölçülmüştür. Alınan kanlardan rutin kan testinde hematolojik parametreler ölçüldü.

Bulgular: Bitkisel omega-3 üründen zengin bir tüketimin hematolojik faktör düzeyleri üzerindeki etkisi MCH (p=0,001), MCHC (p=0,001) ve LENFOSIT (p=0,001) düzeylerinde anlamlı bir fark oluşturmuştur. HCT düzeylerinde sadece erkek bireylerde anlamlı bir artış olduğu tespit edilmiştir. Diğer hematolojik parametre düzeylerinde anlamlı bir değişiklik gözlenmemiştir. Buna ek olarak aktif bireylerin bitkisel omega-3 tüketiminden sonra TC seviyelerinde düşüş (p=0,023), MONOSITE seviyelerinde artış gözlense de (p=0,027), sedanter bireylerde bu fark görülmemiştir. Diğer taraftan, sedanter bireylerin bitikisel omega-3 tüketiminden sonra LENFOSIT seviyelerinde artış (p=0,016), aktif bireylerde bu fark oluşmamıştır. Ayrıca, karbonhidrat, PUFA ve a-linolenik asit alımında TBSA'ya kıyasla istatistiksel olarak anlamlı bir fark vardı. Bireylerin enerji, kolesterol, tekli doymamış yağ asidi ve doymuş yağ asidi alımlarında anlamlı bir fark bulunmamıştır.

Sonuç: Bu çalışmada, sağlıklı gönüllülerin diyetine bitkisel omega-3 yağ asitleri ilavesi bazı hematolojik faktörleri etkilemiştir ve vücudu savunan hücrelere karşı uyarıcı bir etkisi olduğu düşünülmektedir. Düzenli fiziksel aktivite yapan bireylere bitkisel omega-3 takviyesi yapıldığında hematolojik faktörler ve kolesterol seviyelerindeki etkisinin daha yüksek olduğu da görülmüştür. Bitkisel omega-3 yağ asitlerinin hematolojik faktörler üzerindeki etkisinin daha fazla araştırılması gerektiğini düşünüyoruz.

Anahtar Sözcükler: Ceviz tüketimi, bitkisel omega-3 yağ asitleri, a-linolenik asit, fiziksel aktivite, hematolojik parametreler.

Introduction

It is known that there is a strong relationship between nutrition style, cardiovascular system, and diabetes mellitus[1,2]. Walnut consumption affects cardiovascular system diseases[3,4]. While most nuts are rich in monounsaturated fatty acids, walnuts, on the other hand, are incredibly rich in polyunsaturated fatty acids. It is especially rich in terms of a-linolenic acid. For these reasons, walnuts are important due to their anti-atherogenic effects[5,6]. It is known that there was a strong correlation between atherosclerosis with hematological blood factors[7,8].

Hematological markers are found in a part of the blood. Blood consists of suspended elements in a liquid medium called plasma. The blood elements formed have been contained in the red blood cells (RBC), white blood cells (WBC), and platelet (PLT)[9]. On the other hand, the first stage in atherosclerosis development is platelets' adhesion to the endothelium. Large platelets found in the systemic circulation are more prone to adhesion and aggregation depending on mean platelet volume (MPV) levels. In the studies conducted on diabetes mellitus, individuals have been determined to have increased MPV levels[10,11]. It has been seen, there was a significant relationship between cardiovascular system disease with platelet distribution width (PDW) and MPV levels[12].

One study showed that walnuts can reduce cardiovascular risk symptoms as they are a high source of omega-3-containing α-linolenic acid[13]. In addition, omega-3 fatty acids could advance purulent outcomes in hemodialysis diseases[14]. As a result, hemodialysis patients have been wanted to improve hematological factors, but no valid medical nutrition therapy has yet been finalized in this area[15,16]. Based on the studies, a study was conducted on the effects of linseed oil rich in a-linolenic acid on the hematological factors of hemodialysis patients. It has improved hematological factors in hemodialysis patients[17].

It has been stated that physical exercise affects hematological parameters. Athletes who perform intensive exercise programs characteristically have a decrease in Hemoglobin (Hb) and Hematocrit (HCT) values and this condition is considered as athlete anemia. A slight decrease in blood volume is seen especially during heavy exercise[18]. It is also suggested that regular exercise has positive effects on the lipid profile. However, researchers report conflicting results regarding the type and duration of exercise that cause changes in lipid metabolism. While some researchers suggest that acute physical activity in one session will affect lipid parameters, some other researchers report that this change may occur as a result of long-term exercises[19–21].

Studies investigating the effects of marine and plant omega-3 fatty acids on hematological indicators in sick individuals are limited. Whereas similar studies were not found in healthy people. Hence, this research was planned to investigate the things of walnut consumption on healthy adults' hematological factors.

Material and Methods

Participants

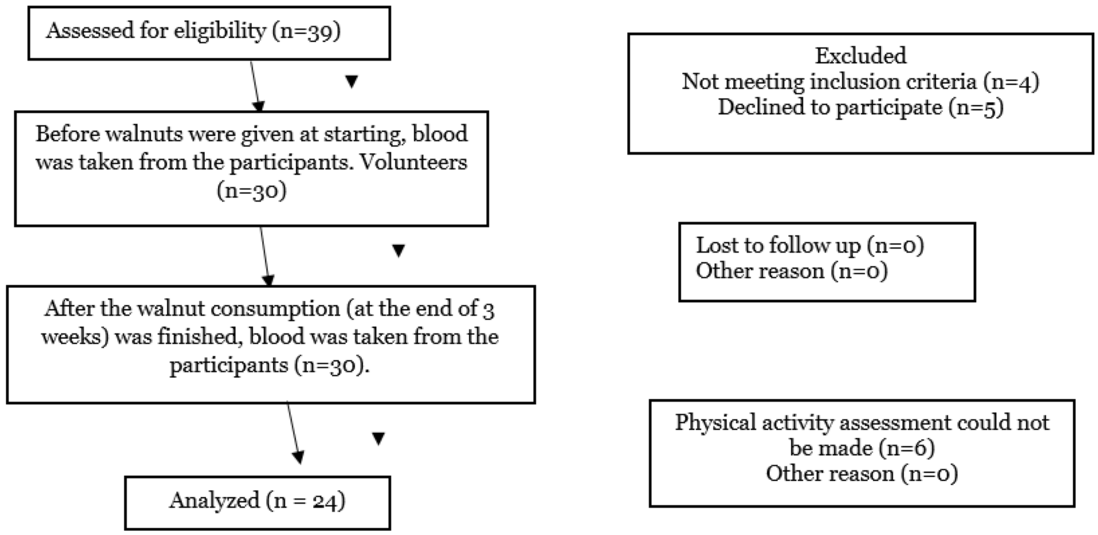
The research was done with thirty volunteers (mean Age; 23.50±3.89, mean BMI; 21.76±2.76, Sleep hours; 7.04±0.71), 16 females and 8 males within the scope of the study criteria (Figure 1). The effect size of the study was calculated as 0.77and its power was 0.80.

The study was conducted on healthy individuals between June 2023 and July 2023, after obtaining regional ethics committee permissions. Inclusion criteria; Non-smoking, nuts those who did not consume any products (the frequency of the subject's intake before the trial should not exceed one month), who were not allergic to foods such as nuts, who did not take drugs continuously (including vitamins and fish oil supplements), who did not have cardiovascular disease, who did not take their medications daily and always were included in the study. Besides, individuals with hepatitis, thyroid (hyperthyroid, hypothyroid and thyroid) cancer, alcoholic, and chronic diseases such as liver, diabetes, cancer, and obesity have been not accepted into the study. Patients with inflammatory disease, previous infectious disease, and recent surgical intervention were also excluded.

Intervention

Participants were asked to eat five pieces (six grams each) of the whole walnuts per diem for three weeks. Individuals have had walnuts on empty stomachs with breakfast. The per diem walnut intake was noted, and daily notice by SMS was sent. When needed, people were called by phone, and reminders were done to eat. The research started with thirty-nine people and was concluded with thirty people due to a few matters (forgetfulness, nausea, illness, and quitting). The total number of participants with physical activity values was determined as 24 (Figure 1).

Figure 1. The flow of healthy volunteers



During the study, five whole walnuts were added to the diet of individuals without interfering with their normal diet. Participants who accepted the study were given twenty-one packets containing thirty grams of walnuts, each of which was weighed and prepared, for 3 weeks.

Identification of Physical Activity

The answers to the questions on sports branches such as volleyball, tennis, etc., physical exercise, running, swimming, long walks, and gardening were obtained by taking the answers more than once a week, once a week, a few times a month, a few times a year and rarely/never. Active and sedentary were classified according to these answers.

Calculation of the Nutrition Habits

A food consumption registration form was taken from the individuals for two days in total (one weekday and one weekend), and then the average was calculated. CEBEBIS program was used for food consumption records.

Biochemical Measurements

Blood specimens were obtained from individuals who were fasting in the morning on the first day and the last day of the study. All blood samples were collected using sterile plastic heparin vacutainer tubes. Blood parameters were studied immediately in whole blood. Hematological parameters (Total Cholesterol, WBC (white blood cells), RBC (red blood cells); HGB (Hemoglobin); HCT (Hematocrit); MCV (mean corpuscular volume); MCH (mean corpuscular hemoglobin); MCHC (mean corpuscular hemoglobin concentration); Plt (platelet); PDW (platelet distribution width); MPV (mean platelet volume); PCT (plateletcrit), NEUTROPHIL, LYMPHOCYTE, MONOSITE, EOSINOPHIL, and BASOPHIL) values have been measured directly. The plasma samples were analyzed by Randox branded device.

Ethical Statement

All volunteers were informed about the study and a consent form was obtained before the study. The clinical research ethics committee of Avrasya University approved all human subjects' procedures. This trial is registered under award numbers 2022-32 date of 24.06.2023. The research was conducted per the ethical standards in the Declaration of Helsinki.

Statistical Analysis

Statistical analysis was done by SPSS 15 version. The conformity of the variables to the normal distribution was examined by analytical methods (Kolmogorov-Smirnov / Shapiro-Wilk tests). Descriptive statistics were made by giving the mean±standard deviation and minimum-maximum values to the normally distributed variables. Dependent groups (comparison of measurement values of the walnut-consuming group before and at the end of the study) between continuous variables (demographic information and hematological factors table) were analyzed by paired t-test. Wilcoxon Signed Rank Test was used for dependent groups that did not show normal distribution, while the Mann-Whitney U test was used for independent groups that did not show normal distribution. Single sample Wilcoxon sign rank test for dietary habits variables. G-Power v.3.1.7 software was used and the p-value was considered significant when less than 0.05.

Results

19 (63%) female and 11 (37%) male individuals contributed to the study. The total number of individuals who participated in the study was thirty. The parameters of male and female individuals specified in the study were examined as Baseline-Day 22 variables. In general, Basic-22. Descriptive statistics of day measurement results were examined. Before comparing these variables, their distribution was examined. Normally distributed and abnormally distributed ones were determined.

Table 1. The nutrition habits of healthy individuals to mean daily intake of Turkish people were compared.

	Female (n=16)			Male (n=8)		
Nutrient Intake	**TBSA**	**Mean±SD**	**p**	**TBSA**	**Mean±SD**	**p**
Energy (kcal)	1649.4	1585.2±389.4	0.872	2241.8	1956.6±423.3	0.091
Carbohydrate (g)	203.6	167.2±59.2	0.027*	281.8	211.4±76.5	0.026*
Protein (g)	51.9	58.1±18.5	0.184	71.3	74.4±13.1	0.248
Total fat (g)	66.6	75.0±16.3	0.064	86.0	89.3±20.8	0.423
SFA (g)	21.7	24.1±9.0	0.520	28.3	26.8±10.8	0.477
MUFA (g)	23.1	22.0±5.2	0.243	30.0	27.1±7.5	0.213
PUFA (g)	17.40	25.4±6.7	<0.001*	21.9	31.7±9.6	0.021*
Linoleic acid (g)	16.1	21.4±6.4	0.002*	20.2	27.1±9.8	0.062
Linolenic acid (g)	1.2	3.1±0.5	<0.001*	1.6	3.1±0.3	0.003*
Cholesterol (mg)	191.8	206.7±96.9	0.809	266.0	304.4±208.0	0.929
Dietary fiber (g)	19.0	18.8±6.8	0.872	22.4	17.7±5.0	0.006*
Iron (mg)	9.9	8.7±2.5	0.061	12.4	10.9±2.3	0.075

TBSA: Standard İntakes of Turkey Nutrition and Health Research (2014) 20, Saturated fatty acid: SFA, Monounsaturated fatty acid: MUFA, Polyunsaturated fatty acid: PUFA, SD: Standard Deviation

*One-Sample Wilcoxon Signed Ranks Test; p values <0.05 were considered statistically significant.

In this study, TBSA values were compared with healthy individuals' nutritional habits[22]. As a result, there is a statistically significant difference in carbohydrate, polyunsaturated fatty acid, and a-linolenic acid intake. A significant difference was found in male individuals' dietary fiber values and female individuals' linoleic acid values (Table 1).

Table 2. Descriptive statistics and comparison of variables

Blood Hb Parameters	First (n=24)		Second (n=24)		p
	Mean±SD	Min.- Max.	Mean±SD	Min.- Max.	
WBC	6.5±0.9	5.2-8.8	6.7±1.4	4.0-9.5	0.258
RBC	4.9±0.5	4.2-5.9	4.9±0.5	4.0-6.1	0.673
HGB	13.8±2.1	7.7-16.7	13.7±2.1	7.8-16.5	0.180
HCT	39.5±6.0	17.3-46.9	40.6±4.7	27.6-48.2	0.214
MCV	81.7±11.5	32.1-92.5	83.5±6.8	62.3-92.4	0.459
MCH	28.4±3.3	17.9-31.9	28.2±3.3	17.6-32.7	0.004**
MCHC	34.0±1.8	28.1-37.0	33.7±1.7	28.3-36.3	0.001*
PLT	269.5±56.2	167.0-368.0	261.8±54.7	168.0-418.0	0.210
PDW	14.3±2.4	10.6-19.8	14.2±2.2	10.7-19.8	0.627
MPV	11.1±1.0	9.5-13.3	11.2±0.9	9.6-13.2	0.821
PCT	0.3±0.1	0.2-0.4	0.3±0.1	0.2-0.5	0.452
NEUTROPHIL	3.7±0.8	2.6-6.1	3.7±1.0	2.0-6.4	0.551
LYMPHOCYTE	2.1±0.4	1.3-2.7	2.3±0.5	0.9-3.4	0.001*
MONOSITE	0.6±0.1	0.3-0.9	0.6±0.1	0.3-0.9	0.489
EOSINOPHIL	0.1±0.07	0.03-0.4	0.15±0.13	0.02-0.57	0.492
BASOPHIL	0.05±0.04	0.01-0.2	0.05±0.03	0.01-0.11	0.919

WBC= white blood cells; RBC = red blood cells; HGB= Hemoglobin; HCT= Hematocrit; MCV = mean corpuscular volume; MCH = mean corpuscular hemoglobin; MCHC = mean corpuscular hemoglobin concentration; Plt= platelet; PDW= platelet distribution width; MPV= mean platelet volume; PCT= plateletcrit.

* Paired- samples t-test

** Wilcoxon Signed Ranks Test; p values <0.05 were considered statistically significant.

The effects of consumed walnuts on hematological factors have been determined. A significant decrease was observed in the MCH (Mean corpuscular hemoglobin) and MCHC (Mean corpuscular hemoglobin concentration) levels between the First and Second. A significant higher was also determined in the LYMPHOCYTE levels between the First and Second. A significant decrease was observed in the MCH (Mean corpuscular hemoglobin) and MCHC (Mean corpuscular hemoglobin concentration) levels between the First and Second. While WBC, HCT (Hematocrit), MCV (Mean corpuscular volume), and MPV levels were ascertained to increase, a significant difference has not been found (Table 2).

Table 3. Comparison of the variables between the female and male groups

	Female (n=16)			**Male (n=8)**		
Blood Hb Parameters	**First**	**Second**	**p**	**First**	**Second**	**p**
	Mean±SD	**Mean±SD**		**Mean±SD**	**Mean±SD**	
WBC	6.4±0.9	6.7±1.3	0.159	6.8±0.8	6.8±1.5	0.790
RBC	4.6±0.3	4.6±0.3	0.872	5.4±0.2	5.4±0.3	0.164
HGB	12.6±1.6	12.5±1.6	0.265	15.9±0.4	15.9±0.4	0.619
HCT	37.8±3.2	37.7±3.2	0.965	42.3±8.4	45.6±1.3	0.012*
MCV	83.2±8.3	83.2±8.5	0.906	79.1±15.8	84.0±2.6	0.141
MCH	27.8±3.9	27.6±4.0	0.114	29.6±1.2	29.2±1.2	0.007*
MCHC	33.2±1.8	33.0±1.8	0.144	35.3±0.8	34.8±0.8	0.005*
PLT	278.7±60.9	267.8±64.0	0.142	253.6±45.1	251.3±33.2	1.000
PDW	14.6±2.6	14.1±2.3	0.410	14.3±2.5	14.3±2.3	0.878
MPV	11.3±1.0	11.2±0.9	0.754	11.1±1.1	11.1±1.0	0.952
PCT	0.3±0.1	0.3±0.1	0.421	0.3±0.04	0.3±0.03	0.888
NEUTROPHIL	3.6±0.7	3.6±1.0	0.872	4.0±0.9	3.8±1.0	0.306
LYMPHOCYTE	2.1±0.4	2.3±0.4	0.003*	2.0±0.3	2.3±0.6	0.083
MONOSITE	0.6±0.1	0.6±0.1	0.304	0.6±0.2	0.5±0.2	0.306
EOSINOPHIL	0.1±0.1	0.2±0.2	0.102	0.1±0.1	0.2±0.1	0.261
BASOPHIL	0.05±0.04	0.04±0.03	0.353	0.05±0.03	0.05±0.03	0.435

WBC= white blood cells; RBC = red blood cells; HGB= Hemoglobin; HCT= Hematocrit; MCV = mean corpuscular volume; MCH = mean corpuscular hemoglobin; MCHC = mean corpuscular hemoglobin concentration; Plt= platelet; PDW= platelet distribution width; MPV= mean platelet volume; PCT= plateletcrit.

* Wilcoxon Signed Ranks Test; p values <0.05 were considered statistically significant.

When blood hematological factors were compared in female groups, A significant decrease was observed in the MCH (Mean corpuscular hemoglobin) and MCHC (Mean corpuscular hemoglobin concentration) levels between the First and Second. In contrast, there was a significant difference in the LYMPHOCYTE values. At the same time, male groups had a significant difference in HCT, MCH, and MCHC (Table 3).

Table 4. Comparison of the variables between the sedentary and active groups

	Sedentary (n=12)			Active (n=12)				
Blood Hb Parameters	**First**	**Second**	p^a	**First**	**Second**	p^b	p^c	p^d
	Mean±SD	**Mean±SD**		**Mean±SD**	**Mean±SD**			
WBC (10*3/uL)	6.43±0.9	6.74±1.4	0.326	6.39±0.7	6.63±1.4	0.490	0.904	0.846
RBC	4.80±0.56	4.78±0.57	0.660	4.86±0.47	4.85±0.54	0.781	0.755	0.738
HGB	12.88±2.22	12.69±2.23	0.138	14.60±1.41	14.48±1.50	0.217	**0.033**	**0.031**
HCT	36.43±7.43	38.63±5.35	0.409	41.67±2.92	41.77±3.59	0.769	**0.033**	0.105
MCV	81.43±8.46	81.13±8.46	0.261	81.78±16.0	86.35±3.39	0.293	0.946	0.067
MCH	26.9±3.90	26.63±3.89	**0.019**	30.13±1.12	29.88±1.12	0.106	**0.017**	**0.016**
MCHC	33.88±1.79	32.68±1.71	0.110	34.99±1.13	34.61±0.89	**0.035**	**0.002**	**0.002**
PLT	274.58±63.47	259.4±68.8	0.166	269.6±60.0	260.6±45.9	0.362	0.845	0.961
PDW	15.63±2.21	15.16±2.26	0.679	13.33±2.48	13.30±2.07	0.920	**0.029**	0.057
MPV	11.69±0.76	11.66±0.81	0.619	10.80±1.09	10.78±0.89	0.863	**0.035**	**0.027**
PCT	0.31±0.07	0.30±0.08	0.378	0.29±0.05	0.28±0.04	0.488	0.360	0.472
NEUTROPHIL	3.76±0.81	3.85±1.13	0.719	3.48±0.42	3.42±0.84	0.795	0.309	0.305
LYMPHOCYTE	1.94±0.28	2.15±0.27	**0.016**	2.20±0.32	2.42±0.56	0.090	**0.044**	0.158
MONOSITE	0.59±0.16	0.58±0.14	0.664	0.51±0.05	0.57±0.10	**0.027**	0.131	0.838
EOSINOPHIL	0.11±0.06	0.12±0.08	0.297	0.16±0.09	0.18±0.18	0.539	0.135	0.323
BASOPHIL	0.04±0.03	0.04±0.03	0.571	0.04±0.03	0.04±0.03	0.713	0.784	0.824

WBC= white blood cells; RBC = red blood cells; HGB= Hemoglobin; HCT= Hematocrit; MCV = mean corpuscular volume; MCH = mean corpuscular hemoglobin; MCHC = mean corpuscular hemoglobin concentration; Plt= platelet; PDW= platelet distribution width; MPV= mean platelet volume; PCT= plateletcrit.

p^a: Sedentary group (The variables between First and Second) was analyzed by Paired- samples t-test

p^b: Active group (The variables between First and Second) was analyzed by Paired- samples t-test

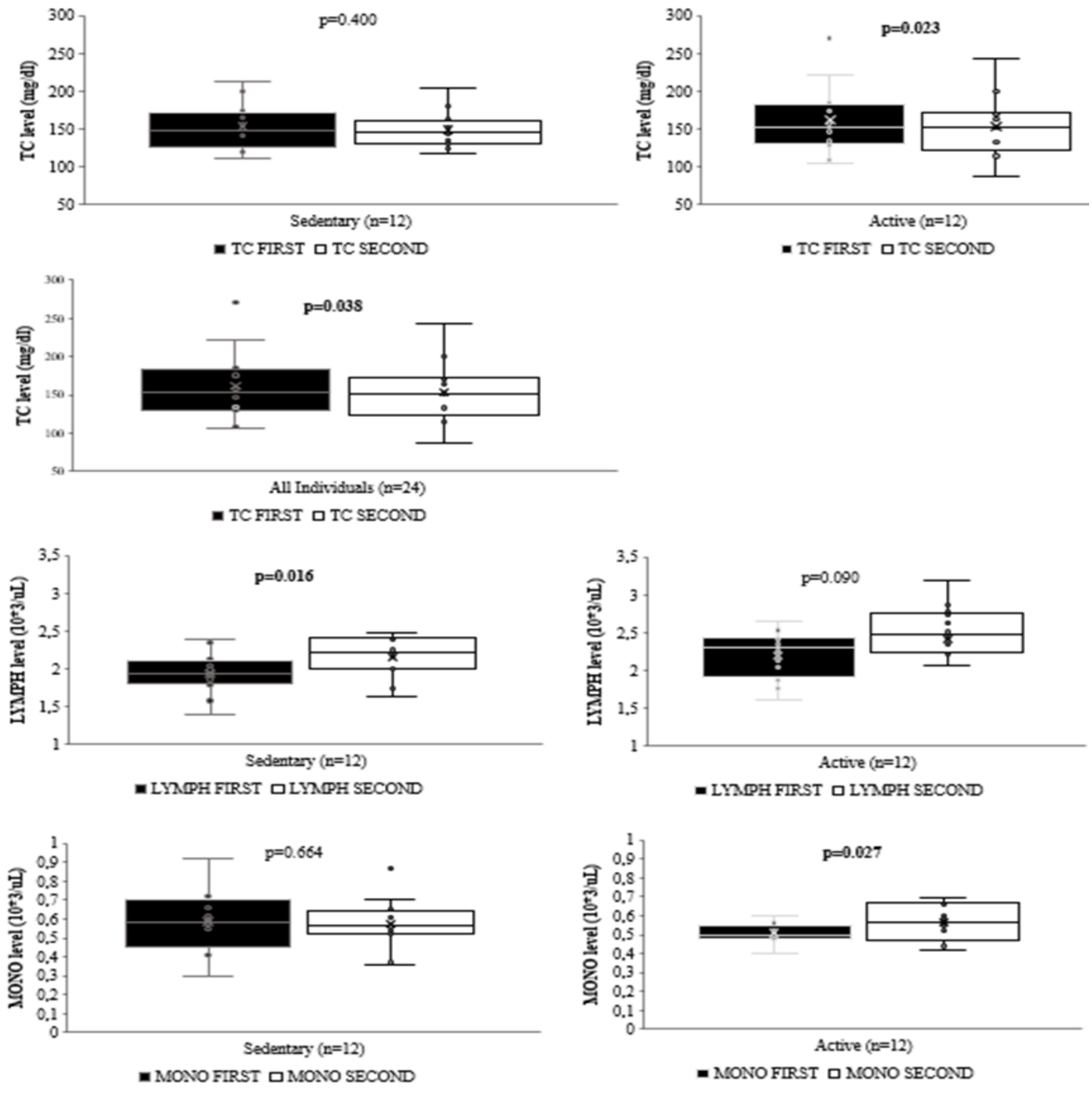
p^c: The variables Between Sedentary First and Active First were analyzed by Independent t-test

p^d: The variables Between Sedentary Second and Active Second were analyzed by Independent t-test

p values <0.05 were considered statistically significant.

There was a significant difference in HGB, HCT, MCH, MCHC, PDW, MPV, and LYMPHOCYTE levels between sedentary and active individuals in the first measurements, while there was no difference in HCT, PDW, and LYMPHOCYTE levels in the last measurements. In addition, there was a significant decrease in MCH levels and a significant increase in LYMPHOCYTE values compared to the first and second measurements of sedentary individuals. According to the first and second measurements of active individuals, there was a significant decrease in MCHC levels and a significant increase in MONOSITE values.

Figure 2. Evaluation of herbal omega-3 consumption according to physical activity status according to total cholesterol (TC)



Physical activity assessment is divided into two classes sedentary and active. It was observed that there was no difference between the initial cholesterol level of the sedentary group and the cholesterol level after consumption started. In the active group, there was a significant decrease in the final measurement levels of total cholesterol. In addition, it was observed that there was a significant increase in MONOSITE (MONO) values of the active group after consumption. It was found that there was an increase in LYMPHOCYTE (LYMPH) levels in the sedentary group after consumption. (Figure 2).

Discussion

Some studies surveyed the effects of walnut intake as a nutrient supplement on human health in the literature[13,23–25]. Furthermore, the effect of walnut consummation on the hematological blood parameters and total cholesterol according to the physical activity status of healthy individuals was examined in elaboration in our study.

The direct or indirect effects of the foods consumed by the participants on hematological factors were examined. There was no significant difference in iron, MUFA, SFA, and cholesterol intake compared to TBSA. It is thought that the effect of the consumption of walnuts rich in PUFA can be seen (Table 2).

One research was planned for nonrenal failure diseases, and an amount of 8.5 g a-linolenic acid was added to the diet[26]. However, an intake of 8.5 grams of a-linolenic acid was not recommended because it was too high. It has been reported that the per day consumption of more than 3 grams of a-linolenic acids is not reliable in terms of the Food and Drug Administration[8,27]. In this study, the a-linolenic (omega-3) acid amount has been planned to adjust the means of 3.1 g (1.8 g from walnuts and 1.2 g from diet) for daily diets. Besides, it was shown proximate to the a-linolenic acid amount determined by the Food and Drug Administration.

Measure hematological blood parameters are crucial for diagnosis, prevention, and control in medicine, and hematological parameters are one of the necessary tools measured in determining health. In our study, healthy individuals' blood hematological parameter values also seem to be in the reference range[28].

In some research, the effect of hemodialysis patients' marine omega-3 fatty acid intake on HGB, HCT, MCV, MCH, and MCHC values have not significantly differed[8,14,29]. Whereas in other studies, it has been seen that there is a significant difference in the increase in HCT, MCH, and MCHC levels in flaxseed oil intake. On the other hand, flaxseed oil is a herbal oil[17]. During the research period, walnut consumption (rich nutrient from a-linolenic acid or PUFA) was determined to increase the effect of HCT values in all healthy participants. Nevertheless, there has not been a significant difference. A significant difference was concluded in the HCT levels increase of male groups' walnut intake. HCT levels were found results similar to the effect of walnut consumption (for only men groups) of the flaxseed oil intake because the fact is that walnut so is a herbal product. As an exception, our study has been conducted on healthy people.

The flaxseed oil study[17] and our study have the opposite result for MCH and MCHC values. Walnut consumption in all individuals (male and female) was caused by to decrease in MCH and MCHC values, and there is a significant difference. However, only male groups decreased significantly in the MCH and MCHC values in sex groups. MCHC levels are calculated by dividing blood HGB by HCT values[28]. The change is not in the HGB values, but there is an increase in HCT levels. The reduction of MCHC in male groups may be due to an increase in HCT value[8].

Flaxseed oil consumption does not change MCV levels[17], again walnut intake has not changed the effect on MCV levels. As a result of walnut consumption, A significant increase was observed in all individuals' LYMPHOCYTE values. Simultaneously, LYMPHOCYTE values have been increased in sex groups, but a significant difference was seen in only female groups. Therefore, it may be said that walnut consumption stimulates LYMPHOCIDE.

These disagreements may be because marine omega-3 fatty acids did not affect inflammation in these studies[30–32]. In comparison, flaxseed oil is emphasized that improves hematological parameters in hemodialysis patients[17]. Nevertheless, healthy individuals were not taken to be a reference in these studies. Marine or herbal omega-3 fatty acids are not known to entirely affect hematological parameters. Quite a lot of research on this subject has been not done.

It is reported that 6 weeks of high-intensity interval training did not cause any change in HCT and HGB levels, 6 weeks of high-intensity interval training did not cause an increase in HCT and HGB levels, and there is a characteristic decrease in hematocrit values in athletes who apply for an intense exercise program. This situation is considered athlete anemia[18]. Monocytes play an important role in vascular endothelial damage caused by inflammation. Monocytes and macrophages are cells involved in the synthesis and release of proinflammatory and prooxidant cytokines. These cells function in tissue regeneration and inflammation[33]. After consuming a product rich in plant Omega-3, MONOSITE values increased in active individuals and LENFOSITE values increased in syndromes.

Multiple mechanisms have been proposed for the effect of physical activity on serum lipid and lipoprotein profiles. In particular, it has been suggested that exercise causes an increase in reverse cholesterol transport[19]. Intake of unsaturated fatty acids is known to lower total cholesterol[6]. In this study, a diet rich in plant omega-3s led to a reduction in total cholesterol levels in active individuals, but not in sedentary individuals.

We found no research on the effects of walnut consumption on hematologic factors in hemodialysis patients or healthy individuals to compare with our study results. However, poor studies have been conducted on the effects of marine omega-3 fatty acids and flaxseed oil on hemodialysis patients' hematologic factors. In this study, the walnut supplement (herbal omega-3 fatty acids) to healthy volunteers' diet has affected some hematological factors. The studies conducted on healthy individuals are not found; therefore, the effect on hematological parameters of PUFA (rich from a-linolenic acid) is hard to interpret. The study period may be short in our study. It was also observed that the effect on hematologic factors and cholesterol levels was higher when plant omega-3 supplements were given to individuals who engaged in regular physical activity. We think that the effect of herbal omega-3 fatty acids on hematological factors should be investigated further.

Acknowledgments

All authors are grateful to the present study participants for their enthusiastic cooperation.

Author Declarations

None of the authors had any conflicts of interest.

Ethical Statement

All volunteers were informed about the study and a consent form was obtained before the study. The clinical research ethics committee of Avrasya University approved all human subjects' procedures. This trial is registered under award numbers 2022-32. The research was conducted per the ethical standards in the Declaration of Helsinki.

REFERENCES

1. Cesur F, Seçkiner S, Kucukerdonmez O, Cagindi O, Saygili LF, Meseri R. Can enzyme-resistant starch snack prevent blood glucose fluctuations? A pilot trial in patients with insulin-treated type 2 diabetes. *Starch/Staerke*. 2023;75(9-10). doi: 10.1002/star.202200279.

2. Cesur F, Atasever Z, Özoran Y. Impact of vitamin D3 supplementation on COVID-19 vaccine response and immunoglobulin G antibodies in deficient women: A randomized controlled trial. *Vaccine*. 2023;41(17):2860-2867. doi: 10.1016/j.vaccine.2023.03.046.

3. Estruch R, Ros E, Salas-Salvadó J, et al. Primary prevention of cardiovascular disease with a mediterranean diet supplemented with extra-virgin olive oil or nuts. *N Engl J Med*. 2018;378(25):e34. doi: 10.1056/nejmoa1800389.

4. Lattimer JM, Haub MD. Effects of dietary fiber and its components on metabolic health. *Nutrients*. 2010;2(12):1266–1289. doi:10.3390/nu2121266

5. Sala-Vila A, Cofán M, Núñez I, Gilabert R, Junyent M, Ros E. Carotid and femoral plaque burden is inversely associated with the α-linolenic acid proportion of serum phospholipids in Spanish subjects with primary dyslipidemia. *Atherosclerosis*. 2011;214(1):209-214. doi: 10.1016/j.atherosclerosis.2010.10.026.

6. Cesur F, Cengiz H, Vural H. The Effect of walnut consumption on small dense low-density lipoprotein and other serum lipid parameters in healthy volunteers. *Turkiye Klin J Heal Sci*. 2022;7(1):11-18. doi: 10.5336/healthsci.2021-81996.

7. Perunicic-Pekovic GB, Rasic ZR, Pljesa SI, et al. Effect of n-3 fatty acids on nutritional status and inflammatory markers in haemodialysis patients. *Nephrology*. 2007;12(4):331-336. doi: 10.1111/j.1440-1797.2007.00777.x.

8. Kooshki A, Taleban FA, Tabibi H, Hedayati M. Effects of omega-3 fatty acids on serum lipids, lipoprotein (a), and hematologic factors in hemodialysis patients. *Ren Fail*. 2011;33(9):892-898. doi: 10.3109/0886022X.2011.605536.

9. Laboratory Hemostasis: A Practical Guide for Pathologists - Sterling T. Bennett, Christopher M. Lehman, George M. Rodgers - Google Kitaplar. Accessed October 25, 2020. https://books.google.com.tr/books?hl=tr&lr=&id=AOzSBAAAQBAJ&oi=fnd&pg=PR5&dq=Bennett+ST,+Lehman+CM,+Rodgers+GM.+2nd+ed.+Heidelberg:+Springer%3B+2015.+Laboratory+hemostasis%3B&ots=GNIbQOPEQb&sig=G_TxGQ27opyn3169CyZXkzByHWw&redir_esc=y#v=onepage&q&f=false.

10. Hekimsoy Z, Payzin B, Örnek T, Kandogan G. Mean platelet volume in Type 2 diabetic patients. *J Diabetes Complications*. 2004;18(3):173-176. doi: 10.1016/S1056-8727(02)00282-9.

11. Coban E, Bostan F, Ozdogan M. The mean platelet volume in subjects with impaired fasting glucose. *Platelets*. 2006;17(1):67-69. doi: 10.1080/09537100500220729.

12. Batista TR, De Figueiredo RC, Rios DRA. Platelets volume indexes and cardiovascular risk factors. *Rev Assoc Med Bras*. 2018;64(6):554-559. doi: 10.1590/1806-9282.64.06.554.

13. Tuccinardi D, Farr OM, Upadhyay J, et al. Mechanisms underlying the cardiometabolic protective effect of walnut consumption in obese people: A cross-over, randomized, double-blind, controlled inpatient physiology study. *Diabetes, Obes Metab*. 2019;21(9):2086-2095. doi: 10.1111/dom.13773.

14. Khor BH, Narayanan SS, Sahathevan S, et al. Efficacy of nutritional interventions on inflammatory markers in haemodialysis patients: A systematic review and limited meta-analysis. *Nutrients*. 2018;10(4). doi: 10.3390/nu10040397.

15. Agarwal R, Georgianos P. Feeding during dialysis - risks and uncertainties. *Nephrol Dial Transplant*. 2018;33(6):917-922. doi: 10.1093/ndt/gfx195.

16. Chauveau P, Aparicio M, Bellizzi V, et al. Mediterranean diet as the diet of choice for patients with chronic kidney disease. *Nephrol Dial Transplant*. 2018;33(5):725-735. doi: 10.1093/ndt/gfx085.

17. Tabibi H, Mirfatahi M, Hedayati M, Nasrollahi A. Effects of flaxseed oil on blood hepcidin and hematologic factors in hemodialysis patients. *Hemodial Int*. 2017;21(4):549-556. doi: 10.1111/hdi.12516.

18. Çakmakçi E. Effects of camp term on some hematological parameters in male taekwondoers. *Niğde Üniversitesi Beden Eğitimi ve Spor Bilim Derg*. 2009;1(3):21-28.

19. Şekeroğlu M, Aslan R, Tarakçıoğlu M, Kara M. Sedanter erkeklerde akut ve programlı egzersizin serum apolipoproteinleri ve lipitleri üzerine etkileri. *Genel Tıp Derg*. 1997;7:5-8.

20. Berg A, Johns J, Baumstark M, Kreutz W, Keul J. Changes in HDL subfractions after a single, extended episode of physical exercise. *Atherosclerosis*. 1983;47(3):231-240. doi: 10.1016/0021-9150(83)90054-0.

21. Sučić M, Orešković I. Effect of kinesiologic recreation on plasma lipoproteins and apolipoproteins in fertile women. *Metabolism*. 1995;44(6):701-704. doi: 10.1016/0026-0495(95)90180-9.

22. TBSA. Türkiye Beslenme ve Sağlık Araştırması. Journal of Visual Languages & Computing. doi:931.

23. Bamberger C, Rossmeier A, Lechner K, et al. A walnut-enriched diet reduces lipids in healthy caucasian subjects, independent of recommended macronutrient replacement and time point of consumption: A prospective, randomized, controlled trial. *Nutrients*. 2017;9(10). doi:10.3390/nu9101097.

24. Fatahi S, Haghighatdoost F, Larijani B, Azadbakht L. Effect of weight reduction diets containing fish, walnut or fish plus walnut on cardiovascular risk factors in overweight and obese women. *Arch Iran Med*. 2019;22(10):574-583.

25. Mohammadi-Sartang M, Bellissimo N, Totosy de Zepetnek JO, Bazyar H, Mahmoodi M, Mazloom Z. Effects of walnuts consumption on vascular endothelial function in humans: A systematic review and meta-analysis of randomized controlled trials. *Clin Nutr ESPEN*. 2018;28:52-58. doi: 10.1016/j.clnesp.2018.07.009.

26. Herrmann W, Biermann J, Kostner GM. Comparison of effects of N-3 to N-6 fatty acids on serum level of lipoprotein(a) in patients with coronary artery disease. *Am J Cardiol*. 1995;76(7):459-462. doi: 10.1016/S0002-9149(99)80130-1.

27. Vergili-Nelsen JM. Benefits of fish oil supplementation for hemodialysis patients. *J Am Diet Assoc*. 2003;103(9):1174-1177. doi: 10.1016/S0002-8223(03)00984-2.

28. Celkan TT. What does a hemogram say to us? *Turkish Arch Pediatr*. 2020;55(2):103-116. doi: 10.14744/TurkPediatriArs.2019.76301.

29. Donnelly SM, Ali MAM, Churchill DN. Effect of n-3 fatty acids from fish oil on hemostasis, blood pressure, and lipid profile of dialysis patients. *J Am Soc Nephrol*. 1992;2(11):1634-1639.

30. Vernaglione L, Cristofano C, Nephrology SCJ. Omega-3 polyunsaturated fatty acids and proxies of cardiovascular disease in hemodialysis: A prospective cohort study. europepmc.org. Accessed November 12, 2020. https://europepmc.org/article/med/18264942.

31. Tayyebi-Khosroshahi H, Houshyar J, Dehgan-Hesari R, et al. Effect of treatment with omega-3 fatty acids on c-reactive protein and tumor necrosis factor-alfa in hemodialysis patients. *Saudi J Kidney Dis Transpl*. 2012;23(3):500-506. doi:10.4103/1319-2442.95769.

32. Gharekhani A, Khatami MR, Dashti-Khavidaki S, et al. Potential effects of omega-3 fatty acids on anemia and inflammatory markers in maintenance hemodialysis patients. *DARU, J Pharm Sci*. 2014;22(1). doi: 10.1186/2008-2231-22-11.

33. Doğan H, Çaltekin MD. Sağlıklı kadınlarda fiziksel aktivite düzeyine göre uyku kalitesi ve monosit/ yüksek yoğunluklu lipoprotein oranın karşılaştırılması. *Kırıkkale Üniversitesi Tıp Fakültesi Derg*. 2021;23(3):522-529. doi: 10.24938/kutfd.956479.