Medical Journal of Bakırköy

Med J Bakirkoy 2025;21(2):172-180
DOI: 10.4274/BMJ.galenos.2024.2024.8-12

Research

Association of IL6 with Laboratory Parameters, Obesity, and Osteoporosis in Turkish Geriatric Patients

Türk Yaşlı Hastalarda IL6 ile Laboratuvar Parametreleri, Obezite ve Osteoporoz Arasındaki İlişki

Deniz Yılmaz[1], Ezgi Şahin[2], Elif Ezirmik[3], Nilgün Işıksaçan[4], Faruk Karandere[1], Felemez Arslan[1]

[1]University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Clinic of Internal Medicine, İstanbul, Türkiye
[2]İstanbul University, İstanbul Faculty of Medicine, Department of Internal Medicine, İstanbul, Türkiye
[3]İstanbul University, İstanbul Faculty of Medicine, Department of Public Health İstanbul, Türkiye
[4]University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Clinic of Biochemistry, İstanbul, Türkiye

ABSTRACT

Objective: The cytokine interleukin (IL)-6 is involved in the inflammatory response and has been linked to obesity and osteoporosis, which are public health issues in the geriatric population.

Methods: The study included 154 patients, 109 females and 45 males over the age of 65 without any complaints, who visited the internal medicine outpatient clinic at Bakırköy Dr. Sadi Konuk Training and Research Hospital. Femoral neck and lumbar L1-L4 vertebra bone densitometry was measured using dual-energy X-ray absorptiometry. Additionally, body mass index, arm and calf circumference, general laboratory parameters, and IL-6 levels were recorded.

Results: A positive correlation was found between IL-6 levels and monocyte and C-reactive protein (CRP) levels. Furthermore, a significant negative correlation was observed between IL-6 and albumin levels (p=0.002, p=0.000, p=0.005). However, no significant relationship was found between IL-6 levels and obesity or osteoporosis.

Conclusion: Results showed a significant positive correlation between IL-6 levels and monocyte and CRP levels and a significant negative correlation with albumin levels. However, no significant relationship was found between IL-6 levels and obesity or osteoporosis. Further studies are needed to fully explain the relationship between IL-6 and these health conditions fully.

Keywords: Interleukin-6, obesity, osteoporosis, inflammatory parameters, C-reactive protein

ÖZ

Amaç: Sitokin interleukin (IL)-6, enflamatuar yanıta dahil olmakta ve yaşlı nüfusta halk sağlığı sorunları olan obezite ve osteoporoz ile ilişkilendirilmektedir.

Gereç ve Yöntem: Çalışmaya, Bakırköy Dr. Sadi Konuk Eğitim ve Araştırma Hastanesi iç hastalıkları polikliniğine başvuran, şikayeti olmayan 65 yaş üstü 109 kadın ve 45 erkek olmak üzere toplam 154 hasta dahil edilmiştir. Femur boynu ve L1-L4 lomber vertebra kemik yoğunlukları çift enerjili X-ışını absorpsiyometrisi ile ölçülmüştür. Ayrıca, vücut kitle indeksi, kol ve baldır çevresi, genel laboratuvar parametreleri ve IL-6 seviyeleri kaydedilmiştir.

Bulgular: IL-6 seviyeleri ile monosit ve C-reaktif protein (CRP) seviyeleri arasında pozitif bir korelasyon bulunmuştur. Ayrıca, IL-6 seviyeleri ile albümin seviyeleri arasında anlamlı bir negatif korelasyon gözlemlenmiştir (p=0,002, p=0,000, p=0,005). Bununla birlikte, IL-6 seviyeleri ile obezite veya osteoporoz arasında anlamlı bir ilişki saptanmamıştır.

Sonuç: Sonuçlar, IL-6 seviyeleri ile monosit ve CRP seviyeleri arasında anlamlı bir pozitif korelasyon ve albümin seviyeleri ile anlamlı bir negatif korelasyon olduğunu göstermiştir. Ancak, IL-6 seviyeleri ile obezite veya osteoporoz arasında anlamlı bir ilişki bulunamamıştır. IL-6 ve bu sağlık koşulları arasındaki ilişkiyi tam olarak açıklamak için daha fazla çalışmaya ihtiyaç vardır.

Anahtar Kelimeler: Interleukin-6, obezite, osteoporoz, enflamatuar parametreler, C-reaktif protein

Address for Correspondence: Felemez Arslan MD, University of Health Science, Bakırkoy Dr. Sadi Konuk Training and Research Hospital
E-mail: feloarslan@gmail.com **ORCID ID:** orcid.org/0000-0001-8318-1860

Cite as: Yılmaz D, Şahin E, Ezirmik E, Işıksaçan N, Karandere F, Arslan F. Association of IL6 with laboratory parameters, obesity, and osteoporosis in Turkish geriatric patients. Med J Bakirkoy. 2025;21(2):172-180

Received: 25.08.2024
Accepted: 31.10.2024
Publication Date: 04.06.2025

Copyright© 2025 The Author. Published by Galenos Publishing House on behalf of Bakırköy Dr. Sadi Konuk Training and Research Hospital.
This is an open access article under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 (CC BY-NC-ND) International License.

INTRODUCTION

Interleukin (IL)-6 is an essential cytokine involved in the systemic inflammatory response. IL-6 released from different cells is a critical stimulator in the hypothalamic-pituitary-adrenal axis and plays a notable role in the acute phase response. It is the leading procoagulant and proinflammatory cytokine. It effectively differentiates between B cells and processes or conditions such as inflammatory diseases, hematopoiesis, and oncogenesis (1-3).

The World Health Organization (WHO) defines the geriatric population as those aged 65 and over. As people age, even if they are completely healthy and functional, an increase in IL-6 and C-reactive protein (CRP) levels is observed, which is characterized by a mild pro-inflammatory state (4).

Malnutrition is defined as a condition caused by an imbalanced or insufficient diet, encompassing both undernutrition and overnutrition. In addition to cachexia and sarcopenia, obesity is included in the definition of malnutrition (5,6).

Obesity is a chronic inflammatory condition that causes an increase in inflammatory cytokines such as IL-6, tumour necrosis factor alpha (TNF alpha), and CRP. It is a substantial health problem that increases significantly in the older age group (7-9).

Increased IL-6 can cause thrombocytosis in lung, gastrointestinal, ovarian, breast, and lymphoma cancer. Similarly, increased IL-6 may lead to granulocytosis in lung, gastrointestinal, ovarian, genitourinary, and non-Hodgkin lymphoma (10).

METHODS

A total of 154 patients from the senior population were included in the study. Patients admitted to the internal medicine outpatient clinic of Bakırköy Dr. Sadi Konuk Training and Research Hospital in 2022 for routine control without any complaints were evaluated prospectively. The ethics committee of the same hospital approved the study with the ethics committee number 2022/10-15. Informed consent was obtained from the patients before the study.

Body mass index (BMI) was calculated as weight/height squared. According to the criteria of the WHO, based on BMI, those between 0-18.4 kg/m^2 were as "thin", those between 18.5 and 24.9 kg/m^2 were "normal", those 25-29.9 kg/m^2 were "overweight", and those >30 kg/m^2 "obese" evaluated.

To evaluate osteoporosis, bone density of the femoral neck and L1-L4 lumbar vertebrae was measured using dual-energy X-ray (DEXA) absorptiometry. T-score ranges between -1 and 1 were considered "normal", between -1 and -2.5 were "osteopenic", and below -2.5 were considered "osteoporotic".

The calf circumference was measured from the widest part of the calf, and the upper arm circumference was measured based on the midpoint between the shoulder and elbow using a tape measure. In the upper middle arm circumference measurement in the non-dominant arm, values between 23.5 cm and 32 cm were "normal", <23.5 cm "low", and >32 cm "high". In the context of calf circumference measurement, below 31 cm was considered "low". A calf circumference of <31 cm was considered an indicator of malnutrition.

Comorbid diseases such as diabetes mellitus (DM), hypertension, congestive heart failure, chronic kidney damage, and medications used by all patients included in the study were recorded.

Patients with a diagnosis of Alzheimer's, dementia, Parkinson's, active infection, malignancy, and those with osteoporosis-related fractures at any time were excluded from the study.

Laboratory Analysis

Collected blood samples were separated to obtain serum within 2 hours and kept in a freezer at -80 degrees until analysis.

The serum IL-6 concentration was measured by the chemiluminescence-immunoassay method in the Roche USA analyzer, and the minimum measurable concentration was one pg/mL. In our hospital, all biochemistry examinations were performed on the Cobas 800 Roche ABD device, and hemogram examinations were performed on the Mindray Cal 8000 device.

Statistical Analysis

Descriptive statistics were presented with mean, standard deviation (SD), median, and minimum-maximum values for continuous data and numbers and percentages for categorical data. The conformity of continuous data to normal distribution was evaluated by Kolmogorov-Smirnov and Shapiro-Wilk tests. In data that do not comply with the normal distribution, the Mann-Whitney U test was used to compare two groups, and the Kruskal-Wallis test was used to compare more than two groups. Spearman's correlation analysis was employed to evaluate the relationships between numerical variables. The study considered a statistical significance level of $p<0.05$. The IBM SPSS 21.0 package program was used for statistical analysis.

RESULTS

This study included 154 patients over the age of 65 who were admitted to the internal medicine outpatient clinic for routine control without any complaints. 70.8% (n=109) of the patients were female, and 29.2% (n=45) were male. The age range was between 65 and 89. The mean age was 71.56 (SD=5.11).

Of the patients, 47.4% (n=73) had DM; 66.9% (n=103) had hypertension; 14.9% (n=23) had coronary artery disease; 5.8% (n=9) had congestive heart failure; 3.2% (n=5) had chronic kidney damage; 1.3% (n=2) had cerebrovascular damage; and 11.7% (n=18) had hypothyroidism.

Among the patients, %37 (n=57) use angiotensin-converting enzyme inhibitor or angiotensin two receptor blocker, 14.3% (n=22) use beta-blocker, 15.6% (n=24) use calcium channel blocker, 13% (n=20) use acetylsalicylic acid, 2.6% (n=4) use alpha-blocker, 1.3% (n=2) use gliclazide, 36.4% (n=56) use metformin, 16.9% (n=26) use dipeptidyl peptidase four inhibitor, 5.8% (n=9) use sodium-glucose co-transporter 2 (SGLT2) inhibitor, 11% (n=17) use insulin, 8.4% (n=13) use levothyroxine, 3.2% (n=5) use selective serotonin reuptake inhibitor/serotonin (SSRI), norepinephrine reuptake inhibitor (SNRI), 24.7% (n=38) use proton pump inhibitor, 18.8% (n=29) use statin, 20.8% (n=32) use thiazide diuretic, 2.6% (n=4) use furosemide, 0% 6 (n=1) used spironolactone.

When body mass indices are evaluated, the average BMI is 29.01±4.63 kg/m^2. The mean arm circumference measured was 28.44 (SD=3.36) cm, and the mean calf circumference was 36.14 (SD=3.76) cm. A statistically significant, positive, and strong correlation was found between arm and calf circumference, r=0.666, p=0.000. A statistically significant positive and robust correlation was found between arm circumference and BMI (r=0.799) (p=0.000). A similarly substantial, positive, and strong correlation was found between calf circumference and BMI (r=0.655, p=0.000) (Table 1).

Considering the laboratory parameters, of the patients, mean glucose was 128.24 (SD=52.96) mg/dL, mean creatinine was 0.85 (SD=0.22) mg/dL, mean albumin was 4.6 (SD=0.34), mean protein was 7.23 (SD=0.44) g/dL, mean low-density lipoprotein (LDL) cholesterol was 118.03 (SD=39.82) mg/dL, mean high-density lipoproteins (HDL) cholesterol was 52.65 (SD=13.23) mg/dL, mean triglyceride was 148.06 (SD=76.31) mg/dL, mean transferrin was 3.45

Table 1. The relationship between IL-6 and biochemical parameters (Spearman correlation analysis was used r: correlation coefficient n: number of individuals)

		Calf circumference	IL- 6	BMI	Monocyte	Transferrin	Albumin	CRP
Arm circumference	r	0.666	0.095	0.799	-0.085	0.155	0.027	0.141
	p	0.000	0.242	0.000	0.294	0.055	0.738	0.082
	n	154	154	154	154	154	154	154
Calf circumference	r		0.079	0.655	-0.039	0.028	-0.058	0.110
	p		0.328	0.000	0.634	0.735	0.478	0.175
	n		154	154	154	154	154	154
IL-6 level	r			0.126	0.254	0.059	-0.227	0.586
	p			0.121	0.002	0.465	0.005	0.000
	n			154	154	154	154	154
BMI	r				-0.131	0.244	-0.048	0.175
	p				0.107	0.002	0.553	0.03
	n				154	154	154	154
Monocyte	r					-0.109	-0.090	0.382
	p					0.180	0.267	0.000
	n					154	154	154
Transferrin	r						0.072	0.046
	p						0.374	0.570
	n						154	154
Albumin	r							-0.172
	p							0.033
	n							154

IL: Interleukin, BMI: Body mass index, CRP: C-reactive protein

(SD=5.79) g/L, mean ferritin was 83.96 (SD=107.35) µg/ dL, mean vitamin B12 was 432.78 (SD=299.54), mean CRP was 5.39 (SD=9.94) mg/L, mean alanine transferase (ALT), was 17.46 (SD=9.67) U/L, mean aspartate transferase (AST) was 19.24 (SD=6.99) U/L, mean alkaline phosphatase (ALP) was 81.06 (SD=25.08) U/L, mean lactate dehydrogenase (LDH) was 192.07 (SD=40.12) U/L, mean total leukocyte count was 7455 (SD=2300)/mm^3, mean hemoglobin was 13.39 hematocrit was 42.78% (SD=32.45), mean neutrophil count (SD=1.60) g/dL, mean was 4550 (SD=1813)/mm^3, platelet count was 262805 (SD=75831)/mm^3, mean lymphocyte count was 2206 (SD=745.73)/mm^3, mean monocytes count was 468.18 (SD=149.80)/mm^3, mean parathyroid hormone was 55.29 (SD=31.77) pg/mL, mean vitamin D level was 20.33 (SD=11.27) µg/L, mean IL-6 level was 3.48 (SD=5.62) pg/mL.

There was a statistically significant, positive, and moderate correlation between IL-6 level and the number of monocytes (r=0.254) (p=0.002). A statistically significant negative and weak correlation was found between IL-6 and albumin levels (r=0.227, p=0.005). A statistically significant, positive, and strong correlation was found between IL-6 and CRP levels (r=0.586); (p=0.000). It was observed that there was a statistically significant, positive, and moderate correlation between the number of monocytes and the CRP level (r=0.382, p=0.000). A statistically significant negative and weak correlation was found between CRP and albumin levels (r=0.172, p=0.033). A weak but statistically significant positive correlation was found between BMI and CRP level (r=0.175) (p=0.030). A positive and weak but statistically significant correlation was found between BMI and transferrin level (r=0.244, p=0.002) (Table 1).

According to BMI, of the patients, 0.6% (n=1) were underweight, 21.4% (n=33) were normal weight, 35.7% (n=55) were overweight, and 42.2% (n=66) were obese. No statistically significant difference was found between the albumin, transferrin, CRP, monocytes, and IL-6 levels in obese and non-obese patients (Table 2).

When the relationship between obesity and other biochemical parameters was investigated, a statistically significant difference was observed in ALT, LDH, ALP, and lymphocyte levels between obese and non-obese patients. ALT, LDH, ALP, and lymphocyte levels were higher in obese patients. (respectively p=0.028; p=0.003; p=0.024; p=0.045) (Table 3).

When the correlation between the use of the drug and BMI, arm circumference, and calf circumference was analyzed, the mean arm circumference of the patients SSRI/SNRI users was 28.5 (SD=3.3) cm, SSRI/SNRI non-users were 25.2 (SD=3.4) cm. The arm circumference of the patients' SSRI/SNRI users was significantly higher than the non-users (p=0.042). No significant correlation was detected between the use of other drugs and the mean arm circumference. The mean calf circumference was 36 cm (SD=3.7) for SGLT2 users and 38.4 cm (SD=3.3) for SGLT2 non-users when the correlation with the mean calf circumference was investigated. The calf circumference of patients using SGLT2 inhibitors was significantly lower than that of SGLT2 non-users (p=0.038). No significant correlation was found between other drugs and calf circumference. The mean BMI of patients who were metformin users was 28.4 (SD=4.4) kg/m^2, and non-users were 30.2 (SD=4.8) kg/m^2. The metformin users had a significantly higher BMI (p=0.026). The patient SGLT2 users' mean BMI was 28.8 (SD=4.5) kg/m^2, and the non-users' mean BMI was 32.6 (SD=4.9) kg/m^2. The BMI of the patients who were SGLT2 non-users was significantly higher than that of the users (p=0.043). No relationship was detected between the use of other drugs and BMI (Table 4).

In the bone densitometry measured with DEXA, the patients' mean femoral neck measurement was -1.25 (SD=0.99), and the L1-L4 vertebra measurement was -0.92 (SD=1.47). Based on the lumbar measurements, 48.1% (n=74) of the patients were average, 34.4% (n=53) were osteopenic, and 17.5% (n=27) were osteoporotic.

Table 2. The relationship between IL-6 and obesity

	Not obese					Obese					Mann-Whitney U test	p-value
	Mean	Standard deviation	Median	Min.	Max.	Mean	Standard deviation	Median	Min.	Max.		
Albumin	4.60	0.40	4.65	2.50	5.32	4.60	0.24	4.61	4.00	5.19	2689.0	0.457
Transferrin	2.74	049	2.70	1.75	4.18	4.43	8.84	2.83	2.16	53.60	2409.5	0.077
CRP	5.68	11.99	2.00	0.00	96.00	4.99	6.19	2.00	0.52	31.00	2546.0	0.199
Monocyte	478.65	146.37	470.00	230.00	970.00	453.85	154.35	420.00	210.00	910.00	2573.0	0.242
IL-6	3.83	6.97	1.30	1.00	56.25	3.01	2.86	1.99	1.00	16.11	2643.5	0.353

IL: Interleukin, CRP: C-reactive protein, Min.: Minimum, Max.: Maximum

Table 3. The relationship between obesity and biochemical parameters

	Not Obese					Obese					Mann-Whitney U test	p-value
	Mean	Standard deviation	Median	Min	Max	Mean	Standard deviation	Median	Min.	Max.		
Glucose	122.76	47.68	106.00	75.20	309.00	135.73	58.99	117.40	84.50	399.00	2385.0	0.063
Urea	36.40	10.93	35.60	18.50	67.80	34.94	10.88	32.40	16.00	58.00	2667.5	0.410
Creatine	0.85	0.23	0.82	0.43	1.53	0.83	0.21	0.80	0.48	1.43	2775.5	0.669
AST	19.21	6.89	17.50	11.00	56.80	19.28	7.17	18.20	8.20	45.40	2855.5	0.892
ALT	15.98	7.91	13.90	8.20	52.30	19.50	11.42	15.60	9.10	68.00	2293.0	0.028
LDH	184.35	33.01	180.00	126.00	292.00	202.65	46.40	203.00	126.00	426.00	2093.5	0.03
ALP	77.87	25.15	76.00	13.00	172.00	85.45	24.49	82.00	35.00	156.00	2274.0	0.024
Protein	7.21	0.43	7.21	6.20	8.65	7.25	0.45	7.23	6.41	8.66	2782.0	0.686
Albumin	4.60	0.40	4.65	2.50	5.32	4.60	0.24	4.61	4.00	5.19	2689.0	0.457
LDL	116.64	40.55	109.80	54.40	255.20	119.94	39.03	121.20	44.60	220.70	2658.5	0.392
HDL	53.11	13.58	52.30	28.00	85.50	52.02	12.83	51.00	27.00	85.40	2835.5	0.835
TG	140.77	76.57	122.00	45.00	449.00	158.05	75.38	140.00	45.00	456.00	2403.5	0.074
Transferrin	2.74	0.49	2.70	1.75	4.18	4.43	8.84	2.83	2.16	53.60	2409.5	0.077
Ferritin	93.37	120.53	57.30	8.60	800.00	71.06	85.33	51.90	8.80	639.00	2637.5	0.351
Vit B12	448.36	302.02	376.00	111.00	2000.00	411.45	297.12	321.00	100.00	1621.00	2510.0	0.162
CRP	5.68	11.99	2.00	0.00	96.00	4.99	6.19	2.00	0.52	31.00	2546.0	0.199
IL-6	3.83	6.97	1.30	1.00	56.25	3.01	2.86	1.99	1.00	16.11	2643.5	0.353
WBC	7509.89	2210.36	7140.0	3040.00	13970.00	7381.38	2434.34	6710.00	2900.00	13900.00	2593.0	0.273
HGB	13.50	1.61	13.60	6.20	16.40	13.25	1.60	13.30	8.60	17.00	2573.0	0.242
HTC	44.88	42.51	40.60	20.20	439.00	39.90	4.21	40.50	28.40	49.10	2615.5	0.311
PLT	260640.45	74502.17	257000.00	850000.00	447000.00	265769.23	78099.65	255000.00	137000.00	506000.00	2884.0	0.975
NEU	4727.30	1816.91	4320.00	1600.00	10270.00	4308.31	1794.23	3830.00	1420.00	10340.00	2396.0	0.069
LYM	2081.57	623.91	2060.00	940.00	4070.00	2377.08	861.95	2200.00	1040.00	4970.00	2343.5	0.045
Monocyte	478.65	146.37	470.00	230.0 0	970.00	453.85	154.35	420.00	210.00	910.00	2573.0	0.242
PTH	53.79	35.18	46.05	18.45	273.90	57.34	26.53	53.67	17.78	146.00	2454.5	0.109
D-vit	20.65	11.28	19.40	3.00	53.50	19.88	11.33	18.50	5.70	74.30	2737.5	0.571

AST: Aspartate transferase, ALT: Alanine transaminase, LDH: Lactate dehydrogenase, ALP: Alkaline phosphatase, LDL: Low-density lipoprotein, HDL: High-density lipoproteins, TG: Thyroglobulin, CRP: C-reactive protein, WBC: White blood count, HGB: Hemoglobin, HTC: Hydrothermal carbonization, PLT : Platelet count, NEU: Neutrophils, LYM: Lymphocytes, PTH: Parathyroid hormone

Table 4. Correlation between drugs used and mean arm circumference, calf circumference, and BMI (Mann-Whitney U test was used)

	N		Arm Circumference						Calf Circumference						BKI					
			Mean	Std. Dev	Median	Min	Max	p	Mean	Std. Dev.	Median	Min	Max	p-value	Mean	Std. Dev.	Median	Min	Max	p
ACE/ARB	NO	97	28.2	3.6	28	21	38	0.248	36.0	4.2	36	27	56	0.249	28.9	5.0	28.5	16.4	44.6	0.569
	YES	57	28.8	2.9	28	21	35		36.3	3.0	37	28	42		29.2	3.9	28.4	21.7	37.9	
Beta-blocker	NO	132	28.5	3.4	28	21	38	0.333	36.2	3.8	36	27	56	0.996	29.1	4.6	28.5	19.0	44.6	0.940
	YES	22	27.8	3.4	28	22	34		36.0	3.5	36.5	30	44		28.8	4.8	29.3	16.4	37.2	
Calcium canal blocker	NO	130	28.4	3.4	28	21	38	0.660	36.0	3.8	36	27	56	0.157	29.0	4.8	28.5	16.4	44.6	0.606
	YES	24	28.6	3.2	28	21	34		36.8	3.6	37	28	44		29.3	3.8	28.5	21.7	37.2	
Anticoagula n	NO	148	28.5	3.4	28	21	38	0.636	36.1	3.8	36	27	56	0.136	29.0	4.6	28.5	16.4	44.6	0.787
	YES	6	27.8	2.6	27	25	31		38.0	2.4	38	35	41		29.4	4.9	30.5	23.6	34.2	
ASA	NO	134	28.4	3.4	28	21	38	0.535	36.2	3,9	36	27	56	0.535	29.0	4.7	28.4	19.0	44,6	0,727
	YES	20	28.8	3.5	28.5	22	34		35.5	3,1	36	30	41		28.9	4.3	30.1	16.4	33,9	
Alpha blocker	NO	150	28.4	3.4	28	21	38	0.955	36.1	3.8	36	27	56	0.479	29.0	4.7	28.5	16.4	44,6	0,633
	YES	4	28.3	1.7	28.5	26	30		37.3	1.9	36.5	36	40		28.1	2.7	27.2	25.9	31,9	
Metformin	NO	98	28.1	3.2	28	21	35	0.163	36.0	3.4	36	27	43	0.763	28.4	4.4	28.1	16.4	40,4	**0,026**
	YES	56	29.0	3.6	28.5	22	38		36.3	4.4	36	28	56		30.2	4.8	29.7	19.0	44,6	
DPP4	NO	128	28,3	3.4	28	21	38	0.381	36.2	3.9	36	27	56	0.369	28.8	4.7	28.5	16.4	44,6	0,246
	YES	26	28.9	3.2	28.5	23	34		35.7	3.3	36	30	44		29.9	4.3	29.1	23.0	39.3	
SGLT2	NO	145	28.3	3.3	28	21	38	0.318	36.0	3.7	36	27	56	**0.038**	28.8	4.5	28.5	16.4	44.6	**0.043**
	YES	9	30.0	4.4	30	24	38		38.4	3.3	38	33	44		326	4.9	31.9	27.9	39.3	
Insulin	NO	137	28.3	3.4	28	21	38	0.287	36.2	3.9	36	27	56	0.728	28.9	4.8	28.5	16.4	44.6	0.242
	YES	17	29.2	2.8	28	24	34		35.9	2.0	36	32	39		29.9	3.1	29.0	24.5	34.2	
Levotiroksi n	NO	141	28.4	3.3	28	21	38	0.369	36.2	3.8	36	27	56	0.645	29.0	4.6	28.5	16.4	44.6	0.966
	YES	13	29.1	3.7	30	21	34		35.8	3.2	36	31	43		29.0	5.0	30.4	19.2	39.3	
SSRI/SNRI	NO	149	28.5	3.3	28	21	38	**0.042**	36.2	3.7	36	27	56	0.122	29.1	4.6	28.6	16.4	44.6	0.127
	YES	5	25.2	3.4	24	21	30		33.8	3.7	33	31	40		25.6	4.0	28.0	19.2	28.8	
PPI	NO	116	28.6	3.3	28	21	38	0.418	36.2	3.9	36	27	56	0.904	29.1	4.7	28.5	16.4	44.6	0.691
	YES	38	28.0	3.6	28	21	38		35.9	3.2	36	30	42		28.7	4.5	28.8	19.0	39.3	
Statin	NO	125	28.4	3.3	28	21	38	0.705	36.2	3.9	36	27	56	0.773	29.0	4.6	28.5	16.4	44.6	0.810

ACE: Angiotensin-converting enzyme inhibitor, ARB: Angiotensin 2 receptor blocker, ASA: American Society of Anesthesiologists, DPP-4: Dipeptidyl peptidase- 4 inhibitor, SGLT2: sodium-glucose co-transporter 2, SSRI: Selective serotonin reuptake inhibitor, SNRI: Serotonin-norepinephrine reuptake inhibitör, PPI: Proton-pump inhibitor

Regarding the measurement of the femur neck, 33.1% (n=51) of participants were of average density, 56.5% (n=87) were osteopenic, and 10.4% (n=16) were osteoporotic. No significant difference was detected between albumin, transferrin, CRP, monocytes, and IL-6 levels of standard, osteopenic, and osteoporotic patients when analyzed separately according to the DEXA scans of the lumbar spine and femoral neck.

DISCUSSION

Seventy-seven point nine percent (n=121) of the patients included in our study had a BMI >25 kg/m^2. Forty-two point two percent (n=66) of them were in the obese category. The presence of such a large number of obese patients, according to BMI, among randomly selected patients in the outpatient clinic indicated that obesity is a considerable problem for our country in the elderly population. When the studies in the literature are reviewed, it is seen that the functional capacity decreases, and there is an increase in issues such as the decrease in muscle mass and malnutrition in the groups with BMI <25 kg/m^2 and BMI >35 kg/m^2 in the geriatric population (11). Just as sarcopenia is a notable public health problem in this age group, obesity is similarly crucial.

A study found a positive and significant correlation between serum IL-6, CRP levels, and BMI. When we investigate other studies on this subject today, obesity is recognized as a chronic inflammatory condition and may increase inflammatory markers such as IL-6, TNF-alpha, and CRP (6-9). In our study, no significant difference was detected between the levels of albumin, transferrin, CRP, monocytes, and IL-6 in obese and non-obese patients, contrary to previous reports. Studies in the literature related to the general population, compared to our senior age group population, may have caused this difference.

Our study found a statistically significant and positive correlation between BMI and CRP levels, a finding that is consistent with previous literature, unlike the non-significant relationship between obesity and CRP levels. Considering previous studies, and as a negative acute phase reactant, transferrin, a negative correlation between BMI and transferrin levels would be expected. However, our study found a significant positive correlation that deviates from this expectation (12,13).

In a study by Jalili et al. (14), ALT, ALP, and gamma-glutamyl transferase (GGT) levels were found to be significantly higher in obese individuals compared to non-obese individuals. In another study, ALT, AST, and GGT levels were significantly higher in obese individuals. Similarly, in our research with the geriatric population, ALT, ALP, and LDH levels were significantly higher in obese individuals compared to non-obese individuals (15). It is postulated that the observed increase in liver function tests in obese individuals, as compared to non-obese individuals, may be attributed to obesity being a significant constituent of metabolic syndrome, which is known to contribute to the development of hepatosteatosis. Moreover, consistent with the findings of previous research, our study revealed a statistically significant elevation in lymphocyte counts among obese individuals when compared to their non-obese counterparts (16).

According to studies in the literature, LDL and triglyceride levels are significantly increased in obese patients compared to non-obese patients, whereas HDL levels show no significant difference (17). Similar to the literature, no significant difference was observed in HDL levels in our study. However, unlike the literature, there was no significant difference in LDL and triglyceride levels, which may be attributed to approximately 18% (n=29) of the patients in our study using lipid-lowering drugs in the statin group, potentially affecting the results.

IL-6 is an essential cytokine in the development of inflammatory responses. Previous literature has shown a negative relationship between IL-6 and albumin, a negative acute phase reactant. Similarly, our study found a negative significant relationship between IL-6 levels and albumin levels, suggesting that an increase in IL-6 levels may contribute to malnutrition in the geriatric population by reducing albumin levels. Our study also found a positive, significant relationship between IL-6 and CRP levels and a negative, significant relationship between CRP levels and albumin levels. This suggests that IL-6 is an critical positive acute phase reactant that can cause an increase in CRP levels and a decrease in negative acute phase reactants such as albumin. Monocytes are cells that increase during inflammation and infection. Our study found a significant positive relationship between monocyte levels and both IL-6 and CRP levels, consistent with previous literature.

Previous studies have shown that the use of SSRI/SNRI drugs can lead to weight gain. Similarly, our study found that patients using SSRI/SNRI drugs had a significantly higher arm circumference than those who did not use these drugs. This suggests that SSRI/SNRI drugs may contribute to weight gain in the geriatric population, particularly in obese individuals, and should be used with caution.

Patients using SGLT2 drugs had significantly lower calf circumferences than those who did not use these drugs. Additionally, patients using SGLT2 and metformin had a

significantly lower BMI than those who did not use these drugs. This could be due to metformin's insulin resistance-reducing effect and the weight loss caused by SGLT2 drugs. Similar to our study, previous literature has shown a negative significant relationship between metformin, SGLT2 inhibitors, and BMI.

According to studies in the literature, there is a significant increase in LDL and triglyceride levels in obese patients when compared to non-obese patients, but no significant difference in HDL levels. In our study, similar to the literature, no significant difference was observed in HDL levels. However, unlike the literature, there was no significant difference in LDL and triglyceride levels, which may be attributed to the fact that approximately 18% (n=29) of the patients in our study were using lipid-lowering drugs in the statin group, which could have affected the results.

Our study found a significant positive relationship between arm circumference and calf circumference; calf circumference and BMI; and arm circumference and BMI. This finding is similar to the studies in the literature and suggests that the measurement of arm and calf circumference can be an essential alternative to the BMI (18,19).

IL-6 is an essential cytokine in the development of the inflammatory response. According to the literature, a negative relationship exists between albumin, a negative acute-phase reactant, and IL-6 (20). Similarly, our study found a significant negative correlation between IL-6 levels and albumin levels. Based on these findings, an increase in IL-6 levels may contribute to malnutrition in the geriatric population by reducing albumin levels.

Our study found a significant positive correlation between IL-6 and CRP levels and a significant negative correlation between CRP and albumin levels. This highlights the crucial role of IL-6 as a significant positive acute-phase marker that can reduce negative acute-phase reactants such as albumin while also contributing to increased CRP levels. Monocytes, which are cells that increase during inflammation and infection, were also found to have a significant positive correlation with IL-6 and CRP levels, reflecting their role as inflammatory markers. These findings are consistent with previous studies in the literature (21,22).

The use of SSRI/SNRI drugs has been shown to cause weight gain in a study conducted by Gafoor et al. (23) Consistent with these data, our study found a significant increase in the mean arm circumference of patients taking SSRI/SNRI drugs compared to those who did not use these drugs. This suggests that SSRI/SNRI drugs may lead to weight gain in the geriatric population and should be used with caution, particularly in obese geriatric patients (23).

In individuals using SGLT2 inhibitors, the average calf circumference was significantly lower than those who did not use these medications. The group of patients using SGLT2 inhibitors and metformin had a significantly lower BMI than those who did not. It is believed that the insulin-sensitizing effect of metformin and the weight loss effect of SGLT2 inhibitors contribute to this result. Similar to these findings, the literature shows a significant negative correlation between metformin/SGLT2 inhibitors and BMI (24,25).

In our study, which involved femoral neck and lumbar L1-L4 vertebrae bone density measurements using DEXA in a geriatric population, no significant differences were found between albumin, transferrin, CRP, monocyte, and IL-6 levels in normal, osteopenic, and osteoporotic groups. However, the literature suggests a significant relationship between increased IL-6 levels and osteoporosis, which was not observed in our study, potentially due to limitations such as the inclusion of only geriatric individuals, and a relatively small sample size compared to previous studies (26,27).

CONCLUSION

Our study data revealed that obesity is a significant public health concern, which can trigger various inflammatory processes and increase inflammatory markers. While the direct relationship between IL-6 and obesity remains unclear, our study suggests that IL-6 plays a role in many indirect inflammatory processes triggered by obesity. However, our limited sample size, multiple comorbidities in the geriatric population, and the use of various medications that could limit study data have made it challenging to obtain more precise and significant results.

Further studies are required to elucidate the relationship between IL-6 and laboratory parameters, obesity, and osteoporosis.

ETHICS

Ethics Committee Approval: The study was approved by the Ethics Committee of Bakırköy Dr. Sadi Konuk Training and Research Hospital for Clinical Research (decision number: 2022-10-15, date: 23.05.2022).

Informed Consent: Written informed consent was obtained from all participants before they participated in the study, and their rights and welfare were protected throughout the study.

FOOTNOTES

Authorship Contributions

Surgical and Medical Practices: D.Y., N.I., Consept: E.Ş., N.I., Design: D.Y., E.E., N.I., F.K., Data Collection or Processing:

E.Ş., E.E., F.K., Analysis or Interpretation: E.E., F.K., F.A., Literature Search: E.Ş., F.A., Writing: D.Y., F.A.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declare that this study was financially supported by the hospital budget, as approved by the expert board (TUEK) under the decision documented as Ao E-14679818-771.

Acknowledgment

I want to express my thanks to Associate Professor B.E., who provided valuable support in organizing and supervising the study.

REFERENCES

1. Akira S, Taga T, Kishimoto T. Interleukin-6 in biology and medicine. Adv Immunol. 1993;54:1-78.
2. Avci AB, Feist E, Burmester GR. Targeting IL-6 or IL-6 receptor in rheumatoid arthritis: What's the difference? BioDrugs. 2018;32:531-46.
3. Choy EH, De Benedetti F, Takeuchi T, et al. Translating IL-6 biology into effective treatments. Nat Rev Rheumatol. 2020;16:335-45.
4. Ferrucci L, Corsi A, Lauretani F, et al. The origins of age-related proinflammatory state. Blood. 2005 Mar 15;105:2294-9.
5. Jensen GL, Mirtallo J, Compher C, et al. Adult starvation and disease-related malnutrition: a proposal for etiology-based diagnosis in the clinical practice setting from the International Consensus Guideline Committee. JPEN J Parenter Enteral Nutr. 2010;34:156-9.
6. Das UN. Is obesity an inflammatory condition? Nutrition. 2001;17:953-66.
7. Yudkin JS, Kumari M, Humphries SE, Mohamed-Ali V. Inflammation, obesity, stress and coronary heart disease: is interleukin-6 the link? Atherosclerosis. 2000;148:209-14.
8. Visser M, Bouter LM, McQuillan GM, Wener MH, Harris TB. Elevated C-reactive protein levels in overweight and obese adults. JAMA. 1999;282:2131-5.
9. Bulló-Bonet M, García-Lorda P, López-Soriano FJ, Argilés JM, Salas-Salvadó J. Tumour necrosis factor, a key role in obesity? FEBS Lett. 1999;451:215-9.
10. Harrison's Principles of Internal Medicine. (2015). Table 121-2. (pp. 612).
11. Kıskaç M, Soysal P, Smith L, Capar E, Zorlu M. What is the optimal body mass index range for older adults? Ann Geriatr Med Res. 2022;26:49-57.
12. Khaodhiar L, Ling PR, Blackburn GL, Bistrian BR. Serum levels of interleukin-6 and C-reactive protein correlate with body mass index across the broad range of obesity. JPEN J Parenter Enteral Nutr. 2004;28:410-5.
13. Kobune M, Kohgo Y, Kato J, Miyazaki E, Niitsu Y. Interleukin-6 enhances hepatic transferrin uptake and ferritin expression in rats. Hepatology. 1994;19:1468-75.
14. Jalili V, Poorahmadi Z, Hasanpour Ardekanizadeh N, et al. The association between obesity with serum levels of liver enzymes, alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase and gamma-glutamyl transferase in adult women. Endocrinol Diabetes Metab. 2022;5:e367.
15. Ali N, Sumon AH, Fariha KA, et al. Assessment of the relationship of serum liver enzymes activity with general and abdominal obesity in an urban Bangladeshi population. Sci Rep. 2021;11:6640.
16. Womack J, Tien PC, Feldman J, et al. Obesity and immune cell counts in women. Metabolism. 2007;56:998-1004.
17. El-Mikkawy DME, El-Sadek MA, El-Badawy MA, Samaha D. Circulating level of interleukin-6 in relation to body mass indices and lipid profile in Egyptian adults with overweight and obesity. Egypt Rheumatol Rehabil. 2020;47:7.
18. Musa IR, Omar SM, Adam I. Mid-upper arm circumference as a substitute for body mass index in the assessment of nutritional status among adults in eastern Sudan. BMC Public Health. 2022;22:2056.
19. Northuis CA, Murray TA, Lutsey PL, et al. Body mass index prediction rule for mid-upper arm circumference: the atherosclerosis risk in communities study. Blood Press Monit. 2022;27:50-4.
20. Bologa RM, Levine DM, Parker TS, et al. Interleukin-6 predicts hypoalbuminemia, hypocholesterolemia, and mortality in hemodialysis patients. Am J Kidney Dis. 1998;32:107-14.
21. Sancéau J, Falcoff R, Beranger F, Carter DB, Wietzerbin J. Secretion of interleukin-6 (IL-6) by human monocytes stimulated by muramyl dipeptide and tumour necrosis factor alpha. Immunology. 1990;69:52-6.
22. Chomarat P, Banchereau J, Davoust J, Palucka AK. IL-6 switches the differentiation of monocytes from dendritic cells to macrophages. Nat Immunol. 2000;1:510-4.
23. Gafoor R, Booth HP, Gulliford MC. Antidepressant utilisation and incidence of weight gain during 10 years' follow-up: population based cohort study. BMJ. 2018;361:k1951.
24. Cheong AJY, Teo YN, Teo YH, et al. SGLT inhibitors on weight and body mass: A meta-analysis of 116 randomized-controlled trials. Obesity (Silver Spring). 2022;30:117-28.
25. Pu R, Shi D, Gan T, et al. Effects of metformin in obesity treatment in different populations: a meta-analysis. Ther Adv Endocrinol Metab. 2020;11:2042018820926000.
26. Toker A, Aksoy H, Borekci B, Ozkan A. Correlations of serum IL-6 levels and prolidase activity between bone turnover markers and bone mineral density in postmenopausal women with and without osteoporosis. Turk J Med Sci. 2007;37:129-34.
27. Jeedigunta Y, Sultana S, Kalashikam RR, Manchala R. Systemic inflammation: A risk factor for osteoporosis in pre- and post-menopausal women. J Women's Health Dev. 2020;3:423-31.