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Original Research Article

The Effects of Cigarette Smoking on Haematological and Biochemical Parameters Among Healthy Adult Males

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ABSTRACT

Cigarette smoking is one of the main reasons of death and lung cancers worldwide, as haematological parameters, lipids and calcium are variously affected by it. The aim of the current study is to measure the unfavourable effects of cigarette smoking on haematological and biochemical characteristics in healthy adult males. This case-control study was conducted on 120 healthy selected male smokers and nonsmokers whose ages ranged between 20 and 40 years old. The first group consisted of 60 smokers, while the second consisted of 60 nonsmokers. The participants of both groups did not have any history of chronic illness and had comfort routine screening. Complete blood cell (CBC) count, lipids and calcium were measured. A significant difference in khat chewing among these two groups was with higher frequencies in smokers than nonsmokers (60 vs. 49, P = 0.001). Exercise activity was less common in smokers than nonsmokers (25 vs. 38, P = 0.017). Khat chewing hours were higher in smokers as compared to nonsmokers (6.13 ± 2.02 vs. 4.57 ± 2.22, P<0.001). Work hours showed an insignificant difference between the two groups. Lymphocytes and neutrophils are significantly different between the study groups, P=0.011 vs. P=0.017, respectively. RBCs indices such as MCV and MCH are also significantly different between smokers and nonsmokers. In conclusion, the study revealed that continuous cigarette smoking had severe adverse effects on total cholesterol and calcium levels. Furthermore, some haematological parameters such as WBCs, platelets, lymphocytes, and neutrophils were affected significantly in the adult smoking males.

Keywords: Cigarette smoking, Complete blood count, Lipids, Calcium.

Introduction

Smoking is a leading preventable cause of death worldwide.[1] The smoke produced from the tobacco cigarette provides acidic pH, which causes reduction of nicotine absorption in the oral cavity, thus gaining a larger quantity of inhaled nicotine. After inhalation, the cigarette smoke occupies a larger surface area of the lung needed by the smoker to satisfy his addiction.[2] Tar is a harmful constituent of cigarette smoke which contains many chemicals dangerous for human body. It gains its access to the blood vessels and gets carried to almost every part of the body and is responsible for various types of lung cancer, chronic obstructive pulmonary disease, besides heart disease.[3]

Also, cigarette smoke contains carbon monoxide, which hampers oxygen carrying capacity of the blood, thus reducing its supply to different tissues and organs in the body. The reduced carrying capacity of oxygen could be harmful, particularly during the period of pregnancy, as it causes a decrease in oxygen supply to the growing foetus, which might lead to harmful conditions.[4]

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As for the prevalence of smoking, more than 1.1 billion people smoked tobacco in 2015 with more males than females.[5] The prevalence estimates presented in this study were calculated using a statistical model that adjusts the survey data to obtain comparable estimates. To minimize this issue in the future, World Health Organization (WHO) has developed a standard set of tobacco survey questions, which might be used in any survey.[6]

Cigarette smoking contributes to the development or progression of numerous chronic and age-related disease processes. Two major risk factors for morbidity and mortality among smokers are cardiovascular disease and lung cancer. Haematological abnormalities have been associated with coronary heart disease and other oxidative damage at the tissue level, which increase with age and are significantly associated with higher haemoglobin concentrations. In their study, Whitehead et al. observed that haemoglobin concentration and hematocrit were significantly increased in those smoking more than 10 cigarettes per day leading to excessive carbon monoxide (CO) exposure.[7] Consequently, carboxyhaemoglobin levels increase with the number of cigarettes consumed per dayproducing a progressive hypoxemia,as the CO binds with Hband functional anemia is produced. This causes impaired oxygenation of tissues and changes in haematologicl parameters.[8,9] In addition to the number of cigarettes smoked per day, the duration of chronic exposure to HbCO correlates with the development of polycythemia.[10,11]

mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) are three main red blood cell indices that help in measuring the average size and haemoglobin composition of the red blood cells. MCV indicates the size of the red blood cell and the presence of red cells smaller or larger than normal size means the person has anemia. MCH is the average weight of haemoglobin that is present inside

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single red blood cell, whereas MCHC denotes the amount of haemoglobin in a specific volume of 'packed' red corpuscles or cells.[12]Lipids play an important role in virtually all aspects of biological life. Some of these roles include serving as hormones or hormone precursors, helping digestion, providing energy, storage function and metabolic fuels. Smoking in different forms is a major risk factor for atherosclerosis and coronary heart disease.[13]
Cigarette leads to an increase in the concentration of serum total cholesterol, triglycerides, LDL-cholesterol, VLDL-cholesterol and fall in the levels of HDL-cholesterol.[14] There are various mechanisms that lead to lipid alteration by smoking. There are a wide variety of mechanisms by which smoking induces bone toxic effects. A decrease in intestinal calcium absorption, low body weight, and earlier menopausal age have been described.[15,16] The current study aimed to elucidate the unfavourable effects of cigarette smoking on haematological and biochemical characteristics in healthy adult males.

Materials and Methods

Study subjects
This case-control study was performed on 120 healthy selected males matched smokers and nonsmokers whose ages range between 20 and 40 years old. The first group consisted of 60 smokers, while the second consisted of 60 nonsmokers. The participants of both groups did not have any history of chronic illness and had comfort routine screening. All subjects (smokers and nonsmokers) were selected randomly from different populations including students, teachers, and farmers from different areas in Ibb province, Yemen. The subjects who had not acute infections, chronic diseases, or acute bleeding were included in the study. Each participant was interviewed and asked to complete a questionnaire with questions about person's habitual behaviours, including khat chewing, daily coffee drinks, hard work, and daily exercise. Patient's age, body weight (kg), height (cm), and blood pressures were measured. The subjects who suffered from any diseases were excluded. The study was done at Naser General Hospital, Ibb province, Yemen.

Ethical Clearance

The study was approved by Ibb University, Ibb, Yemen (No. 2117-8)

Laboratory measurements
Blood samples were collected in two types of tubes: first tube k3-EDTA tube for CBC estimation and another tube (without anticoagulation agent) to obtain serum for biochemical analysis including total cholesterol, triglyceride, and calcium. All blood samples were collected from every subject after overnight fasting. Complete Blood Count (CBC) was measured by a CBC device made by Sysmex Company. CBC was measured immediately after blood sampling, which evaluates WBC count, RBC count, haemoglobin, platelets, PCV, MCV, MCH, and MCHC. Calcium was measured using *o*-cresolphtalein to form a complex compound, which at alkaline pH can yield a red colored complex, whose intensity is proportional to the calcium concentration. Enzymatic colorimetric methods were used to quantitate total cholesterol and triglyceride levels based on the manufacturer instructions.

Statistical analysis
Frequency tables were used for descriptive statistics. Categorical variables were compared using the *Chi*-square test. The three study groups were compared using One-way analysis of variance (ANOVA) test. Independent sample t-test was used for quantitative comparison between two groups. Quantitative baseline characteristics are presented as mean ± standard deviation. A p-value of < 0.05 was considered statistically significant. Statistical analysis was performed using SPSS version 22.

Results and Discussion

Lifestyle habits of the study groups
Lifestyle behaviours of the smoker and nonsmoker groups were compared. Table 1 presents a comparison between the persons' behaviours, including daily exercise, hard work, khat chewing, enough daily drinks and use of drug stimulants. Table 1 and Figure 1 show significant differences in khat chewing among these two groups with higher frequencies in smokers than nonsmokers (60 vs. 49, P = 0.001). It is expected that smokers have a significantly higher percentage of khat consumption than non-smokers as khat use habit is often accompanied with smoking. A previous study on male smokers proved more than half of them who chew khat reported that they smoke to improve the effects of khat.[17] On the other hand, the exercise activity was less common in smokers than nonsmokers (25 vs. 38, P = 0.017) as seen in Figure 2A. Other lifestyle behaviours have similar frequencies (P > 0.05). For example, the frequency of hard workers was similar in both smoker and nonsmoker groups (Figure 2B). As shown in Table 2, body mass index (BMI) was higher in smokers as compared to non-smokers (P = 0.002). A previous work reported the effect of lifetime smoking, smoking initiation, and smoking heaviness on BMI.[18]Such findings were also observed in our results as male subjects with increased BMI were from the smoker category. These results were supported by other researchers, which show that smoking cessation leads to weight gain and the amount gained varies greatly between individuals.[19,20] A more recent Mendelian randomization (MR) study found that BMI has a causal effect on smoking behaviour.[21]

Demographic and biochemical parameters in smokers and nonsmokers
The effects of cigarette smoking on the hours spent during khat use and daily hard work are shown in Table 2. There is a significant difference in the khat chewing hours between the study groups with increased khat chewing hours in smokers as compared to nonsmokers (6.13 ± 2.02 vs. 4.57 ± 2.22, P<0.001). Work hours showed insignificant difference between smokers and non-smokers. (P=0.43). As revealed in Table 2 and Figure 3, there is a significant difference in the total cholesterol level between smokers and non-smokers (185.4 ± 38.4 vs. 169.8 ± 40.6, P = 0.04).

Table 1: Frequency of lifestyle behavior in smokers and nonsmokers

Parameter		Smokers (N = 60)	Nonsmokers (N = 60)	*P* value
Daily hard work	Yes	19	25	0.31
	No	41	35	
Exercise	Yes	25	38	0.017
	No	35	22	
Drug Stimulant	Yes	8	7	0.78
	No	52	53	
Daily khat Chewing	Yes	60	49	0.001
	No	0	11	
Enough daily drinks	Yes	52	55	0.38
	No	8	5	

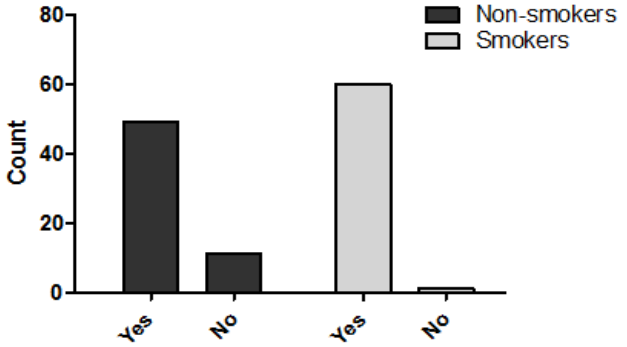

Figure 1: Frequency of daily khat chewers among smokers and nonsmokers.

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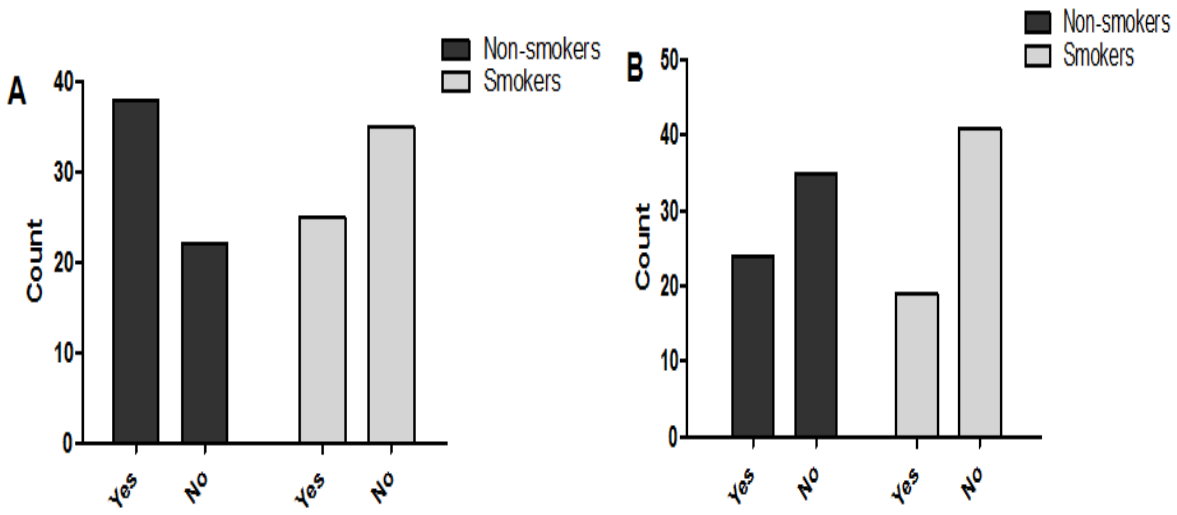

Figure 2: Frequencies of daily exercise activity (a) and hard work (b) among study groups.

Table 2: Values of the demographic parameters and biochemical tests among smokers and nonsmokers

Parameter	Group	Mean	Standard Deviation	*P* value*
Age (years)	Smokers	29.4	6.3	0.16
	Nonsmokers	27.7	6.6	
Khat use (hrs/day)	Smokers	6.13	2.02	<0.001
	Nonsmokers	4.57	2.22	
Hard Work (hrs/day)	Smokers	6.06	3.34	0.43
	Nonsmokers	6.53	2.48	
Systolic blood pressure (mmHg)	Smokers	118.2	8.4	0.93
	Nonsmokers	118.0	13.8	
Systolic blood pressure (mmHg)	Smokers	76.2	8.8	0.21
	Nonsmokers	74.1	8.5	
Body Mass Index, BMI (kg/m^2)	Smokers	22.95	3.28	0.002
	Nonsmokers	20.88	3.52	
Coffee (cups/day)	Smokers	4.29	2.30	0.77
	Nonsmokers	4.41	2.24	
Triglyceride (mg/dl)	Smokers	179.4	50.1	0.92
	Nonsmokers	180.5	60.6	
Total Cholesterol (mg/dl)	Smokers	185.4	38.4	0.04
	Nonsmokers	169.8	40.6	
Calcium (mg/dl)	Smokers	7.84	1.42	0.011
	Nonsmokers	8.48	1.17	

*Significant difference between the two groups if P value < 0.05.

In addition, calcium levels are significantly lower in smokers (7.84 ± 1.42) than non-smokers (8.48 ± 1.17, P=0.011). The mean levels of triglyceride were similar in both groups.

Our findings clearly reveal that cigarette smoking has severe adverse effects on biochemical tests (e.g. Total cholesterol and Calcium), besides other factors such as; Khat use and body mass index. Previous works revealed that cigarette smoking increased total cholesterol, low-density lipoprotein cholesterol (LDL-C) and triglycerides, but decreased high-density lipoprotein cholesterol (HDL-C) concentrations.[22] In addition, Acrolein found in cigarettes, interferes with LDL that hampers the enzyme responsible for LDL protection. This enzyme is essential and its absence makes LDL susceptible to oxidation that leads to alter its molecular structure resulting in cells that could not recognize LDL.[23] The presence of oxidized LDL in the bloodstream induces the risk of heart attack or stroke. Besides, smoking has an impact on lower levels of high-density lipoprotein (HDL) for it reduces its protective effects against heart disease.[24]

The above results also revealed that smokers have an elevated level of calcium compared with non-smokers. The blood supply to the bones and other tissues is decreased, due to cigarette smoking. The nicotine in cigarettes negatively affects the production of osteoblasts cells that play a role in the production of bone cells. This results in reducing body's absorption of calcium in smoking individuals, which is a necessary mineral for vital cellular functions and healthy bone.[25]

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Comparison of haematological characteristics in the study groups

As Table 3 and Figure 4 show, there is a significant difference (P = 0.023) between mean platelet count in smokers and non-smokers, 294.7± 66.3 vs. 267.0 ± 60.3, respectively. WBCs counts are significantly higher in cigarette smokers (7.07± 2.08) than nonsmokers (6.03± 2.27, P = 0.014). Furthermore, the percentages of lymphocytes and neutrophils are significantly different between the study groups, P = 0.011 vs. P = 0.017, respectively. Although RBCs count, haemoglobin, PCV, and MCHC did not reveal any differences between the two groups (P > 0.05), other RBCs indices such as MCV and MCH are significantly different between smokers and nonsmokers. Findings of the current study clearly show that cigarette smoking has severe adverse effects on haematological parameters (e.g. platelets, white blood cell count, MCV, MCH, lymphocytes and neutrophils). It has been found in a previous that smoking impairs fibrin crosslinking, resulting in thrombogenic state, which contributes to the pathophysiology of acute coronary syndromes.[26] Adult male smokers and non-smokers had no significant difference in the values of the total erythrocyte count, haemoglobin, PCV and MCHC. This study also revealed that both hematocrit, Hb level and the RBC count were not statistically significant and these results differ from previous researches.[5,27] Increase in haemoglobin concentration was seen, but not significantly; this could be caused by exposure to carbon monoxide. Oxygen carrying capacity is directly affected as the inactive form of haemoglobin is caused when the carbon monoxide binds with Hb to form carboxyhaemoglobin. In addition, Hb dissociation curve shifted to the left side by the carboxyhaemoglobin leading to a decrease in the ability of Hb to deliver oxygen to tissues. Therefore, smokers maintain a higher haemoglobin level than non-smokers in order to compensate the reduced oxygen delivering capacity.[28] The red blood cell indices, including; MCV, MCH and MCHC are help in measuring the average size and haemoglobin composition of the red blood cells. Results of the present study obviously reveal that both MCV and MCH have significantly larger values among smokers, while there are no significant changes in the values of MCHC between smokers and non-smokers. Previous studies confirmed the increasing values of MCV and MCH in smokers compared with non-smokers.[9,29]

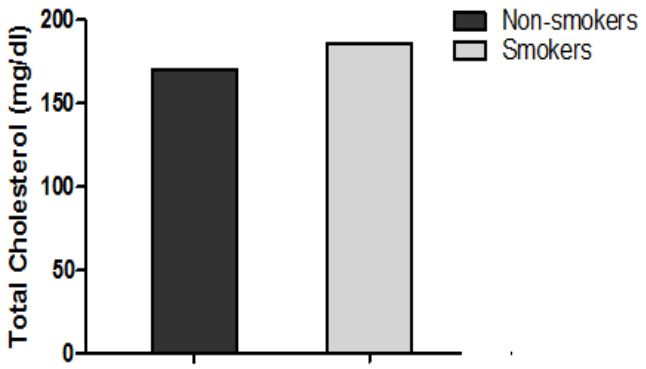

Figure 3: Comparison between total cholesterol levels in smokers and nonsmokers.

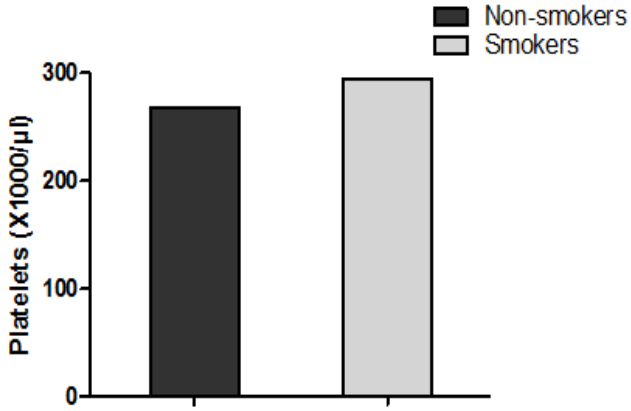

Figure 4: Comparison between platelets count in smokers and nonsmokers.

Table 3: Haematological indices in smokers and nonsmokers groups.

Parameter	Group	Mean	Std. Deviation	*P* value*
Platelets ($X10^3$/µl)	Smokers	294.7	66.3	0.023
	Nonsmokers	267.0	60.3	
WBCs ($X10^3$/µl)	Smokers	7.07	2.08	0.014
	Nonsmokers	6.03	2.27	
RBCs ($X10^6$/µl)	Smokers	5.60	0.65	0.26
	Nonsmokers	5.72	0.50	
Haemoglobin (g/dl)	Smokers	15.82	1.67	0.25
	Nonsmokers	15.12	4.16	
PCV (%)	Smokers	47.95	4.97	0.28
	Nonsmokers	47.04	3.43	
MCV(fl)	Smokers	84.75	4.58	0.006
	Nonsmokers	82.30	4.59	
MCH (pg)	Smokers	28.39	2.13	0.016
	Nonsmokers	27.36	2.32	
MCHC (g/dl)	Smokers	33.48	1.37	0.56
	Nonsmokers	33.32	1.52	
Lymphocytes (%)	Smokers	38.66	8.72	0.011
	Nonsmokers	43.72	11.65	
Neutrophils (%)	Smokers	49.80	9.90	0.017
	Nonsmokers	44.03	13.23	

WBCs: White blood cells, RBCs: Red blood cells, PCV: Packed cell volume, MCV: Mean corpuscular volume, MCH: Mean corpuscular haemoglobin, MCHC: Mean corpuscular haemoglobin concentration.

As MCV indicates the size of a red blood cell, the changes in RBC size, whether bigger or smaller than normal size, means the person anemic. Increasing the value of MCV in the current study indicates that smokers might suffer from profound megaloblastic, hemolytic, pernicious or macrocytic anemia, due to iron and folic acid deficiencies. These alterations might be associated with a greater risk for developing atherosclerosis, polycythemia vera, chronic obstructive pulmonary disease and/or cardiovascular diseases.

The current study also shows that smokers have a larger number of leukocytes which are statistically significant, compared with non-smokers. Earlier studies were also proved an increase in the total eukocyte count in adult smokers. As smoking plays a role in inducing leukocytosis through several factors, the exact mechanism is still not fully explained. Other researchers pointed out that nicotine may have a role in stimulating the release of catecholamine and steroid hormones besides some particular endogenous hormones, such as epinephrine and cortisol that result in inducing leukocyte count.[30,31] In addition, the increased number of leukocytes could be caused by an irritation of the respiratory tree because of cigarette smoke which leads to inflammation. These inflammatory stimulations of the respiratory tract have an impact on the number of white blood cells for they encourage the production of inflammatory markers in circulation such as cytokines.

Conclusion

The results of this study indicate that cigarette smoking has an adverse effect on total cholesterol and calcium levels. Furthermore, some haematological parameters such as WBCs, platelets, lymphocytes, and neutrophils were changed significantly in adult male smokers in comparison with those who are not.

Conflict of interests

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article are original and that any liability for claims relating to the content of this article will be borne by them.

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