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Comparative effects of vaping and cigarette smoking on hematological parameters in young male university students

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Abstract:

BACKGROUND: Smoking and vaping tobacco present substantial health hazards. Nevertheless, the precise impact of vaping and cigarette smoking on hematological indicators, such as complete blood count (CBC) and erythrocyte sedimentation rate (ESR), is still uncertain.

OBJECTIVES: This study was conducted to examine the impacts of vaping and smoking on hematological parameters on young, physically fit male university students.

MATERIALS AND METHODS: A cross-sectional study was carried out that included 102 male students from Komar University of Science and Technology. The study was conducted between February and June 2024. Standard techniques were employed to collect and analyze blood samples for CBC and ESR.

RESULTS: Out of the 102 participants, with an average age of 21 years, 71 were smokers and 31 were nonsmokers. Smokers exhibited significantly higher red blood cell (RBC) count, hemoglobin (HGB) levels, and hematocrit (HCT) compared to nonsmokers. The platelet count was lower in smokers in compare to nonsmokers. On the other hand, vapers demonstrated the highest RBC count among the subgroups, followed by those who smoked both cigarettes and vapes. Furthermore, there were no notable disparities detected in ESR and other CBC values between the participant groups.

CONCLUSIONS: The study revealed that smoking significantly elevates RBC count, HGB, and HCT levels while reducing platelet counts. Among vapers, RBC levels were highest, but no significant differences were observed in platelet counts nor ESR. Therefore, smoking and vaping have an impact on the characteristics of RBCs; this signifies that additional research is required to investigate the long-term impacts of smoking and vaping on hematological parameters.

Keywords:

Hematological parameters, smoking, vaping

Introduction

Tobacco cigarettes have a role in increasing the global mortality rates.[1] Smoking is associated with many illnesses, such as chronic obstructive lung disease, lung cancer, cardiovascular disease, pancreatitis, and oral periodontal diseases. Tobacco smoke has more than 4000 hazardous compounds including carbon monoxide, nicotine, and free radicals, which are the main contributors to its pharmacological effects.[2] Smoking cessation decreases smoking-related drawbacks and improves overall well-being; it will give advantages in both the immediate and long periods.[3]

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Over the past years, vaping devices, often known as electronic cigarettes, have become increasingly used, especially among young people and teenagers. People like vaping devices because of its nice flavors they offer and the concept of having negative health consequences compared to conventional tobacco smoking. The exact long-term drawbacks of continuous vaping on the overall health issues remain unclear,[4] unlike the well-established literature about the harmful effects of cigarette smoke on the human body. Different amounts of nicotine, flavorings, glycerin, propylene glycol, and other nonnicotine compounds are included in vapes. These compounds might contain dangerous poisons including acetaldehyde and formaldehyde.[5]

Research indicates that changes in hematological markers, such as the erythrocyte sedimentation rate (ESR) and complete blood count (CBC), can result from smoking and vaping.[2,6] In addition, a common hematological test that might identify a generalized increase in the body's inflammatory activity is the ESR. This increase in inflammatory activity can be brought on by infections, tumors, or autoimmune diseases. Elevated ESR readings are not specific to any one illness, although they could suggest the presence of an underlying inflammatory condition.[7]

Based on these findings, our study compares the hematological parameters of smokers and nonsmokers and looks into how different nicotine delivery techniques (traditional smoking versus vaping) may affect these parameters differently. This study could improve public health campaigns and increase our understanding of the risks associated with vaping and smoking.

Materials and Methods

Patients

This cross-sectional study was conducted between February and June 2024, where the samples were collected randomly from participants located at Komar University of Science and Technology (KUST), Sulaimani, Iraq. To be included in the study, the participants were ought to be smokers (cigarette and/or vape) or nonsmokers and willing to participate voluntarily. Participants who had blood and bleeding disorders (e.g., anemia, thalassemia, epistaxis, etc.) were excluded from the study. Eventually, 102 male participants were recruited; 71 of them were smokers (cigarette and/or vape) and 31 were nonsmokers. Following that, blood samples were obtained from each volunteer through a venipuncture method. Each participant had one ethylenediaminetetraacetic acid (EDTA) tube filled for the CBC panel and one black-topped tube filled for the ESR test.

Comprehensive hematology panel

The CBC panel was conducted using the Sysmex XN-1000, an automated hematology analyzer that provides a 5-part differential analysis. This sophisticated analyzer offers thorough and precise evaluation of hematological conditions and accurately distinguishes and quantifies different cell types in the blood.

The Complete blood count (CBC) is an automated measure of the blood counts. The CBC consist of three main parameters; first, red blood cell parameters which includes red blood cell count (RBC) x 10^6 cells per microliter(µL) ,hemoglobin (HGB)in gram/dl, hematocrit (HCT) in %, mean corpuscular hemoglobin (MCH) in picograms, mean corpuscular hemoglobin concentration (MCHC) in gm/dl, red cell distribution width (RDW) in %. The second is white blood cell parameters (WBC); includes total WBC count, neutrophil, lymphocytes, monocytes, basophils and eosinophils in thousands of cells per microliter 10^3/µL. The third one is platelets count which includes, total counts in thousands of cells per microliter 10^3/µL, mean platelets volume (MPV) in fl, and platelets distribution width in %

Measurement of erythrocyte sedimentation rate

Regarding the ESR measurements, the blood sample was obtained in a tube with a black cover, which contained sodium citrate as an anticoagulant; once the tube was filled, it was delicately inverted multiple times to thoroughly blend the blood with the anticoagulant. Subsequently, the tube was inserted into the Alcor iSED, an automated ESR analyzer, which is a rapid detector for ESR, and left for a duration of 30 min. This instrument employs photometric rheology to continually monitor the sedimentation process, delivering fast and dependable ESR data.

The ESR is quantified in millimeters per hour (mm/hr). Blood samples were collected through venipuncture.

Statistical analysis

The data were analyzed by GraphPad Prism (Ver 10.2.3) using descriptive statistics, ANOVA, and Mann–Whitney *U*-test. The significance level was set at $P < 0.05$.

Results

Out of 102 male healthy university students, their ages ranged from 18 to 28 years with a mean of 21 years old. The most common age groups were those with 21 and 22 (47%) years, as shown in Table 1. It included 71 smokers and 31 nonsmokers. Among the smokers, 43 (60.56%) smoked both vape and cigarette, 22 (30.98%) smoked only vape, and 6 (8.45%) smoked only cigarette, meaning that most of the participants were using both cigarettes and vape together (42%).

A high RBC, HGB, HCT, and low platelet count were noted among the smokers in comparison to the nonsmokers with a significant *P* value, as shown in Table 2.

A significant difference in RBC, HGB, MCV, and MCH among the subgroups was noted. These levels varied for each parameter; RBC was highest in vapers; HGB was highest in both cigarette and vape; HCT and MCV were highest in cigarette smokers, as shown in Table 3 and Figure 1.

However, no significant difference was found in the levels of MCV, MCH, and MCHC, while a significant difference was found in RDW between smokers and nonsmokers, as it can be seen in Figure 2. Meanwhile, the difference in the white blood cell parameters such as WBC, neutrophil, lymphocyte, monocyte, eosinophil, and basophil was insignificant, as shown in Figure 3. In addition, the difference between the platelet counts was significant between the participant groups. The platelet count displayed a lower count in smokers in comparison to nonsmokers. However, there is no difference in PDW and MPV levels among smokers and nonsmokers [Figure 4].

Table 1: The demographic data of the study participants

Variables	Category	*n*=102, *n* (%)
Age	18–20	27 (26.5)
	21–22	48 (47)
	23–24	22 (21.6)
	25–26	4 (3.9)
	27–28	1 (1)
Smoking	Smoker	71 (69.6)
	Nonsmoker	31 (30.4)
Type of smoke	Cigarette	6 (8.45)
	Vape	22 (30.98)
	Cigarette and vape	43 (60.56)

As indicated in Figure 5, there was no significant difference in the ESR levels of the study participant groups.

Discussion

Our study was conducted to compare the impact of smoking and vaping on the hematological parameters of healthy college students and found that male smokers (cigarette and vaping) have higher levels of RBCs and HCT measurements. This could be attributed to tissue hypoxia caused by increased production of carboxyhemoglobin, which triggers the release of erythropoietin, leading to increased RBC production. Similar results are also seen in other studies.[2,8-13]

The significant elevations in HGB, RBC, and HCT among smokers in our study align with the findings of Hussein *et al*.,[14] indicating that smoking elevates the levels of carboxyhemoglobin due to the inhalation of CO_2, resulting in tissue hypoxia, which stimulates the production of erythropoietin that by its role, increases the RBC, HGB, and HCT counts. Similar observations were also reported by Malenica *et al*.[2] who stated that smokers had significantly higher RBC and HGB levels compared to nonsmokers due to the chronic hypoxia induced by smoking. Another study reported elevated HGB and HCT levels in smokers compared to nonsmokers within a similar demographic. However, unlike our findings,

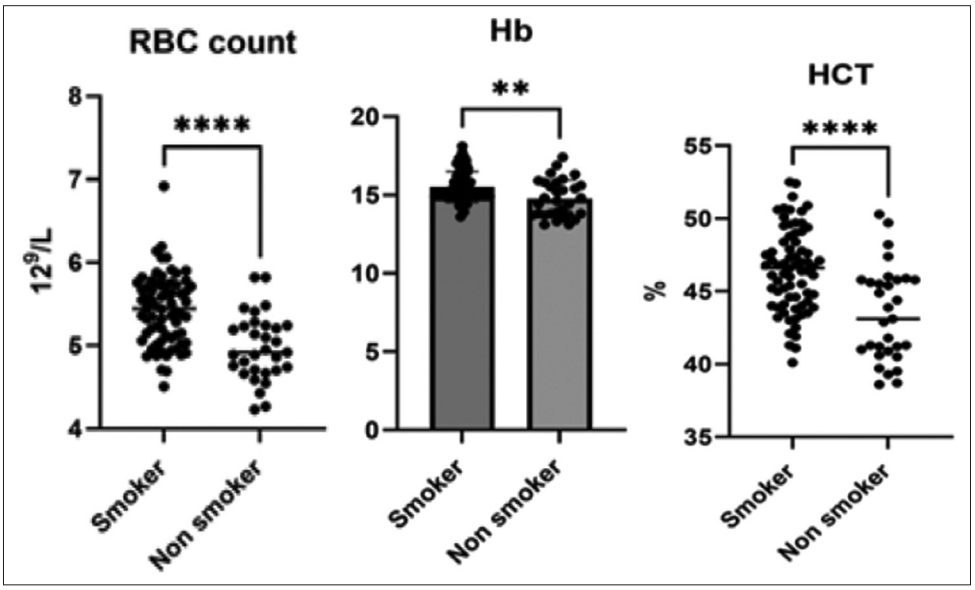

Figure 1: The Mann–Whitney U test for RBC, HGB and HCT parameters between smokers and non-smokers. RBC: Red blood cells, HGB: Hemoglobin, HCT: Hematocrit

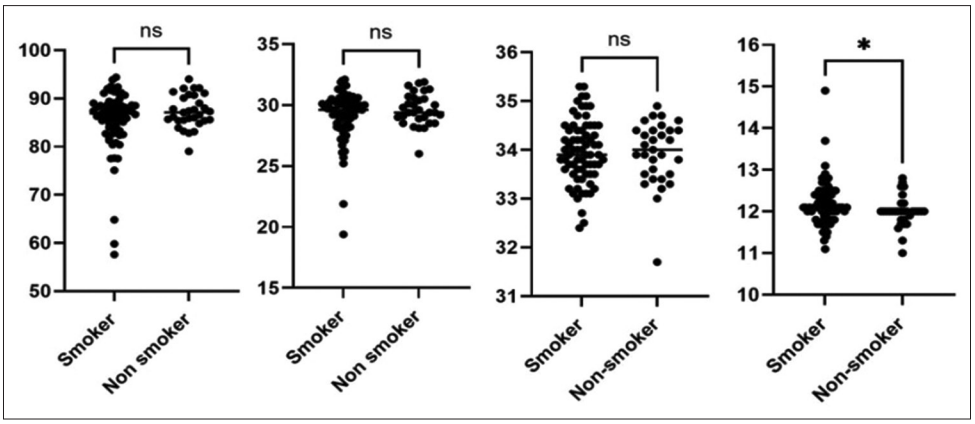

Figure 2: Mean corpuscular volume, mean corpuscular hemoglobin (MCH), and MCH concentration indices among the male smokers and nonsmokers. MCH: Mean corpuscular hemoglobin, MCV: Mean corpuscular volume, MCHC: MCH concentration, RDW: Red cell distribution width

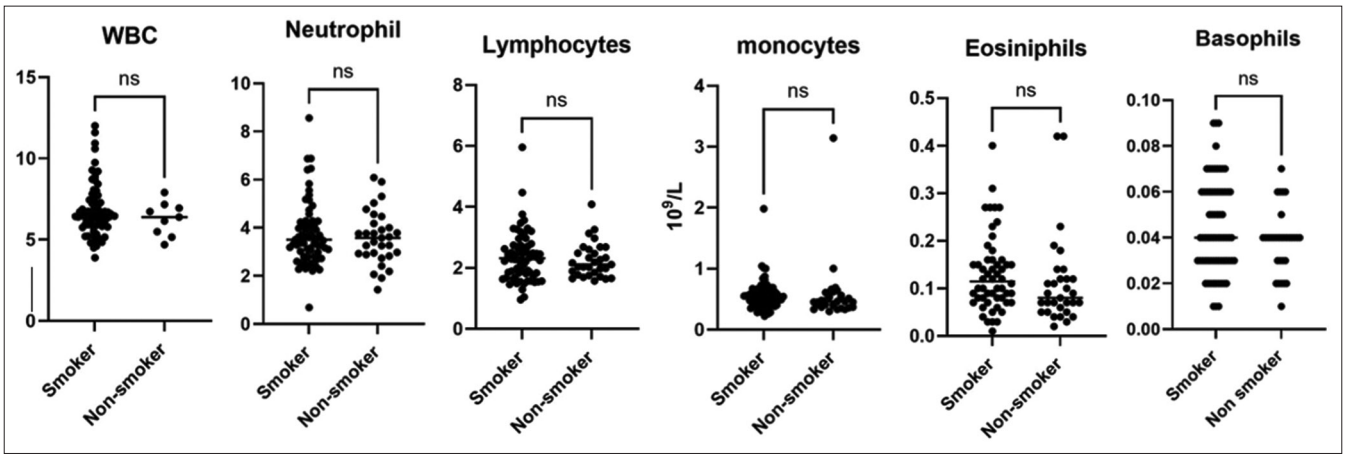

Figure 3: The white blood cell parameters among the male smokers and nonsmokers. WBC: White blood cell

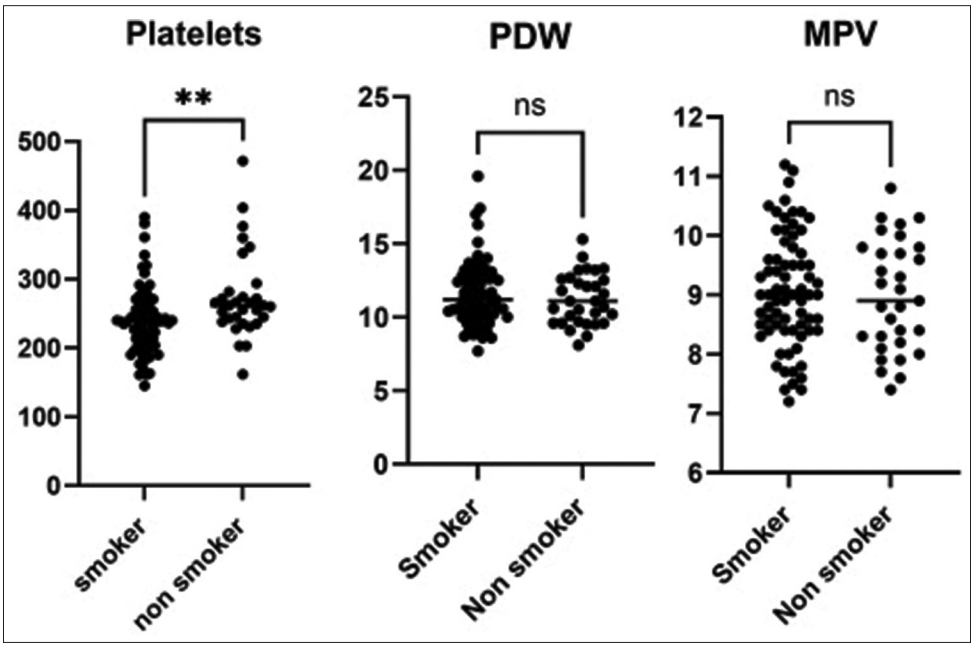

Figure 4: The significant difference in the platelet count among the smokers and nonsmokers. PDW: Platelet distribution width, MPV: Mean platelet volume

the study did not explore the impact of vaping, limiting direct comparisons.[15]

On the other hand, vaping, although associated with lower overall hematological impact compared to smoking, showed the highest RBC count among the subgroups of our study. It could be due to that nicotine delivery through vaping may independently stimulate erythropoiesis. An analysis conducted by Febriyanto *et al*.[16] have shown similar results, where the RBC levels increased among vapers compared to smokers.

Regarding the platelet count, according to the results of a previous study conducted by Ahmed,[17] there is no significant difference in platelet counts between smokers and nonsmokers, which contradicts our findings that demonstrate a lower platelet count among smokers. The reduction in platelet count in our study could be related to the inhibitory effect of nicotine on the production of platelets in individuals who smoke; this effect is also seen in other studies, such as ALgmati *et al*.,[18] who showed similar results, and concluded that the platelet levels of smokers are less than that of nonsmokers; this may

Table 2: The mean±standard deviation and P value of the erythrocyte sedimentation rate and hematological parameters among the smokers and nonsmokers in the study participants

Hematological parameters	Smokers (*n*=71)	Nonsmoker (*n*=31)	*P*
ESR (mm/h)	6.7958±3.515	9.1935±6.789	0.21
RBC (10^6/μL)	5.4293±0.420	4.9771±0.396	0.000*
HGB (g/dL)	15.5028±0.978	14.7548±1.189	0.001*
HCT (%)	46.4535±2.829	43.4258±3.234	0.000*
MCV (fL)	85.4507±6.602	87.3548±3.392	0.132
MCH (pg)	29.1662±2.072	29.6581±1.305	0.226
MCHC (g/dL)	33.9606±0.646	33.9323±0.656	0.840
RDW (%)	12.2014±0.543	11.958±0.416	0.29
WBC (10^3/μL)	6.8094±1.607	8.2869±9.818	0.219
NEU (10^3/μL)	3.7127±1.293	3.5803±1.110	0.621
LYM (10^3/μL)	2.3569±0.800	2.2461±0.568	0.488
MON (10^3/μL)	0.5594±0.243	0.5706±0.497	0.879
EOS (10^3/μL)	0.1301±0.078	0.1116±0.955	0.308
BAS (10^3/μL)	0.0441±0.020	0.0384±0.139	0.158
PLT (10^3/μL)	239.4789±48.985	274.4194±63.076	0.003*
PDW (fL)	11.6169±2.192	11.2290±1.745	0.386
MPV (fL)	9.0662±0.949	8.9871±0.934	0.698

*P<0.05, statistically significant. ESR=Erythrocyte sedimentation rate, RBC=Red blood cell, HGB=Hemoglobin, HCT=Hematocrit, MCV=Mean corpuscular volume, MCHC=Mean corpuscular hemoglobin concentration, RDW=Red cell distribution width, WBC=White blood cell, LYM=Lymphocyte, NEU=Neutrophils, MON=Monocyte, EOS=Eosinophils, BAS=Basophil, PLT=Platelet, PDW=Platelet distribution width, MPV=Mean platelet volume

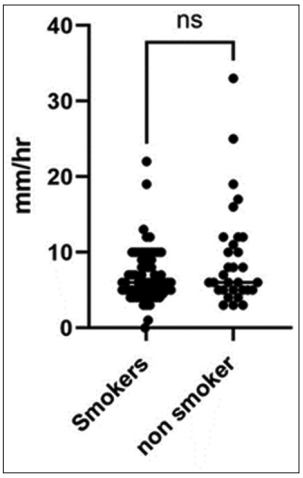

Figure 5: The erythrocyte sedimentation rate difference between the two groups, smokers and nonsmokers. ESR: Erythrocyte sedimentation rate

Table 3: The comparison of hematological parameters between the subtypes of smokers

Hematological parameters	Cigarette smoker (*n*=6)	Vape (*n*=21)	Both (*n*=43)	*P*
ESR (mm/h)	8.5000±2.3452	6.7955±2.7021	6.5581±3.9779	0.454
RBC (10^6/μL)	5.3983±0.2815	5.6232±0.4449	5.3344±0.3970	0.030*
HGB (g/dL)	15.6500±0.7368	14.9682±0.6700	15.7558±1.0434	0.007*
HCT (%)	46.8333±2.0205	46.6318±2.7608	46.3093±2.9980	0.861
MCV (fL)	87.0000±6.5933	82.0818±9.5677	86.9581±3.6173	0.014*
MCH (pg)	29.6500±2.3997	28.1182±2.8138	29.6349±1.2961	0.015*
MCHC (g/dL)	34.0333±0.4501	33.7000±0.6172	34.0837±0.6560	0.072
RDW (%)	12.2667±0.2503	12.3500±0.7288	12.1163±0.4477	0.252
WBC (10^3/μL)	7.0167±1.4232	7.3850±1.8138	6.4860±1.4613	0.096
NEU (10^3/μL)	4.2267±1.1849	4.0818±1.4290	3.4521±1.1915	0.105
LYM (10^3/μL)	1.9400±0.3100	2.6000±0.9113	2.2902±0.7626	0.137
MON (10^3/μL)	0.6733±0.2546	0.5050±0.1323	0.5714±0.2810	0.289
EOS (10^3/μL)	0.1250±0.0647	0.1364±0.7416	0.1277±0.8349	0.904
BAS (10^3/μL)	0.0517±0.2858	0.0409±0.0195	0.0447±0.0195	0.499
PLT (10^3/μL)	231.1667±46.0061	244.9545±51.71025	237.0837±48.8052	0.785
PDW (fL)	11.4333±1.6145	12.5045±2.8611	11.1884±1.7323	0.069
MPV (fL)	9.0833±0.9389	9.2455±1.0400	8.9721±0.9121	0.553

*P<0.05, statistically significant. ESR=Erythrocyte sedimentation rate, RBC=Red blood cell, HGB=Hemoglobin, HCT=Hematocrit, MCV=Mean corpuscular volume, MCHC=Mean corpuscular hemoglobin concentration, RDW=Red cell distribution width, WBC=White blood cell, LYM=Lymphocyte, NEU=Neutrophils, MON=Monocyte, EOS=Eosinophils, BAS=Basophil, PLT=Platelet, PDW=Platelet distribution width, MPV=Mean platelet volume

assign a high risk of bleeding disorders for the smoker population in the future.

Regarding the differences in hematological markers between forms of smoking (cigarette smoking versus vaping), individuals who vaped had the greatest RBC counts, followed by cigarette smokers and those who vaped and smoked simultaneously. Individuals who used both methods of smoking had the highest levels of HGB, followed by vapers and cigarette smokers. Cigarette smokers had the highest MCV and MCH levels, followed by those who used both cigarettes and vapes and then vapers. The observed inconsistencies could be ascribed to an unequal distribution of participants among different groups, resulting in contradicting results.

The ESR levels did not show any significant differences between smokers and nonsmokers, which is consistent with the findings of Mohamed *et al*.[19] However, this contradicts the report by Thriveni *et al*.,[20] who observed greater ESR levels in smokers.

It is important to note that while the elevation in these parameters might initially appear as an adaptive response, chronic increases in RBC, HGB, and HCT count can contribute to hyperviscosity of the blood,[21] thereby increasing the risk of cardiovascular complications such as hypertension, thrombosis, and stroke.[22-24] This further emphasizes the need for public health measures elevating the prevalence of smoking cessation programs and restricting the trade and marketing of vapes.

Conclusions

This study highlights significant differences in the hematological effects of vaping and smoking of healthy, young, and male college students. The levels of RBC, HGB, and HCT were higher in smokers compared to nonsmokers. Conversely, vapers exhibited the highest RBC counts among the subgroups, suggesting that vaping may influence erythropoiesis process. However, the platelet count was significantly lower among smokers but not significantly affected in vapers, indicating that smoking might have an impact on platelet production or destruction lesser than that of vaping. The changes of other parameters such as MCV, MCH, and MCHC were not significant. Furthermore, the study revealed that no significant changes were noticed in the subgroups in regard to their ESR and other WBC parameters.

Limitations of the study

This study has several limitations that should be mentioned such as the small sample size and the focus on specific population, young and healthy college male students, and healthy males. In addition, self-reported smoking and vaping habits may introduce recall bias or underreporting. Moreover, the duration and intensity of smoking and vaping were not evaluated, which could have influenced the observed results.

Recommendations for further studies

Further studies can determine the impact of smoking and vaping on a broader population, including females and older individuals, Along with correlating the duration and intensity of smoking and vaping with the hematological parameter's changes.

Ethical approval

This study received the approval of both KUST from OSAR (Office of Student Affairs and Registration) and the University of Sulaimani, College of Medicine. The student's identities were protected, and their anonymity was maintained throughout the whole process. Finally, no data were shared with any external parties not involved in the research and writing process.

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Conflicts of interest

There are no conflicts of interest.

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