

The Effect of Smoking on Hematological Parameters

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Introduction: The purpose of this study was to investigate the effects of smoking on hematological parameters.

Materials and Methods: A total of 295 participants who were older than 18 years of age, did not have any known diseases, applied to our clinics for check-ups, and had no diseases revealed in their check-up procedures were included in the study.

Results: Compared to the non-smokers, the smokers had higher levels of hemoglobin (15.6 g/dL vs. 13.5 g/dL, respectively; $p < 0.001$), mean corpuscular volume (MCV) (88.1 fL vs. 83.4 fL, respectively; $p < 0.001$), white blood cell (WBC) count ($9 \times 10^3/\mu\text{L}$ vs. $6.95 \times 10^3/\mu\text{L}$, respectively; $p < 0.001$), neutrophil count ($5.4 \times 10^3/\mu\text{L}$ vs. $4.1 \times 10^3/\mu\text{L}$, respectively; $p < 0.001$), lymphocyte count ($2.5 \times 10^3/\mu\text{L}$ vs. $2 \times 10^3/\mu\text{L}$, respectively; $p < 0.001$), monocyte count ($0.7 \times 10^3/\mu\text{L}$ vs. $0.5 \times 10^3/\mu\text{L}$, respectively; $p < 0.001$), and eosinophil count ($0.2 \times 10^3/\mu\text{L}$ vs. $0.1 \times 10^3/\mu\text{L}$, respectively; $p < 0.001$). There was a significant positive correlation between smoking time and MCV ($r = 0.155$, $p = 0.038$), WBC count ($r = 0.179$, $p = 0.016$), neutrophil count ($r = 0.147$, $p = 0.049$), and monocyte count ($r = 0.150$, $p = 0.046$). There was a positive correlation between the number of cigarettes smoked per day and hemoglobin level ($r = 0.275$, $p < 0.001$) and MCV ($r = 0.149$, $p = 0.046$).

Conclusion: We found that hematological parameters, particularly hemoglobin level and WBC count, were affected in smokers compared to non-smokers.

Keywords: Hematological parameters, hemoglobin, platelet, smoking, white blood cell

Introduction

According to World Health Organization data, about 5 million people around the world die from smoking-related diseases each year (1). The rate is much higher in developing countries. Despite this high mortality rate, the number of smokers is also increasing every day. It is believed that there are 4.5 billion smokers

in the world and this will increase up to about 7.1 billion by 2025 (2).

A cigarette contains about 4,000 compounds that can cause cellular-level damage in the human body (3). Among these compounds, free radicals, nicotine, and carbon monoxide are believed to be responsible for the worst

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pharmacological effects of smoking. These compounds are often thought to be associated with cancer, lung diseases, and cardiovascular diseases (3). However, compounds mentioned above play a role in the etiopathogenesis of many other diseases, as well.

The formation of hematological components begins in the bone marrow and they continue to mature in the peripheral blood tissue. Therefore, they are affected by many harmful compounds that cause damage to the bone marrow and peripheral blood tissue. Tobacco contains many such harmful compounds. There is a limited number of studies in the literature investigating the effects of smoking on hematological parameters. Some of these studies investigated a limited number of hematological parameters and some have contradictory results. Therefore, the purpose of this study is to perform a comprehensive investigation of the effects of smoking on hematological parameters.

Materials and Methods

This study was conducted in the Hematology and Internal Medicine Clinics of Adana Education and Research Hospital, University of Health Sciences. A total of 295 participants who were older than 18 years of age, did not have any known diseases, applied to our clinics for check-ups, and had no diseases revealed in the check-up procedure were included in the study.

Patients admitted to our clinic for check-ups were excluded from the study in the following cases: those with any known acute/chronic disease; those being followed for iron deficiency, vitamin B12 deficiency, or folate-deficiency anemia; and those using vitamin supplements, antioxidants, or anticoagulant/antiaggregant drugs. Clinical and demographic

characteristics (gender, age, smoking time, and the number of cigarettes smoked per day) and laboratory findings (hematological parameters incomplete blood count) of the participants were taken from patient files. The neutrophil/lymphocyte ratio (NLR) was calculated by comparing neutrophil count to the lymphocyte count in the same units. The individuals with hemoglobin levels of >16.5 g/dL in men and >16 g/dL in women were checked for poly cythemia vera. The study was approved by the Ethics Committee of the Faculty of Medicine of Çukurova University.

Statistical analysis

SPSS for Windows 20 (IBM Corp., Armonk, NY, USA) was used for statistical analysis. The normal distribution of the data was evaluated using the Kolmogorov-Smirnov. The variables with normal distribution were presented as mean±standard deviation and the variables with non-normal distribution were presented as median (min-max). The categorical variables were given as number and percentage. Spearman correlation analysis was used for correlation analysis. All p-values were 2-sided with statistical significance at 0.05.

Results

The detailed clinical and demographic findings of the study population are given in Table-1. The ratio of female participants was higher in the non-smoker group, while the ratio of male participants was higher in the smoker group. There was no difference between the groups in terms of median age (smokers: 40 years (19-78) vs. non-smokers: 35 years (18-78); $p=0.583$). The smoking rate was higher among the male participants compared to the female participants [120(67%) vs. 59(33%)], respectively; $p=0.037$.

Table-1. The characteristic of smokers and non-smokers

Variables	Smokers n=179	Non-smokers n=116	P value
Gender, n, (%)			
Female	59 (33)	53 (45)	0.037
Male	120 (67)	63 (55)	
Age, (years)	40 (19-78)	35 (18-75)	0.583
The number cigarette, (day)	20 (2-60)	-	-
Duration of smoking, (years)	20 (1-65)	-	-

The laboratory findings of the study population showed that the smokers had higher levels of hemoglobin (15.6 g/dL vs 13.5 g/dL, respectively; $p < 0.001$), mean corpuscular volume (MCV) (88.1 fL vs. 83.4 fL, respectively; $p < 0.001$), white

blood cell (WBC) count ($9 \times 10^3/\mu\text{L}$ vs. $6.95 \times 10^3/\mu\text{L}$, respectively; $p < 0.001$), neutrophil count ($5.4 \times 10^3/\mu\text{L}$ vs $4.1 \times 10^3/\mu\text{L}$, respectively; $p < 0.001$), lymphocyte count ($2.5 \times 10^3/\mu\text{L}$ vs. $2 \times 10^3/\mu\text{L}$, respectively; $p < 0.001$), monocyte count ($0.7 \times 10^3/\mu\text{L}$ vs. $0.5 \times 10^3/\mu\text{L}$, respectively; $p < 0.001$), and eosinophil count ($0.2 \times 10^3/\mu\text{L}$ vs $0.1 \times 10^3/\mu\text{L}$, respectively; $p < 0.001$) compared to the non-smokers. There was no significant difference in terms of other parameters (Table-2).

The relationships between smoking time and number of cigarettes smoked day and hematological parameters are shown in Table-3 in detail. There was a significant positive correlation between smoking time and

Table-2. The comparison of hematological parameters in the cigarette smokers and the non-smokers

Variables	Smokers n=179	Non-smokers n=116	P-value
Hemoglobin, (gr/dL)	15.6 (8.4-19.5)	13.5 (9.4-16.6)	<0.001
MCV, (fL)	88.1 (60.8-108.7)	83.4 (57.2-99)	<0.001
Platelet, ($\times 10^3/\mu\text{L}$)	242 (109-666)	235 (100-490)	0.488
WBC, ($\times 10^3/\mu\text{L}$)	9 (3.5-27.8)	6.95 (3.6-13.2)	<0.001
Neutrophil, ($\times 10^3/\mu\text{L}$)	5.4 (1.1-15)	4.1 (1.4-9.8)	<0.001
Lymphocyte, ($\times 10^3/\mu\text{L}$)	2.5 (0.7-19.9)	2 (0.9-4.1)	<0.001
Monocyte, ($\times 10^3/\mu\text{L}$)	0.7 (0.3-1.4)	0.5 (0.2-8)	<0.001
Eosinophils, ($\times 10^3/\mu\text{L}$)	0.2 (0-1.5)	0.1 (0-0.9)	<0.001
NLR	2.02 (0.22-10.71)	2.12 (0.61-5.4)	0.554
Fibrinogen, (g/L)	372 (177-606)	318 (201-545)	0.179

Abbreviations: WBC: White Blood Cell, NLR: Neutrophile to Lymphocyte Ratio

Table-3. The correlation of the hematological parameters with the duration of smoking and number of cigarette/day

Variables	Duration of cigarette smoking		The number of cigarettes	
	r value	P value	r value	P value
Hemoglobin, (gr/dL)	0.067	0.376	0.275	<0.001
MCV, (fL)	0.155	0.038	0.149	0.046
Platelet, ($\times 10^3/\mu\text{L}$)	0.06	0.427	-0.042	0.581
WBC, ($\times 10^3/\mu\text{L}$)	0.179	0.016	0.029	0.698
Neutrophil, ($\times 10^3/\mu\text{L}$)	0.147	0.049	0.031	0.676
Lymphocyte, ($\times 10^3/\mu\text{L}$)	0.119	0.113	-0.014	0.848
Monocyte, ($\times 10^3/\mu\text{L}$)	0.150	0.046	0.092	0.22
Eosinophils, ($\times 10^3/\mu\text{L}$)	0.072	0.338	0.027	0.719
NLR	0.048	0.525	0.043	0.566
Fibrinogen, (g/L)	0.13	0.436	-0.06	0.723

Abbreviations: MCV: Main Corpuscular volume, WBC: White Blood Cell, NLR: Neutrophile to Lymphocyte Ratio

MCV ($r=0.155$, $p=0.038$), WBC count ($r=0.179$, $p=0.016$), neutrophil count ($r=0.147$, $p=0.049$), and monocyte count ($r=0.150$, $p=0.046$). There was also a positive correlation between the number of cigarettes smoked per day and hemoglobin level ($r=0.275$, $p<0.001$) and MCV ($r=0.149$, $p=0.046$).

Discussion

We found that levels of hemoglobin, MCV, WBC count, neutrophil count, lymphocyte count, monocyte count, and eosinophil count were higher in the smoker group compared to the non-smoker group. There was a significant positive correlation between smoking time and MCV, WBC count, neutrophil count, and monocyte count. A positive correlation was also found between the number of cigarettes smoked per day and the hemoglobin and MCV.

Smoking causes destruction at a cellular level in all tissues due to the harmful molecules that cigarettes contain. Nicotine triggers the formation of clots in coronary vascular structures, causing endothelial dysfunction (4). Increased carboxyhemoglobin levels due to smoking lead to hypoxia as well as increased vascular permeability and lipid accumulation, resulting in endothelial edema. Increased levels of free radicals and peroxides in smokers increase the synthesis of prostaglandins and thromboxane, and they contribute to the development of chronic inflammatory diseases, carcinogenesis, and atherosclerosis (3). In addition to these harmful compounds, several other molecules in tobacco cause destruction at a cellular level. Recently, researchers have been showing more interest in the effects of smoking on hematological parameters.

Similar to our study, Aula et al. found higher WBC, neutrophil, eosinophil, monocyte, and

lymphocyte counts in smokers compared to non-smokers(5). Nadia et al. found hemoglobin levels and WBC counts to be higher in smokers compared to non-smokers, but they did not find a significant difference in terms of MCV (6). Malenica et al. found levels of hemoglobin, WBC count, and MCV to be significantly higher in smokers compared to non-smokers, but there was no significant difference in terms of lymphocyte and monocyte counts (3). We believe that increased hemoglobin and WBC counts in smokers are associated with increased hypoxia due to carbon monoxide and other molecules (7, 8). The synthesis of erythropoietin in renal capillary tubular cells increases in response to hypoxia. The WBC, platelet, and red blood cell production in bone marrow increases due to stimulation by erythropoietin. This, in turn, leads to increased hemoglobin levels (9). The strength of our study compared to the studies mentioned above is that levels of granulocytic and agranulocytic series cells, subgroups of leukocytes, were also higher in smokers. Because we know that smoking increases chronic inflammation (10), causes catecholamine discharge from the adrenal medulla (11), and leads to ischemia or ischemic reperfusion damage due to increased carboxy hemoglobin levels (12), an increase in leukocyte series is expected due to all these factors.

In terms of MCV, different results have been obtained in various studies. In our study, we found smokers to have higher MCV; however, there was no difference between groups in other studies (6). There may be several possible explanations for this situation. The patients included in these studies may have had different B12 and folic acid levels. Similarly, there may be a difference in terms of carboxyhemoglobin levels.

Cho et al. found higher fibrinogen levels in smokers, unlike our study (13). Actually, since smoking triggers atherosclerosis and chronic inflammation, increased fibrinogen levels are expected in smokers. Similarly, Tomoyuki et al. (14) found higher fibrinogen levels in smokers and there was also a positive correlation between increased smoking and fibrinogen levels. Everett et al. found that black smokers and non-smokers had higher fibrinogen levels than non-black smokers and non-smokers (15). We found no difference between the smoker group and the non-smoker group in terms of fibrinogen levels, which might be related to other risk factors (e.g., cigarette brands and the amounts, types, and levels of toxic substances in their contents) (16).

Lakshmi et al. (17) and Whitehead et al. (18) showed that hemoglobin increases depending on the number of cigarettes smoked per day. Tomoyuki et al. (14) also found an association between the number of cigarettes smoked per day and the WBC count. Similar to these studies, we found relationships between smoking time and the number of cigarettes smoked per day and hematological parameters. This is believed to be associated with greater and longer exposure to the toxic compounds in tobacco. In our study, there was no significant difference between the smoker group and the non-smoker group in terms of NLR Gumus et al., on the other hand, found this ratio, which is considered to be an indicator of chronic inflammatory processes, to be higher in the smoker group (19).

The limitations of our study include its retrospective design and the limited number of participants included in the study in order to investigate the effects of smoking on hematological parameters, although smoking

affects the entire society and tobacco is very widely consumed. Another limitation of the study is that we did not have any information about what brands of cigarettes were consumed by the smoker group or about their preferred smoking method (pipes, cigars, cigarettes, hand-rolled cigarettes, etc.). In addition, our lack of information about the smokers' chronic inflammation markers, reactive oxygen species markers, and toxic substance levels was another limitation.

In conclusion, we found that hematological parameters, particularly hemoglobin level and WBC count, were affected in smokers compared to non-smokers. We also found that this might be specifically related to smoking time and the number of cigarettes smoked per day. Prospective randomized controlled trials are needed to explain the possible reasons why hematological parameters differ in this way between smokers and non-smokers.

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Conflict of Interests

The authors have declared no conflict of interest for the present article.

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