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Effect of Cigarette Smoking on Haematological Parameters Among Male in Derna, Libya

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ABSTRACT

Smoking remains a major global health concern with well-documented systemic effects, including haematological alterations. However, regional studies are limited, especially within Libyan populations. This study aimed to investigate the impact of smoking on haematological indices among Libyan men in Derna. A comparative cross-sectional study was conducted involving adult male participants from Derna. Haematological parameters including red blood cell count (RBC), white blood cell count (WBC), haemoglobin concentration (Hb), haematocrit (Hct), platelet count, and mean corpuscular volume (MCV) were measured and statistically analysed. The 108 participants, 42 (38.9%) were smokers and 66 (61.1%) were non-smokers. The mean haemoglobin level was significantly higher in smokers (14.19 ± 0.93 g/dL) compared to non-smokers (13.66 ± 1.18 g/dL) with a p-value of 0.015, indicating a statistically significant difference. Other parameters such as RBC, WBC, MCV, MCH, MCHC, and PLT showed no significant differences between the two groups. Age and BMI were also found to be contributing factors in the variation of haematological values among smokers. Smoking is associated with measurable alterations in haematological parameters among Libyan men in Derna, with age and BMI playing additional roles. These findings highlight the importance of integrating haematological monitoring in smoking-related health assessments and reinforce the need for targeted public health interventions in this population.

Keywords: Cigarette Smoking, Haematological Parameters, Male, Derna, Libya.

تأثر تدخين السجائر على المعايير الدموية بين الرجال في مدينة درنة، ليبيا

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ملخـــــص البحـــــث

يُعد التدخين مشكلة صحية عالمية كبرى ذات تأثيرات جهازية متعدّدة، من بينها التغيرات الدموية. ورغم ذلك، تظل الدراسات الإقليمية حول هذه التأثيرات محدودة، خصوصًا في المجتمع الليبي. هدفت هذه الدراسة إلى تقييم تأثير التدخين على المؤشرات الدموية بين الرجال الليبيين في مدينة درنة. أُجريت دراسة مقطعية مقارنة شملت (108) مشاركًا من الذكور البالغين، حيث بلغ عدد المدخنين (42؛ 38.9%) مقابل (66 '61.1%) من غير المدخنين. جرى قياس مؤشرات دموية شملت: عدد كريات الدم

الحمراء (RBC) ، عدد كريات الدم البيضاء (WBC) ، تركيز الهيموغلوبين (Hb) ، نسبة الهيماتوكريت (Hct) ، عدد الصفائح الدموية (PLT) ، ومتوسط حجم الكرية (MCV) ، وخضعت النتائج للتحليل الإحصائي. أظهرت النتائج أن متوسط تركيز الهيموغلوبين كان أعلى بشكل ملحوظ لدى المدخنين (14.19 ± 0.93 جم/دل) مقارنة بغير المدخنين (13.66 ± 1.18 جم/دل) مع دلالة إحصائية ($p = 0.015$) بينما لم تُظهر باقي المؤشرات (RBC، WBC، MCV، MCH، MCHC، PLT) فروقًا ذات دلالة إحصائية بين المجموعتين. كما تبين أن العمر ومؤشر كتلة الجسم (BMI) من العوامل المساهمة في اختلاف القيم الدموية بين المدخنين. في الخلاصة يرتبط التدخين بحدوث تغيرات ملحوظة في بعض المؤشرات الدموية بين الرجال الليبيين في مدينة درنة، مع دور إضافي لكل من العمر ومؤشر كتلة الجسم. تؤكد هذه النتائج أهمية إدراج الفحوص الدموية ضمن التقييمات الصحية المتعلقة بالتدخين، وتدعم الحاجة إلى تدخلات صحية عامة موجهة لهذه الفئة من السكان.

الكلمات الدالة: تدخين السجائر ، المعايير الدموية، الرجال، مدينة درنة، ليبيا

1. Introduction

Tobacco Smoking is one of the leading causes of preventable morbidity and mortality worldwide. [1] It is well documented that tobacco smoking is risk factor for many diseases like: cancers, chronic respiratory and cardiovascular disease, but the association between smoking and hematological indices gets little attention. The ingredients in cigarette and water pipe (shisha) like nicotine leads to increase in leukocyte count [2,3]. The Role of nicotine is suggested to be either by stimulation of hormones secretion that leads to an increase in leukocyte count [4] or due to the irritant effect of smoke on the respiratory system leads to inflammation and synthesis of cytokines which can influence the increase in leukocyte count [5]. Those results are thought to take their effects in a dose-dependent manner.

On the other hand, a relevant note during cessation of smoking shows associated decrease in leukocyte count.[6] The longer people abstain from cigarettes the lower the leukocyte count gets Regarding the differential of WBCs: Neutrophils, Baso- phils, Eosinophils, Lymphocytes and monocytes counts the data is mostly inconsistent.[7]

Tobacco Smoking also affects red blood cells and hemoglobin. Hemoglobin and hematocrit are higher in smokers this increase in hemoglobin concentration is believed to be mediated by exposure of carbon monoxide and some scientists suggested that an increase in hemoglobin level in the blood of smokers could be a compensatory mechanism.[8,9]

Red blood cells count (erythrocyte count) and Hematocrit (PCV) are associated with blood viscosity and clot- ting in smokers. [10,11] Mean cell volume (MCV), Mean cell hemoglobin (MCH) and Mean cell hemoglobin con- centration (MCHC) are three main red blood cell indices that help in measuring the average size and hemoglobin composition of the red blood cells.

A conflicting study described the effect of smoking on the above parameters, greater values of MCV and MCH in smokers, in relation to non-smokers were confirmed by some studies.[12,13] Some reports an increase in MCV and a decrease in MCH and MCHC levels in smokers.[14]

Platelets is also an affected parameter Studies concluded that in smokers' plasma fibrinogen concentration and platelet count increase significantly. And a regular monitoring of these two parameters in smokers was advised.[15] Platelet count—just like WBCs count—also shows a respectful decrease with smoking cessation.[16]

In Libya, tobacco smoking remains a significant public health concern. In 2021, tobacco smoking caused 4,776 deaths in the country, of which 4,016 were among males and 760 among females. These deaths accounted for 10.29% of all fatalities, with 14.67% of male deaths and

3.99% of female deaths attributed to smoking. Compared to 2016, this shows a noticeable increase in the total number of smoking-related deaths, which was 3,620, with male and female deaths accounting for 3,130 and 490, respectively. The percentage of all deaths attributable to tobacco smoking decreased from 18.12% in 2016 to 10.29% in 2021.
According to 2009 data, adult daily smoking prevalence in Libya was 47.6% among males and just 0.1% among females, indicating a significantly higher
smoking rate among men. These figures highlight the urgent need for sustained public health efforts and regulatory interventions to mitigate the harmful effects of tobacco use in Libya.[17] Smoking remains a harmful behavior largely driven by nicotine addiction. Cigarettes contain numerous toxic substances, many of which are carcinogenic. The adverse effects of smoking extend to various biochemical and hematological processes, which can be detected through laboratory testing.[18]

1.1. Aim of study

This study aimed to investigate the impact of smoking on haematological indices among Libyan men in Derna.

1.2. Objective

- To compare hematological parameters between smokers and non-smokers**.**
- To determine the prevalence of hematological abnormality in Smoker.
- To assess the associated factors (Age and BMI) of haematological abnormality in smoker.

2. Materials and Methods

This descriptive analytical cross-sectional study was carried out between December 1, 2024, and January 30, 2025. The study population consisted of adult Libyan men aged 18 years and older. Data were collected using a structured questionnaire that obtained information on demographic characteristics (age, marital status, and economic status), anthropometric measurements (weight and height), smoking habits, and general health status. Laboratory investigations included hematological parameters such as red blood cell count (RBC), white blood cell count (WBC), hemoglobin (HGB), mean corpuscular volume (MCV),
mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and platelet count (PLT), all measured using a fully automated hematology analyzer. Participants were recruited through a non-probability convenience sampling method, and all provided information voluntarily. Individuals with a known history of blood disorders were excluded from the study.

2.1. Statistical analysis

Data were analysed using the Statistical Package for Social Sciences (SPSS) version 26. Continuous variables were presented as means and standard deviations, while categorical variables were presented as frequencies and percentages. Chi-square test was used for, categorical variables, and independent student's t-test was used for continuous variables. A p-value of <0.05 was considered statistically significant.

3. Results

A total of 108 male participants were included in the study. Participants' ages ranged from 18 to 71 years, with a mean age of 25.7±10.2 for both smokers and non-smokers. Most of participants 76 (70.4%) were under 25 years old. Most of participants, 86(79.6%) were single

and 96(88.9%) were in middle economic background. The mean weight of the participants was 71.36 ± 12.84 kg, ranging from 47 to 119 kg, and the mean height was 175.39 ± 7.62 cm, ranging from 153 to 190 cm. Most participants, 71 (65.7%), were of normal weight, 24 (22.2%) were overweight, and 13 (12%) were underweight with a mean of 23.49±5.13 (Table 1). None of the participants have a medical history of blood disorders.

Table 1: The Baseline characteristics of the study participants**.**

	No	%
Age		
<25	76	70.4
25-35	17	15.7
≥36	15	13.9
Marital status		
Divorced	1	0.9
Married	20	18.5
Single	86	79.6
Widowed	1	0.9
Economic status		
High	4	3.7
Middle	96	88.9
Poor	8	7.4
BMI		
Underweight	13	12.0
Normal weight	71	65.7
Overweight	24	22.2

Out of the participants, 42 (38.9%) were smokers and 66 (61.1%) were non-smokers. More than half of the smokers consumed 10 or more cigarettes daily with mean of 16.12±9.9 cigarettes daily, and the majority, 33 (78.6%), had been smoking for 10 years or more with a mean of 7.46±6.5 years.

45.4% of participants were always exposed to passive smoking, 45 (41.7%) were sometimes exposed, and 14 (13%) were rarely exposed (Table 2).

Table 2: Smoking habits among participants.

	No	%
Smoking		
Yes	42	38.9
No	66	61.1
Duration of smoking (in years)		
<10	33	78.6
≥10	9	21.4

Number of cigarettes smoked daily		
<10	17	40.5
≥10	25	59.6
Exposed to passive smoking		
Always	49	45.4
Really	14	13.0
Sometimes	45	41.7

The descriptive statistics for haematological parameters among the study participants are presented in the table 3. The mean red blood cell (RBC) count was 5.12± million/µL (SD = 0.47), ranging from 3.51 to 6.17. The white blood cell (WBC) count had a mean of 7.28 ×10⁹/L (SD = 1.90), with values ranging from 2.80 to 11.70. The mean haemoglobin (HGB) concentration was 13.86 g/dL (SD = 1.12), with a minimum of 10.00 and a maximum of 16.30. The mean corpuscular volume (MCV) showed a mean value of 87.14 fL (SD = 9.34), with values between 25.0 and 108.0. The mean corpuscular haemoglobin (MCH) had a mean of 27.24 pg (SD = 2.27), while the mean corpuscular haemoglobin concentration (MCHC) averaged 30.95 g/dL (SD = 2.06). Platelet (PLT) counts ranged from 117 to 430 ×10⁹/L, with a mean of 262.02 and a standard deviation of 59.8. These values fall within the expected physiological ranges for a general adult population.

Table 3: Haematological parameters in smokers and non-smokers.

	Minimum	Maximum	Mean	Std. Deviation
RBC	3.51	6.17	5.12	0.47
WBC	2.80	11.70	7.28	1.90
HGB	10.00	16.30	13.86	1.12
MCV	25.0	108.0	87.14	9.34
MCH	21.9	33.6	27.24	2.27
MCHC	27.3	37.2	30.95	2.06
PLT	117	430	262.02	59.8

Table 4: Comparison of age and BMI between smokers and non-smokers.

Hematological parameters	Smokers (n = 42) Mean±SD	Nonsmokers (n = 66) Mean±SD	t-test	*p*-value
Age	26.43±9.51	25.29±10.62	0.566	0.573
BMI	22.99±6.04	23.80±4.48	-0.803	0.424

The mean±SD age was 26.43 ± 9.51 years for smokers and 25.29 ± 10.62 years for non-smokers. The age difference between smokers and non-smokers was not statistically significant (p= 0.573). The mean ± SD body mass index (BMI) was 22.99 ± 6.04 kg/m² in smokers and 23.80 ± 4.48 kg/m² in non-smokers. The difference in BMI between smokers and non-smokers was not statistically significant (p = 0.424) (Table 4).

Table 5: Comparison of hematological parameters between smokers and non-smokers.

Hematological parameters	Smokers (n= 42) Mean±SD	Nonsmokers (n = 66) Mean±SD	t-test	*p*-value
RBC	5.18±0.49	5.08±0.45	1.10	0.274
WBC	7.21±2.07	7.32±1.80	-0.292	0.771
HGB	14.19±0.93	13.66±1.18	2.462	0.015
MCV	88.12±10.47	86.51±8.58	0.873	0.385
MCH	27.56±2.53	27.03±2.09	1.180	0.241
MCHC	30.94±2.035	30.95±2.09	-0.17	0.986
PLT	265.64±61.6	259.71±58.99	0.500	0.618

The mean RBC count ± SD was 5.18±0.49×106/µl in smokers and 5.08±0.45 ×106/µl in non-smokers; difference was not statistically significant (p=0.274). The mean WBC count ± SD was 7.21±2.07 × 10^9/L in smokers and 7.32±1.80 × 10^9/L in non-smokers; difference was not statistically significant (p=0.771). The mean haemoglobin (g/dl) was 14.19±0.93 g/dl in smokers and 13.66±1.18 g/dl in non-smokers; difference was statistically significant (p=0.015). The mean MCV was 88.12±10.47 fl in smoker and 86.51±8.58 fl in non-smoker; difference was not significant (p=0.385). The mean MCH was 27.56±2.53 pg in smoker and 27.03±2.09 pg in non-smoker; difference was not significant (p=0.241). The mean MCHC was 30.94±2.035 g/dl in smoker and 30.95±2.09 g/dl in non-smoker; difference was not significant (p=0.986). The mean PLT was 265.64±61.6 in smoker and 259.71±58.99 in non-smoker; difference was not significant (p=0.618) (Table 5).

Table 6: Association Between Smoking Status and Haematological Parameters.

	No (%)	Smoking		X^2	P-value
		Smokers No(%)	Nonsmokers No(%)		
RBC					
Normal	101(93.5)	38(35.2)	63(58.3)	1.049	0.263
Abnormal	7(6.5)	4(3.7)	3(2.8)		
WBC					
Normal	92(85.2)	35(32.4)	57(52.8)	0.187	0.433
Abnormal	16(14.8)	7(6.5)	9(8.3)		

HB					
Normal	104(96.3)	42(38.9)	62(57.4)	2.643	0.134
Abnormal	4(3.7)	0(0.0)	4(3.7)		
MCV					
Normal	96(88.9)	36(33.3)	60(55.6)	0.701	0.296
Abnormal	12(11.1)	6(5.6)	6(5.6)		
MCH					
Normal	57(52.8)	23(21.3)	34(31.5)	0.109	0.448
Abnormal	51(47.2)	19(17.6)	32(29.6)		
MCHC					
Normal	51(47.2)	20(18.5)	31(28.7)	0.004	0.552
Abnormal	57(52.8)	22(20.4)	35(32.4)		
PLT					
Normal	106(98.1)	40(37.0)	66(61.1)	3.202	0.149
Abnormal	2(1.9)	2(1.9)	0(0.0)		

Table 6 presents the comparison of haematological parameters between smokers and non-smokers using the Chi-square test to assess statistical significance. Although some differences were observed in the distribution of normal and abnormal values between the two groups, none of these differences were statistically significant, as all p-values were greater than 0.05. For instance, while a slightly higher percentage of smokers had abnormal RBC, WBC, and MCH values compared to non-smokers, these variations did not reach statistical significance (RBC: $p = 0.263$; WBC: $p = 0.433$; MCH: $p = 0.448$). Similarly, no significant associations were found for haemoglobin ($p = 0.134$), mean corpuscular volume ($p = 0.296$), mean corpuscular haemoglobin concentration ($p = 0.552$), or platelet count ($p = 0.149$). Therefore, the findings suggest that smoking status is not significantly associated with any of the haematological parameters examined in this study.

4. Discussion

This study investigated the effect of cigarette smoking on hematological parameters among adult males in Derna, Libya. The findings showed that smokers had significantly higher hemoglobin levels compared to non-smokers, whereas no significant differences were observed in RBC, WBC, MCV, MCH, MCHC, or platelet counts. These results are partly consistent with prior studies that have reported smoking to influence hematological indices through hypoxia-induced erythropoiesis and oxidative stress mechanisms. [19,20]

The higher hemoglobin concentration observed among smokers (14.19 g/dL vs. 13.66 g/dL, $p = 0.015$) may be explained by chronic exposure to carbon monoxide in cigarette smoke. Carbon monoxide has a higher affinity for hemoglobin than oxygen, leading to carboxyhemoglobinemia and tissue hypoxia. In compensation, the body increases

erythropoietin production, which stimulates red blood cell production and raises hemoglobin levels.[20] This adaptive mechanism has been described in several studies across different populations, supporting our findings [21,22].

However, despite higher hemoglobin levels, the mean RBC count in smokers did not differ significantly from non-smokers. This finding suggests that smoking may primarily affect hemoglobin concentration rather than RBC numbers, possibly through increased hemoglobin affinity alterations or changes in plasma volume [23]. Similarly, the lack of significant difference in MCV, MCH, and MCHC between groups indicates that cigarette smoking may not strongly influence erythrocyte indices beyond hemoglobin concentration.

Regarding leukocytes, our results showed no significant difference in WBC counts between smokers and non-smokers. While some studies have demonstrated elevated WBC counts in smokers due to chronic systemic inflammation and oxidative stress [24,25], other research has reported no significant differences, aligning with our results [26]. The discrepancy across studies may be attributed to sample size, smoking intensity, or genetic and environmental factors.

Platelet counts were also similar in both groups, consistent with some reports that smoking does not significantly alter platelet numbers but rather affects platelet function, aggregation, and activation.[27] This functional effect increases the risk of thrombosis, even if platelet counts remain within normal ranges.

Sociodemographic findings indicated that most participants were young, single, and from middle economic backgrounds, with nearly 40% being smokers. This reflects concerning trends of tobacco use among young adults in Libya, similar to reports from other Middle Eastern and North African countries.[28] The high rate of passive smoking exposure (87.1% reporting always or sometimes exposed) further emphasizes the widespread public health implications of smoking in this population.

Overall, our study confirms that cigarette smoking is associated with higher hemoglobin concentration, while other hematological parameters remain largely unaffected. This pattern highlights the compensatory hematological response to hypoxia induced by smoking.

4.1. Limitations

This study has some limitations. The cross-sectional design prevents establishing causality between smoking and hematological changes. The sample size was modest and limited to males in Derna, which restricts generalizability. Smoking status was self-reported, which may have led to misclassification bias. Furthermore, additional parameters such as serum erythropoietin levels, carboxyhemoglobin, and platelet function were not assessed, which could provide further mechanistic insights.

5. Conclusion

The findings indicate that cigarette smoking significantly increases hemoglobin levels among males in Derna, Libya, but has no significant effect on RBC, WBC, MCV, MCH, MCHC, or platelet counts. These results underscore the physiological adaptations to hypoxia in smokers and highlight the need for continued tobacco control efforts in Libya to reduce smoking prevalence and related health risks.

Recommendation

- Strengthen anti-smoking campaigns targeting young adults, particularly since most participants were under 25 years and a considerable proportion were smokers.
- Implement community-based awareness programs on the risks of both active and passive smoking, highlighting effects on blood health and long-term disease outcomes.
- Physicians should consider routine hematological monitoring of smokers to detect early hematological changes, especially elevated hemoglobin, which may predispose to polycythemia and related complications.
- Counseling for smoking cessation should be integrated into primary healthcare services, with emphasis on both active smokers and individuals frequently exposed to secondhand smoke.
- Enforce stricter regulations on tobacco advertising, accessibility, and public smoking restrictions to reduce both direct and passive smoking exposure.
- Introduce taxation policies on cigarettes and invest revenue in smoking cessation and health education programs.
- Conduct larger, multi-center studies including both males and females to increase generalizability of findings across Libya.
- Future studies should explore additional biomarkers such as serum erythropoietin, carboxyhemoglobin, and platelet function to better understand the physiological mechanisms of smoking on hematological parameters.
- Longitudinal studies are needed to establish causal relationships and evaluate long-term hematological and cardiovascular risks associated with smoking.

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