International Journal of Multidisciplinary Research and Growth Evaluation.

Effect of Tobacco Cigarette Smoking on Complete Blood Count (CBC) among Students of Sarhad University of Science & Information Technology, Peshawar

Ahmad Khan [1], Aamir Zada [2*], Shumaila Ijaz [3], Shakir Ullah [4], Shakil Ahmad [5]
[1, 4, 5] Medical Lab Technology, Sarhad University of Science & Information Technology, Pakistan
[2] Medical Lab Diagnostics (Master-Doctoral Student), Xuzhou Medical University, China
[3] Microbiology (Mphil), Abasyn University, Peshawar, Pakistan

* Corresponding Author: **Aamir Zada**

Article Info
ISSN (online): 2582-7138
Volume: 06
Issue: 02
March-April 2025
Received: 15-02-2025
Accepted: 13-03-2025
Page No: 1003-1015

Abstract
The research (study) investigates the impact of tobacco smoking on complete blood count (CBC) parameters among students at This study examines the influence of tobacco cigarette smoking on complete blood count (CBC) parameters among students at Sarhad University of Science and Information Technology (SUIT) in Peshawar. The research aims to know and investigate the prevalence of smoking in students and identify which CBC parameters are most affected by smoking. A descriptive cross-sectional study was conducted over six months, involving 30 undergraduate male smokers. Blood samples were collected and analyzed using an automated hematology analyzer to measure various CBC parameters, including WBC, RBC, Hb, HCT and platelets. The results revealed significant changes in CBC parameters among smokers. Notably, elevated WBC and RBC counts were the most significant findings. Specifically, 17 out of the 30 respondents exhibited high WBC counts (greater than 11.00 cells/uL), and 18 respondents showed elevated RBC counts (greater than 6 million cells/uL). Hemoglobin and hematocrit levels were mostly within the normal range, while platelet counts were also generally normal, with only one respondent showing elevated levels. These study and investigation suggest that cigarette has a detrimental effect on hematological parameters, potentially increasing the risk of inflammation, immune dysfunction, and circulatory disorders. The study emphasizes the importance of smoking cessation and regular health monitoring to mitigate these adverse effects. Recommendations include adopting healthier lifestyles, seeking professional support for smoking cessation, and conducting further longitudinal studies with larger sample sizes to explore the long-term impacts of smoking on CBC parameters. Sarhad University of Science and Information Technology (SUIT) in Peshawar. The research aims to determine and analyze the prevalence of smoking (cigarette) in students and identify the CBC parameters most affected by smoking. A descriptive cross-sectional study was conducted over six months, involving 30 undergraduate male smokers. Blood samples were collected and analyzed using an automated hematology analyzer to measure CBC parameters, including WBC, RBC, Hb, HCT and platelets. The results revealed significant alterations in CBC parameters among smokers, with elevated WBC and RBC counts being the most notable changes. Specifically, 17 out of 30 respondents exhibited high WBC counts (>11.00 cells/uL), and 18 respondents showed elevated RBC counts (>6 million cells/uL). Hemoglobin and hematocrit levels were mostly within the normal range, while platelet counts were also generally normal, with only one respondent showing elevated levels. The findings suggest that smoking adversely affects hematological parameters, potentially increasing the risk of inflammation, immune dysfunction, and circulatory disorders. The study known us the smoking cessation and regular health monitoring to mitigate these effects. Recommendations include adopting healthier lifestyles, seeking professional support for smoking cessation, and conducting further longitudinal studies with larger sample sizes to explore the long-term impacts of smoking on CBC parameters.

Keywords: Smoking, Complete Blood Count, White Blood Cells, Red Blood Cells, Hemoglobin, Hematocrit, Platelets

Introduction
Cigarette is one of the leading and impactful causes of death and poses a significant public (individuals) health challenge worldwide (Kume *et al*., 2009) [24]. Smoking negatively affects hematological parameters and exposes smokers to over 4,000 chemicals found in cigarette smoke, including different products and other harmful gaseous (Gitte, 2011) [17].

It is well established that smokers are at a higher risk for various health issues, including heart diseases like hypertension, heart attack, inflammation, stroke, cardiovascular diseases, clotting disorders and respiratory diseases (Abel *et al*., 2005) [1]. Furthermore, cigarette smoking accelerates the development of several types of cancer of different organs (Islam *et al*., 2007) [20]. Smoking also alters the pH levels in the stomach, leading to peptic ulcers and gastric diseases (Kume *et al*., 2009) [24]. The importance of smoking cessation are well-documented. Quitting smoking decrease or overcome health risks and improves or increase quality of life, significantly lowering the cumulative risk of death from heart disease and pulmonary diseases by up to 90%, even if the cessation occurs later in life. Therefore, it is essential to actively encourage all smokers to stop smoking. Given smoking highly addictive nature, cessation attempts should be supported by healthcare professionals to achieve and gain long-term abstinence. Physicians or healthcare professionals are in an ideal position to advise and educate individuals and patients about the dangers of smoking and can also serve as role models, potentially influencing the smoking behaviors of others (Anthonisen, 2005) [4]. However, relatively few individuals (15-38%) consider it necessary and important to advise smokers (one group) to quit before they develop or occurs a smoking-related disease (Raupach *et al*., 2009) [33]. Tobacco smoking is also more common and prevalent among students in healthcare professions. For instance, a study found that 29% of students of Applied Medical Sciences (AMS) in Riyadh, KSA, were current smokers. In another four studies, the prevalence rate of regular smoking among students at the University College of Medicine in Abha, KSA, was reported to be 13.6% (Al-Turki, 2006) [3]. In the past decade, research has suggested or guided that cigarette smoking affects or impact blood characteristics and can lead to death. For example, a well-established relationship exists between smoking (one group) and white blood cell count (Torres de Heens *et al*., 2009) [40]. Most studies indicate that smokers tend to have higher WBC counts than non-smokers (Wannamethee *et al*., 2005) [43]. Some scientists propose that the increase (high range) in hemoglobin levels among smokers may be a compensatory process or mechanism; however, this does not apply to all smokers and may relate to individual tolerance to various diseases. Additionally, factors such as the duration or time period of smoking and the age of the smoker (individual) might influence the adverse effects of smoking on blood characteristics (Asif *et al*., 2013) [6]. While some studies propose that the increase in hemoglobin levels in smokers is a compensatory process or mechanism, not all smokers exhibit this increase, which may depend on specific circumstances (Tarazi *et al*., 2008) [39]. Research has also shown the effects or impact of opium addiction on red blood cell counts, levels of various red blood cell-related parameters i.e. peripheral white blood cells count (Fernández *et al*., 2012) [16]. Although it has been suggested that morphine may indirectly affect some immune cells, it can also directly influence the functions of macrophages (phagocytosis), polymorphonuclear leukocytes and control or regulate the expression of certain T-cell surface markers (Liang *et al*., 2016) [25]. This can directly impact lymphocyte function and subsequently influence cytokine networks, thus affecting immune cell differentiation and proliferation. Furthermore, studies have found that papaverine and other opium alkaloids can induce apoptosis in various cell lines (Schuler *et al*., 2003) [36]. These events can disrupt the metabolism and functions of lymphocytes. Papaverine has also been reported to stimulate the production of growth factor-β (TGF-β), which has power or potent immunosuppressive (autoimmune) effects, leading to severe conditions such as constrictive bronchiolitis (Sajadian *et al*., 2015) [34].

Our previous studies on the effects and impact of opium on apoptosis (Karam *et al*., 2008) [22], hematological parameters, and the influence and role of cigarette smoking on cell physiology (functions) prompted us to evaluate the biological role or effects of opium and cigarettes on peripheral blood cells in individuals who are opium-taking addicted, cigarette smokers (one group) and non-opium-addicted cigarette smokers (Asadikaram *et al*., 2010) [5]. The prevalence of smoking is much higher in developing countries. Despite the high mortality rate associated with smoking, the number of smokers continues to increase daily. It is estimated that there are currently 4.5 billion smokers worldwide, a figure projected to rise to about 7.1 billion by 2025 (Doll *et al*., 1994) [12]. A cigarette contains approximately 4,000 items that can cause or may be a reason of cellular-level damage in the human body (Malenica *et al*., 2017) [27]. In this all compounds, free radicals, nicotine, different products and carbon monoxide are believed to be responsible for the most severe pharmacological effects of smoking. These substances are commonly linked to cancer, pulmonary diseases and heart (cardiovascular) diseases (Ernst, 1993) [15].

Nicotine, a psychostimulant found in tobacco smoke, affects arousal in both the cortical and autonomic nervous systems. Additionally, factors such as vascular constriction, hypoxia, and impaired fibrinolysis can cause harm to musculoskeletal tissues (Khan, 2022) [23]. Specific carcinogens are transported via inhalation to the bronchoalveolar region, leading to the development of adenocarcinoma (Mjøs, 1988) [28]. The number of cigarettes smoked is directly proportional to an increase in serum HDL levels, although HDL is inversely related to the number of cigarettes smoked each day. Increased exposure to cigarette smoke lowers HDL levels, contributing to cardiovascular disease. A lipid profile, a simple test, can be used to predict future cardiovascular morbidity and mortality in smokers. This is likely related to nicotine, hydrogen cyanide, and carbon monoxide, all of which are present in cigarettes (Stefanadis *et al*., 1997) [37]. The main cause of cardiovascular disease is heightened exposure to cigarette smoke, which leads to endothelial dysfunction, arterial stiffness, inflammation, and changes in lipid levels. This exposure causes an increase in blood pressure due to arterial rigidity, damaging organ tissues, and this effect can be observed within just five minutes of smoking (WHO, 2011) [44]. Worldwide, approximately 7.2 million people (individuals) die each year from smoking-related diseases (it's one of the cause) and this number is expected to timely rise (Monti *et al*., 2014) [30]. Epicardial adipose tissue make the 80% of the heart's tissue (surface). It is an active (functional) tissue that secretes hormones, named cytokines, and inflammatory mediators. It also provides or give mechanical protection for the heart and partially meets the heart's energy demands (Eiras *et al*., 2008) [13]. The effects of EAT can be both harmful and protective, and this balance is delicate. For example, if the cells increase production of leptin while impairing secretion of adiponectin in patients with hypertension, metabolic syndrome, coronary artery disease (CAD), and obesity. Decreased adiponectin levels

lead to dysfunction of endothelial, systemic inflammation and increased in oxidative stress. In contrast, elevated leptin levels can cause endothelium atherogenic changes by releasing inflammatory cytokines and their effect on blood lipid levels is negative (Liu *et al*., 2018) [26].

Many studies have shown that the counts of neutrophils, lymphocytes, platelets, and mean platelet volume (MPV), or the ratios of these values, serve as inflammatory markers in complete blood count tests (Asif *et al*., 2013) [6]. Tobacco smoking is one of the most prevalent addictions across all age groups and is a significant etiological factor for various chronic illnesses, including infections, cancers, heart diseases, and respiratory diseases (Aula & Qadir, 2013) [7]. According to the World Health Organization (WHO), approximately 2.4 billion people worldwide are addicted to tobacco in various forms, including chewing, snuffing, and dipping (Okafor & Okoroiwu, 2017) [31]. The WHO has estimated that by 2030, deaths due to tobacco will reach 8.3 million, with projections suggesting that tobacco-related deaths could total one billion by the end of the 21st century (WHO, 2011) [44]. In Pakistan, approximately 19.1% (23.9 million) of the adult population currently uses different forms of tobacco products, with 10.5% being cigarette smokers (Saqib *et al*., 2018). Tobacco smokers are exposed to many harmful chemicals, including nicotine, carbon monoxide, and other gaseous substances. Nicotine is the primary addictive and stimulant agent among these chemicals. These substances negatively affect almost every organ system in the human body, particularly the respiratory, cardiovascular, and gastrointestinal systems (Aftab & Al Shammari, 2015) [2].

Research indicates that smoking adversely impacts various hematological parameters, including hemoglobin (Hb) concentration, red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), white blood cell (WBC) count, platelet counts, clotting profile, and erythrocyte sedimentation rate (ESR), leading to systemic inflammation. Additionally, smoking causes platelet aggregation and alters the clotting profile, which increases blood viscosity and contributes to conditions such as atherosclerosis and myocardial infarction (Inal *et al*., 2014) [19]. Some studies have shown that certain changes in these parameters can be temporary and reversible after quitting smoking. Cigarette smoking is responsible for 17-30% of cardiovascular diseases, making it a significant preventable cause (Malenica *et al*., 2017) [27].

Literature Review

(Mohamed *et al*., 2023) [29] concluded that cigarette smoking is a well-known significant contributor to the development of many illnesses that have an inflammatory component. Smoking exerts both acute and chronic effects on hematological parameters. Their case-control study involved 30 healthy active smokers, 30 healthy passive smokers, and 30 age- and sex-matched healthy non-smokers. Data regarding age, sex, smoking index, and smoking duration were recorded. The study measured complete blood count (CBC), differential leukocyte count, platelets-to-lymphocytes ratio (PLR), neutrophils-to-lymphocytes ratio (NLR), C-reactive protein (CRP), and erythrocyte sedimentation rate (ESR). Statistically significant differences were found between active and passive smoker groups regarding CBC and inflammatory marker parameters, except for the percentage of neutrophils. ESR and CRP showed no statistically significant differences. Additionally, significant differences were identified between the active smoker group and the control group across all CBC indices and inflammatory markers, including PLR, NLR, ESR, and CRP. In contrast, no statistical differences were observed between the passive smoker group and the control group except in monocyte percentage and ESR, which both had statistically significant differences. This suggests that passive smoking also affects hematological indices and inflammatory markers similar to active smoking. Therefore, it is crucial to recognize that both active and passive smoking can contribute to changes in blood indices. (Bhadarge *et al*., 2021) [9] studied the increased risk of cardiovascular diseases related to cigarette smoking in India, such as coronary heart disease and peripheral vascular disease. Conditions like atherosclerosis, myocardial infarction, and stroke are examples of ischemic heart disease linked to smoking. Cigarette smoke contains more than 4,000 substances, many of which have harmful effects on human health, including free radicals, nicotine, and notably carbon monoxide. Tobacco smoke is responsible for the deaths of approximately 6 million people annually, with many succumbing to lung cancer, chronic obstructive pulmonary disease (COPD), and cardiovascular diseases (CVD). Compared to non-smokers, smokers generally lose 10 to 15 years of life and are at a higher risk of developing tobacco-related disorders, including coronary disease.

In a study on the effects of cigarette smoking on lipid profiles, it was observed that total cholesterol, triglycerides, low-density lipoprotein (LDL), and very low-density lipoprotein (VLDL) levels were statistically higher in smokers compared to non-smokers. Conversely, smokers had slightly lower high-density lipoprotein (HDL) cholesterol levels than non-smokers. (Jaafar, 2020) [21] conducted a study testing the effects of cigarette smoking on parameters indicative of critical health issues in the human body. This research included fifty Iraqi male smokers from Baghdad who smoked at least 10 cigarettes per day for a minimum of 15 years. The study included a control group of 25 non-smokers, matched for age (20 to 55 years). The results showed significant increases in various blood parameters among smokers: hemoglobin (Hb) levels were recorded at 16.09 g/dl, packed cell volume (PCV) at 49.2%, red blood cells (RBC) at 5.476 x 10^12/L, white blood cells (WBC) at 12.556 x 10^9/L, and platelets (PLT) at 430 x 10^12/L. Similar significant changes were observed in serum biochemical parameters related to kidney function (urea at 53.24 mg/dl; creatinine at 1.548 mg/dl) and liver function (alanine aminotransferase - ALT at 104.92 U/l; aspartate transaminase - AST at 122.30 U/l; alkaline phosphatase - ALP at 337.40 U/l; total serum bilirubin - TSB at 0.678 mg/dl). However, smokers exhibited significantly lower levels of total protein (60.68 mg/dl) and uric acid (4.24 mg/dl) compared to non-smokers. The experiment involved blood samples collected via venipuncture (5 ml) placed in non-heparinized tubes, which were then centrifuged at 3000 rpm for 15 minutes. Hemoglobin, PCV, WBC, RBC, and platelets were assessed in EDTA-coated tubes using a Mindray BC-30 automated hematological analyzer, which accurately performed 18 hematological parameters. Each sample was allowed to clot and then centrifuged for 15 minutes at 3000 rpm. The serum parameters related to kidney and liver functions were subsequently analyzed. (Hussain *et al*., 2020) [18] examined the effects of cigarette and Narghile smoking on various blood parameters and Vitamin D levels in a sample of young smokers aged 20-35 in Ramadi. The study included complete

blood count (C.B.C) tests, which involved measuring total white blood cell and red blood cell counts, determining the concentration of total hemoglobin, and calculating the platelet count. The study also calculated red blood cell indicators, including mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and mean red blood cell volume (MCV). Additionally, the researchers evaluated Vitamin D concentrations. The results revealed an increase in the number of white blood cells, red blood cells, hemoglobin concentration, and platelet count among smokers. There was also an increase in red blood cell volume, mean hemoglobin concentration, and MCHC in smokers' blood, alongside a decreased concentration of Vitamin D.

(Elisia *et al*., 2020) [14] investigated how smoking e-cigarettes differs significantly from traditional tobacco smoking, highlighting that e-cigarette aerosols contain numerous chemicals absent in conventional cigarette smoke. Chronic use of e-cigarettes is likely to induce pathological changes in both the heart and lungs. The researchers reviewed human and animal studies to summarize the cardiopulmonary physiological changes induced by vaping. Acute exposure to e-cigarette aerosols in humans resulted in increased blood pressure and heart rate, similar to traditional cigarettes. Chronic exposure in animal models led to increased arterial stiffness, vascular endothelial changes, increased angiogenesis, cardiac renal fibrosis, and elevated atherosclerotic plaque formation. Pulmonary physiology was also negatively impacted by inhaling e-cigarette aerosols, resulting in increased airway reactivity, airway obstruction, inflammation, and emphysema. The research suggests that both the heart and lungs undergo significant changes in response to e-cigarette use, with the development of disease depending on the interplay between these changes and environmental or genetic factors. Although e-cigarettes are marketed as a healthier alternative to traditional smoking, there is insufficient evidence to support claims that they are safe or healthier. Data from human and animal studies consistently indicate that vaping can produce health effects similar to and different from those caused by cigarette smoking. Further research is needed to understand the long-term cardiopulmonary effects of e-cigarette use in humans. (Hussain *et al*., 2020) [18] conducted a study demonstrating that cigarette smoking is associated with an increased risk of cardiovascular diseases, such as coronary artery disease, peripheral vascular disease, ischemic heart disease, atherosclerosis, myocardial infarction, and stroke. The study aimed to determine the effects of smoking on hematological parameters, including ferritin and transferrin saturation. It was performed retrospectively, evaluating 149 patients admitted to Hacettepe University Hospitals between September 2018 and November 2018. The sample consisted of 95 (63.7%) healthy non-smokers and 54 (36.3%) healthy smokers, with a median age of 32 years (ranging from 18 to 61). Among the participants, there were 47 (31.5%) males and 102 (68.5%) females. The results showed that hemoglobin ($p < 0.001$), hematocrit (HCT) ($p < 0.001$), and mean corpuscular volume (MCV) ($p = 0.002$) values were significantly higher in smokers compared to non-smokers. Additionally, leukocyte ($p<0.001$), neutrophil ($p=0.001$), and lymphocyte ($p = 0.04$) counts were notably higher in the smokers group. This study indicated that cigarette smoking adversely affects hematological parameters such as hemoglobin, leukocytes, lymphocytes, MCV, and HCT, which may be linked to an increased risk of secondary polycythemia, atherosclerosis, chronic obstructive pulmonary disease, and cardiovascular diseases.

(Tsai *et al*., 2020) [41] researched the adverse effects of smoking in Turkey, focusing on various pathologies mediated by its impact on the inflammatory system. The monocyte to high-density lipoprotein cholesterol (HDL-C) ratio (MHR) has recently emerged as a significant indicator of inflammation. The study aimed to investigate the relationship between MHR and cigarette smoking. Three hundred and ninety-seven smokers and 515 healthy non-smokers participated in the study. Complete blood count parameters and lipid profiles were analyzed for all participants, and smoking habits were quantified in pack-years and the number of cigarettes smoked per day. The results showed that MHR levels were significantly higher in smokers compared to non-smokers, with values being 15.71 (12.02–20.00) for smokers and 11.17 (8.50–14.16) for non-smokers ($p < 0.0001$). Pearson's correlation analysis revealed a weak but positive correlation. (Çiftçiler *et al*., 2019) [11] studied the effects of tobacco cigarette smoking, which is one of the leading causes of death worldwide. Smoking has both acute and chronic effects on hematological parameters. The aim of the study was to assess the extent of adverse effects of cigarette smoking on biochemical characteristics in healthy smokers. A total of 156 subjects participated in this study, including 56 smokers and 100 non-smokers. The smokers were regular consumers of 10-20 cigarettes per day for at least three years. A complete blood cell count was analyzed using a CELL-DYN 3700 fully automatic hematological analyzer.

The results showed that smokers had higher levels (significantly) of white blood cells ($p<0.001$) and ($p=0.042$) for hemoglobin, mean corpuscular volume ($p=0.001$) and ($p<0.001$) for mean corpuscular Hb concentration. All other measured parameters did not significantly differ from each other. Cigarette smoking caused an impactful and meaningful increase ($p<0.001$) in red blood cells and white blood cells ($p=0.040$), for hemoglobin ($p<0.001$), for hematocrit ($p=0.047$) and mean corpuscular hemoglobin has ($p<0.001$) in males (young health) compared to female smokers (young health). The study indicated and investigate that continuous cigarette smoking has severe adverse effects on hematological parameters (e.g., hemoglobin, white blood cell count, mean corpuscular volume, mean corpuscular hemoglobin concentration, red blood cell count and hematocrit). These alterations may be associated with a greater risk of developing atherosclerosis, polycythemia vera, chronic obstructive pulmonary disease, and/or cardiovascular diseases. In another study, (Yılmaz & Kayançiçek, 2018) [45] investigated the effects of cigarette smoking on some hematological test profiles in Basrah, Iraq. This study, which included 60 males (30 smokers and 30 non-smokers) aged 20-49 years, assessed complete blood counts (CBC) as well as blood pressure, heart rate, and renal function tests, including blood urea nitrogen (BUN) and serum creatinine (Scr). The results revealed that white blood cell counts (WBC) were significantly higher ($p < 0.05$) in the 20-49 age group of smokers compared to non-smokers. Additionally, red blood cell (RBC) counts, hemoglobin (Hb), and hematocrit (Hct) were significantly higher ($p < 0.05$) in the 30-49 age group of smokers compared to the same age group of non-smokers. Mean corpuscular volume (MCV) was also significantly increased ($p < 0.05$) in smokers aged 20-49 years compared

to the control group, while mean corpuscular hemoglobin concentration (MCHC) was significantly lower in smokers aged 30-49 years compared to the same age group of non-smokers. However, no significant changes were observed in mean corpuscular hemoglobin (MCH) or platelet (Plt) counts in all age groups ($p < 0.05$).

The study found that lymphocytes were ($p < 0.05$) significantly higher in smokers aged 20-49 years compared to non-smokers (one group) of the same age, while eosinophils were significantly higher ($p < 0.05$) in smokers aged 40-49 years compared to non-smokers of the same age. Neutrophils (Neut), monocytes (Mono), and basophils (Baso) showed no significant changes across all age groups ($p < 0.05$). Additionally, systolic and diastolic blood pressures, as well as heart rates, were significantly higher in smokers aged 30-49 years compared to their non-smoking peers. Serum creatinine (Scr) and blood urea nitrogen (BUN) were also significantly elevated ($p < 0.05$) in smokers aged 20-49 years compared to non-smokers in the same age group. The study aimed to identify or know the impact of smoking on various hematological test profiles, revealing that smoking causes significant and impactful increases in WBC, RBC, Hb, Hct, MCV, Lym, and Eosinophil counts, while MCHC was significantly lower; no significant changes were noted in MCH, Plt, Neut, Mono, and Baso counts. Furthermore, there were significant increases in systolic blood pressure (SBP) and diastolic blood pressure (DBP), heart rate (HR), serum creatinine (S.Cr) and blood urea nitrogen (BUN). Lastly, (Tulgar *et al*., 2016) [42] evaluated the neutrophil and lymphocyte ratio, platelet and lymphocyte ratio and platelet indices in Turkey, stressing their diagnosis importance, prognosis of disease and severity of some diseases. The status of smoking for the patients in these studies had not been well defined. In this study, the researchers compared ratios derived from complete blood counts and platelet indices against smoking status and duration among smokers (one group) and non-smokers (another group). Data were collected from males and females (healthy) and with age of 18 to 60 years who came to the institute for routine check-ups. Subjects were divided into two groups: smokers (one group) and non-smokers (another group). Any history of disease or laboratory results reports that could affect the inflammatory response were exclusion criteria.

Results indicated that white blood cell, neutrophil, basophil, and eosinophil counts, as well as MCV, RCDW and neutrophil and lymphocyte ratio were higher significantly in smokers (one group) compared to non-smokers (another group) ($p<0.05$). The neutrophil/lymphocyte ratio increased in correlation with pack-years, while the platelet/lymphocyte ratio was also affected by smoking status. (Swaminathan *et al*., 2015) [38] conducted a study indicating that smoking is a major factor for causing cardiovascular means heart diseases, inflammatory disorders (infections) and oxidative stress. It is known that cigarette smoking increases the total leukocyte count; however, its impact on platelet parameters is largely unexplored. Timely detection or knowing of thromboembolic diseases can be enhanced through the use of specific platelet indices. Research shows that platelets with increased volume exhibit heightened activity compared to those with smaller volume. Thus, MPV can serve as an indicator of platelet activity. The objective of this cross-sectional study was to examine the impact of cigarette smoking on platelet parameters. It included 50 male (healthy young smokers) and 50 male (healthy young nonsmokers), aged 18 to 50 years, at Medical College named SRM, Tamil Nadu, India. Approval was obtained from the institutional ethical committee prior to the study. Participants with acute illnesses, diabetes mellitus, or those on antiplatelet medications were excluded. Data was collected per day regarding the current smoking status, the number of cigarettes smoked, then pack-years of smoking, and years since quitting.

A complete blood count was performed, which included measurements of platelet indices such as PC, MPV, PDW, P-LCR, PCT. Smokers were classified based on their smoking habits into 1. Mild, 2. Moderate and 3. Heavy categories. The results indicated that smokers exhibited significantly higher values of MPV and PDW compared to nonsmokers ($P < 0.05$). Additionally, MPV, PDW, and P-LCR were associated with the smoking intensity positively and duration of smoking. In conclusion, smokers demonstrated elevated levels of MPV, PDW, and P-LCR, which may indicate a potentially higher risk for developing thromboembolic diseases.

Aim and Objectives

The aim of this study was to investigate the effects of tobacco cigarette smoking on the complete blood count among students at Sarhad University of Science and Information Technology in Peshawar. The study specifically focused on smokers and had the following objectives:

1. To determine the prevalence of smoking among students at Sarhad University.
2. To identify the parameters of the complete blood count test that are most affected in smokers.

Methodology

Study Duration

The research study was conducted over a duration of six months, from March to August 2023.

Study Setting

The study took place at Sarhad University of Science and Information Technology in Peshawar, which provided a suitable environment for data collection.

Study Design

A design (descriptive cross-sectional study) was used for this study means research.

Sample Size

Census sampling was utilized.

Sampling Method

Not applicable.

Inclusion Criteria

The study included undergraduate students who smoked and were currently enrolled in any program at Sarhad University of Science and Information Technology (SUIT).

Exclusion Criteria

Postgraduate students, female students, faculty, and support staff were excluded from the study to maintain a focus on the target population of undergraduate students.

Method of Collection

A pre-designed and pre-tested questionnaire (Appendix I) was used and employed to gather and collect information

from participants, such as age, frequency, duration and any related diseases of the smoking.

Handling of Blood Samples
A sample of 3ml venous blood was drawn or collected in an anticoagulant container (EDTA) following proper procedures and gently (properly) mixed in the hematology mixture. The blood sample was analyzed within one hour using the System KX-21N automated hematology analyzer.

Sample Processing
3ml of EDTA venous blood was collected (withdrawn) using a 5ml disposable syringe then checked for clots and breakdown (hemolysis), then mixed properly before analysis. A 50µl aliquot from each blood sample was drawn using the apparatus needle. The results for each sample were obtained immediately and retained for subsequent statistical analysis.

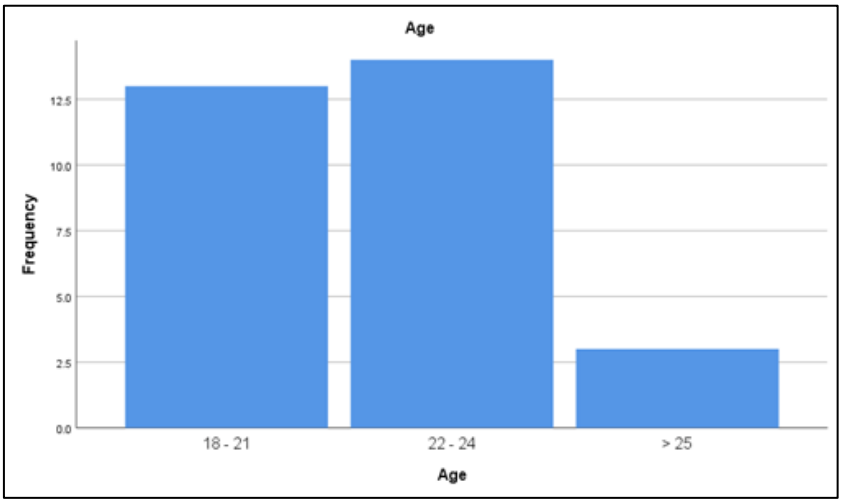
CBC (Complete Blood Count)
The evaluation of cell counts was performed and analyzed using the Sysmex automated analyzer, which is capable of measuring 21 hematological parameters with very high accuracy and precision. The Sysmex analyzer primarily operates on the electronic impedance (resistance) detection method for analyzing, counting and recognizing leukocytes, erythrocytes, and platelets. It employs three (3) preliminary hydraulic systems for analyzing WBCs, RBCs, hemoglobin, and platelets, and displays the blood count results on a liquid crystal display (LCD) along with a histogram. Results are printed on thermal paper.

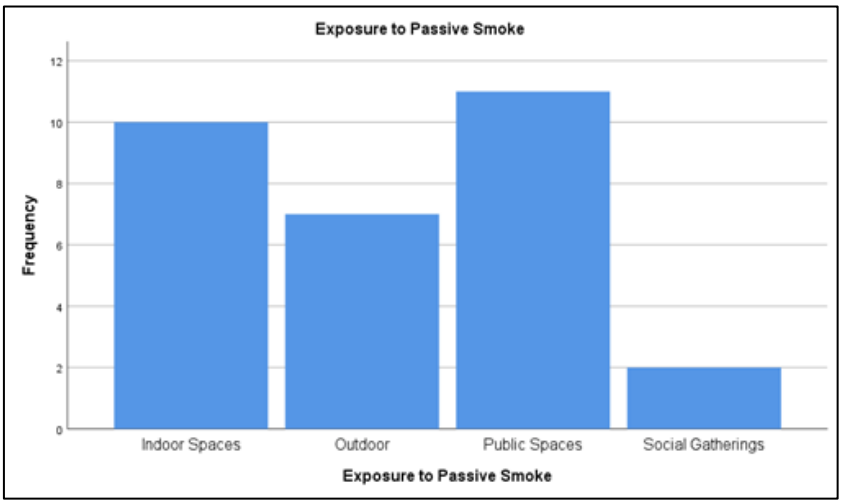
Quality Control
Quality control for the SYSMEX KX-21 machine was conducted as instructed. Daily, weekly, and monthly (3 ways) maintenance and calibration procedures were implemented to ensure and confirm quality assurance. Additionally, before using or working with the apparatus, one of the blood samples from the previous day was re-analyzed (rechecked) for a delta check.

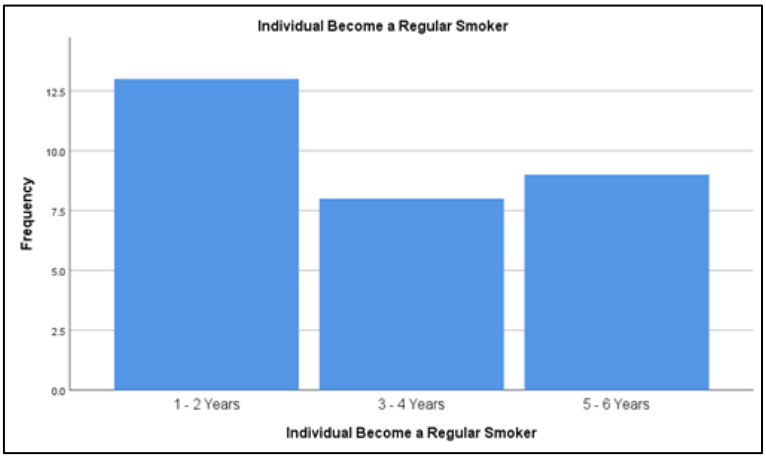
Ethical Consideration
Step before blood sample collection, written informed paper consent was obtained from all participants and the ideal sample (blood) collection procedures were followed to ensure their safety.

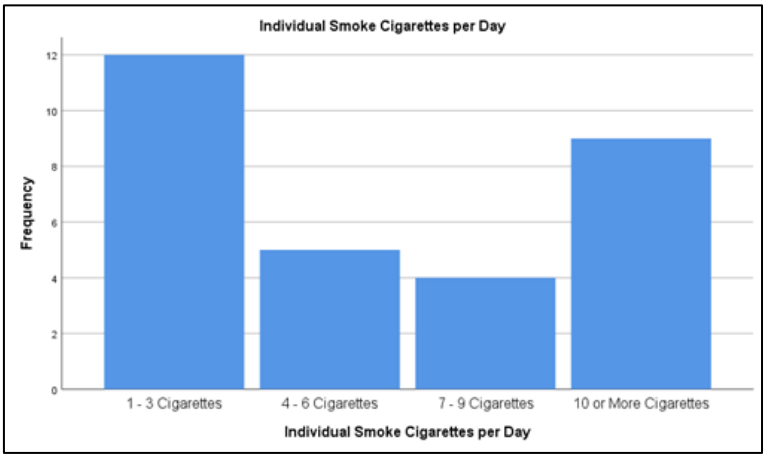
Data Analysis Procedure
Numerical data collected during the study IBM SPSS Statistics version 25 was used for interpretation. Including frequencies and percentages (Descriptive statistics) were computed for the study variables.

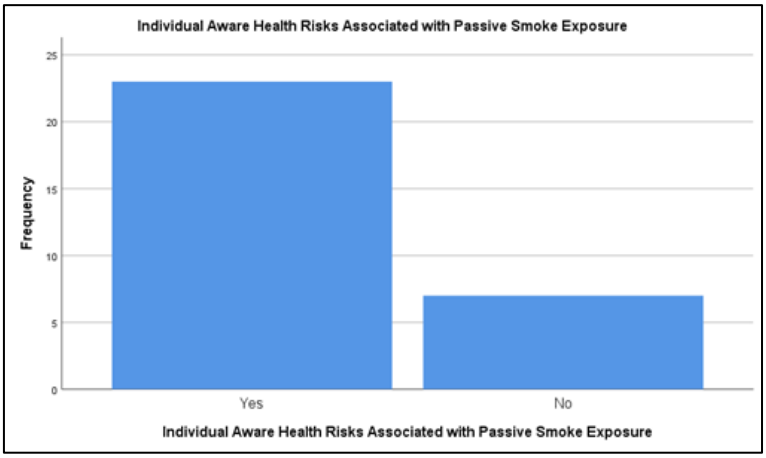
Results
Data representation through chart

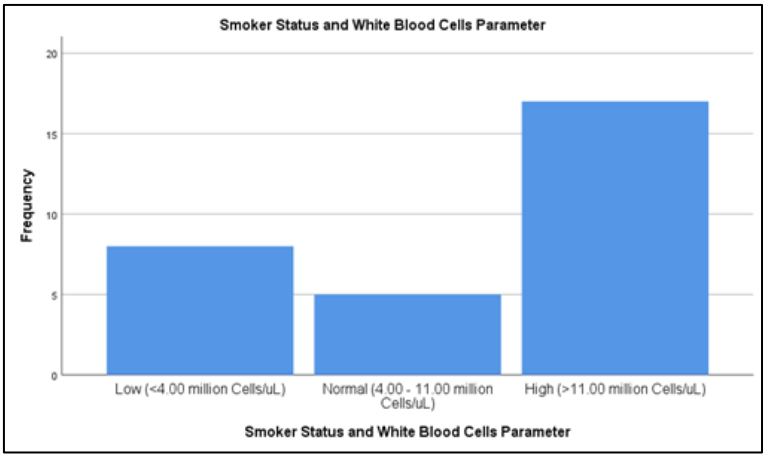


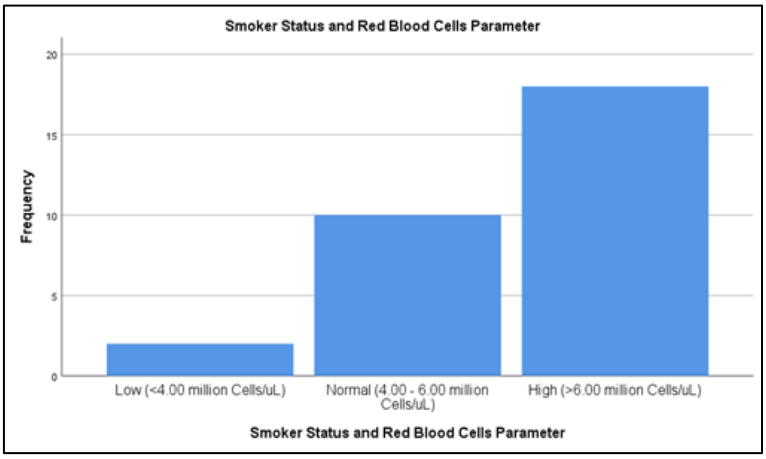


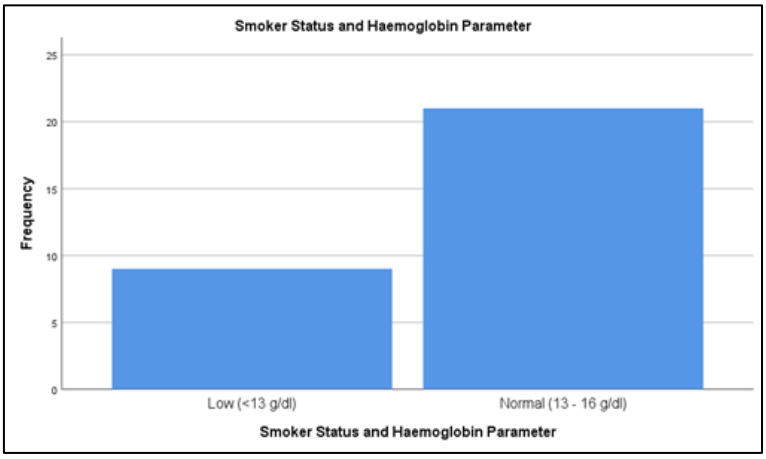

Individual Become a Regular Smoker
Frequency
12.5
10.0
7.5
5.0
2.5
0.0
1 - 2 Years
3 - 4 Years
5 - 6 Years
Individual Become a Regular Smoker

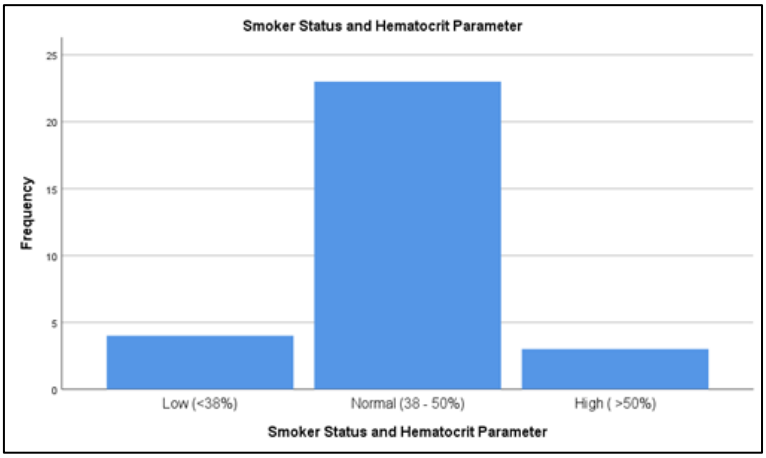

Individual Smoke Cigarettes per Day
Frequency
12
10
8
6
4
2
0
1 - 3 Cigarettes
4 - 6 Cigarettes
7 - 9 Cigarettes
10 or More Cigarettes
Individual Smoke Cigarettes per Day


Individual Aware Health Risks Associated with Passive Smoke Exposure
Frequency
25
20
15
10
5
0
Yes
No
Individual Aware Health Risks Associated with Passive Smoke Exposure


Smoker Status and White Blood Cells Parameter
Frequency
20
15
10
5
0
Low (<4.00 million Cells/uL)
Normal (4.00 - 11.00 million Cells/uL)
High (>11.00 million Cells/uL)
Smoker Status and White Blood Cells Parameter


Smoker Status and Red Blood Cells Parameter
Frequency
20
15
10
5
0
Low (<4.00 million Cells/uL)
Normal (4.00 - 6.00 million Cells/uL)
High (>6.00 million Cells/uL)
Smoker Status and Red Blood Cells Parameter


Smoker Status and Haemoglobin Parameter
Frequency
25
20
15
10
5
0
Low (<13 g/dl)
Normal (13 - 16 g/dl)
Smoker Status and Haemoglobin Parameter


Smoker Status and Hematocrit Parameter
Frequency
25
20
15
10
5
0
Low (<38%)
Normal (38 - 50%)
High (>50%)
Smoker Status and Hematocrit Parameter

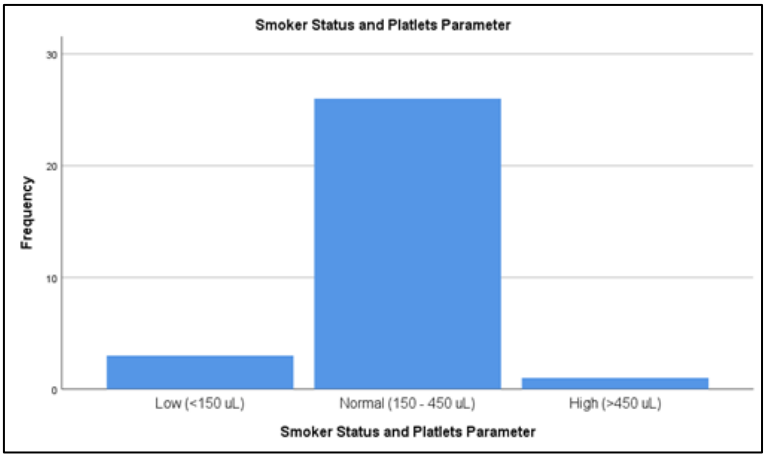

Smoker Status and Platlets Parameter
Frequency
30
20
10
0
Low (<150 uL)
Normal (150 - 450 uL)
High (>450 uL)
Smoker Status and Platlets Parameter

Table 1: Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18 - 21	13	43.3	43.3	43.3
	22 - 24	14	46.7	46.7	90.0
	> 25	3	10.0	10.0	100.0
	Total	30	100.0	100.0	

Table 1 shows the distribution of age for the respondents, which comprises a total 30 individuals. We categorized the respondents into three groups: 13 responses of responded from 18 years to 21 years, 14 responses of responded from 22 years to 24 years, and 3 responses of responded from over 25 years.

Table 2: Smoker's Pattern

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	30	100.0	100.0	100.0

Table 2 various patterns of smoking among the respondents, totaling 30 individuals. The data is divided into four categories:

Table 3: Exposure to Passive Smoke

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Indoor Spaces	10	33.3	33.3	33.3
	Outdoor	7	23.3	23.3	56.7
	Public Spaces	11	36.7	36.7	93.3
	Social Gatherings	2	6.7	6.7	100.0
	Total	30	100.0	100.0	

Table 3: 10 respondents for Indoor spaces, 7 respondents for Outdoor, 11 respondents for Public places & 2 respondents for Social gatherings.

Table 4: Individual Become a Regular Smoker

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - 2 Years	13	43.3	43.3	43.3
	3 - 4 Years	8	26.7	26.7	70.0
	5 - 6 Years	9	30.0	30.0	100.0
	Total	30	100.0	100.0	

Table 4: 13 respondents for 1 to 2 years old, 8 respondents for 3 to 4 years old & 9 respondents for 5 to 6 years old

Table 5: Individual Smoke Cigarettes per Day

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 - 3 Cigarettes	12	40.0	40.0	40.0
	4 - 6 Cigarettes	5	16.7	16.7	56.7
	7 - 9 Cigarettes	4	13.3	13.3	70.0
	10 or More Cigarettes	9	30.0	30.0	100.0
	Total	30	100.0	100.0	

Table 5: 12 respondents for 1 to 3 Cigarettes, 5 respondents for 4 to 6 Cigarettes: 4 respondents for 7 to 9 Cigarettes 12 respondents & 9 respondents for 10 or More Cigarettes

Table 6: Individual Aware Health Risks Associated with Passive Smoke Exposure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	23	76.7	76.7	76.7
	No	7	23.3	23.3	100.0
	Total	30	100.0	100.0	

Table 6: 10 respondents for Yes & 7 respondents for No.

Table 7: Smoker Status and White Blood Cells Parameter

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low (<4.00 million Cells/uL)	8	26.7	26.7	26.7
	Normal (4.00 - 11.00 million Cells/uL)	5	16.7	16.7	43.3
	High (>11.00 million Cells/uL)	17	56.7	56.7	100.0
	Total	30	100.0	100.0	

Table 7 showed that the age of the respondent which the total number of respondent 30 were divide in three category the age group of Low <4.00 cell/uL which are 8 respondents, Normal 4.00-11.00 cell/uL are 5 respondents and high >11.00 cell/uL are total 17 respondents.

Table 8: Smoker Status and Red Blood Cells Parameter

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low (<4.00 million Cells/uL)	2	6.7	6.7	6.7
	Normal (4.00 - 6.00 million Cells/uL)	10	33.3	33.3	40.0
	High (>6.00 million Cells/uL)	18	60.0	60.0	100.0
	Total	30	100.0	100.0	

Table 8 showed that the age of the respondent which the total number of respondent 30 were divide in three category the age group of Low <4 million cell/uL are 2 Respondents, Normal 4-6 million cell/uL are 10 respondents and High >6 million cell/uL are total 18 respondents.

Table 9: Smoker Status and Haemoglobin Parameter

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low (<13 g/dl)	9	30.0	30.0	30.0
	Normal (13 - 16 g/dl)	21	70.0	70.0	100.0
	Total	30	100.0	100.0	

Table 9 showed that the age of the respondent which the total number of respondent 30 Were divide in three category the age group of Low <13 g/dl are 8 respondents, Normal 13-16 g/dl 21 are respondents and High > 16 g/dl is only 1 respondents.

Table 10: Smoker Status and Hematocrit Parameter

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low (<38%)	4	13.3	13.3	13.3
	Normal (38 - 50%)	23	76.7	76.7	90.0
	High (>50%)	3	10.0	10.0	100.0
	Total	30	100.0	100.0	

Table 10 showed that the age of the respondent which the total number of respondent 30 were divide in three category the age group of Low < 38% are 4 respondents, Normal 38-50% 23 are respondents and High >50 are 3 respondents.

Table 11: Smoker Status and Platlets Parameter

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low (<150uL)	3	10.0	10.0	10.0
	Normal (150 - 450uL)	26	86.7	86.7	96.7
	High (>450uL)	1	3.3	3.3	100.0
	Total	30	100.0	100.0	

Table 11 showed that the age of the respondent which the total number of respondent 30 were divide in three category the age group of Low < 150ul are 3 respondents, Normal 150-450ul are 26 respondents and High > 450ul is only 1 respondents.

Fig.4.7 Smoker Status and PLT Parameters

Discussion

In our study encompassing 30 respondents, participants were segmented into three age categories. The first group, comprising 8 respondents, exhibited low white blood cell counts (WBC) of <4.00 cells/uL. The second group, consisting of 5 respondents, demonstrated normal WBC counts ranging from 4.00 to 11.00 cells/uL. And the third group, composed of 17 respondents, displayed high White blood cell counts (WBC) exceeding 11.00 cells/uL. This research was performed at University of Basrah, Iraq give a significant increase ($p< 0.05$) in blood cells like WBC, Red blood cells count, HCT valve and Mean Cells Value in smokers comparably analysis with non-smoker of the same age group. The MCHC was significantly and statistically down means decreased ($p<0.05$) in smoker of age groups 30 years to 40 years compared with non-smoker of the group (same age). A non-significant variation and changes were noted in MCH valves and blood cells like platelet count in all age groups (Q AL-temimi, 2017). In our study involving 30 respondents, we divided into three categories, distinct patterns emerged. The initial category, with 2 respondents, displayed red blood cell counts (RBC) below 4 million cells/uL, indicating a subnormal level. The subsequent category, comprising 10 respondents, showcased RBC counts within the 4-6 million cells/uL normal range. The third category, encompassing 18 respondents, demonstrated RBC counts exceeding 6 million cells/uL, though still within the bounds of normal. Another study conducted at the University of Athens, GREECE. Storage (data base) over time slightly altered means changed some quality parameters, such as HCT, Hb and hemolysis and COHb levels, in RBC packs. COHb levels were higher in red blood cells from smokers which is 8% compare from non-smokers which is 2%, and increased as a function of the number (1,2,3…) of cigarettes smoked daily (in routine) and time elapsed since the last cigarette smoked before donation. The levels were found low in red blood cells packs from donors (individuals) who smoked fewer or less than 20 cigarettes per day in routine or remained abstinent (left) for more than 12 hours before giving means donating blood (Boehm *et al*., 2018).

In our study involving 30 respondents, we divided into three categories. The first category, comprising 8 respondents, exhibited hemoglobin (HB) levels below 13 g/dl, indicating

a subnormal range. The Second category, encompassing 21 respondents HB levels within the 13-16 g/dl normal range. And only 1 respondent in the third category displayed HB levels surpassing 16 g/dl, signifying an elevated level. This study was conducted at Al-Azhar University, Egypt, that heavy smokers (we call it chain smokers) had a statistically more increase in of Hb, PLTs, and neutrophils means blood cells in comparison to both smoker's group i.e. moderate and mild. First, in moderate group in comparison to mild group no statistically significant and important change was found in blood cells between heavy, moderate and mild smokers. In addition, there was no statistically significant or important difference in inflammatory markers like NLR. PLR. CRP and ESR among this groups (mild, moderate, and heavy smokers' groups ($p > 0.05$) (Mohamed *et al*., 2023) [29]. In our study involving 30 respondents we divide into three categorized distinct platelet (PLT) level patterns. The first category, with 3 respondents, displayed PLT levels below 150uL—below the normal. In the second category, 26 respondents showed PLT levels within normal 150-450uL range, reflecting normalcy. The third category exhibited high PLT levels exceeding 450uL. This study (research) was conducted (performed) at Rawalpindi Medical College (RMC) Compares the anthropometric parameters between two groups' i.e. smokers and nonsmokers, which interpretive that there is no significant difference smokers and non-smokers. Table number 2 compares the platelet parameters analysis between this two group's i.e. smokers and non-smokers, which results a statistically significant increase in MPV and PDW in the one group (smokers). Table 3 compares the platelet parameters between three group's i.e. mild, moderate, and heavy smokers, which results that the parameters MPV, PDW and P-LCR were significantly increased (high) in heavy smokers. The issues and abnormalities of platelet parameters were more impactful and significant when the smoking intensity increases formation (Batool *et al*., 2023).

In our analysis of 30 respondents categorized, we are divide into three category distinct hematocrit (HCT) trends emerged. The first category, involving 4 respondents, displayed HCT levels below 38%, normal of them. Among the second category of 23 respondents, HCT levels fell within the 38-50% range, representing typical values. The third category, comprising 3 respondents, exhibited elevated HCT levels exceeding 50%, while remaining within the normal range. This study conducted at Al-Azhar University, Egypt, that heavy smokers (we call it chain smokers) had a statistically more increase in of Hb, PLTs, and neutrophils means blood cells in comparison to both smoker's group i.e. moderate and mild. First, in moderate group in comparison to mild group no statistically significant and important change was found in blood cells between heavy, moderate and mild smokers. In addition, there was no statistically significant or important difference in inflammatory markers like NLR. PLR. CRP and ESR among mild, moderate, and heavy smokers' groups ($p>0.05$) (Mohamed *et al*., 2023) [29].

Conclusion & Recommendations

The effect (impact) of cigarette (tobacco) smoking on the complete blood count (CBC) have been extensively studied. Smoking can lead to several alterations in CBC parameters due to the harmful chemicals present in tobacco smoke. Here are some of the key effects. Those people who used tobacco cigarette smoking, effect on blood cells parameters become higher than normal, As a result when WBC counts are raised that will show adverse effect, for example, leading to inflammation, weakened immune function, and heightened disease risk, In the result when RBC counts are elevated that show revealed variations in blood oxygen of carrying capacity. This can negatively affect oxygen delivery to organs and tissues, for example, Circulatory Disorders, Blood clothing. In Those smoker CBC parameters are raised along with WBC and RBC and further parameter like Hematocrit (HCT), hemoglobin (HB), and platelets (PLT) become normal.

Recommendation for Future research

The most significant recommendation to mitigate the negative effects on CBC and overall health is to quit smoking altogether. Smoking cessation can le ad to a gradual reversal of some CBC abnormalities, reducing the risk of cardiovascular and respiratory diseases. Encourage individuals who smoke to follow a healthier and good lifestyle, including regular exercise, balanced diet (nutrition) and sufficient fluids intake (hydration) to support their blood cell counts and overall well-being. Regularly monitor CBC parameters through routine health check-ups, especially for individuals who continue to smoke or those who recently quit. This will help track any improvements and identify potential health issues early on Seek Professional Support: For those struggling to quit smoking, seeking professional support, such as counseling or nicotine replacement therapies, can significantly increase the chances of successfully quitting. Limit exposure to secondhand smoke, as it can also have adverse effects on CBC parameters and overall health. In conclusion, tobacco cigarette smoking can have various detrimental effects on the complete blood count. Encouraging smoking cessation and adopting a healthy lifestyle are crucial steps to safeguarding CBC parameters and overall health. Regular health check-ups and seeking professional assistance can aid in this process and promote a healthier life. Furthermore, longitudinal study are required with large sample size and both genders.

References

1. Abel GA, Hays JT, Decker PA, Croghan GA, Kuter DJ, Rigotti NA. Effects of biochemically confirmed smoking cessation on white blood cell count. Mayo Clinic Proceedings. 2005;80(8):1022–8.
2. Aftab K, Al Shammari M. Impact of nicotine on hematological parameters and its comparative studies on active and passive smokers. European Journal of Pharmaceutical and Medical Research. 2015;2(6):79–82.
3. Al-Turki YA. Smoking habits among medical students in Central Saudi Arabia. Saudi Medical Journal. 2006;27(5):700–3.
4. Anthonisen N. The effects of a smoking cessation intervention on 14.5-year mortality-response. Annals of Internal Medicine. 2005;143(8):615.
5. Asadikaram G, Asiabanha M, Sayadi A, Jafarzadeh A, Hassanshahi G. Impact of opium on the serum levels of TGF-β in diabetic, addicted and addicted-diabetic rats. Iranian Journal of Immunology. 2010;7(3):186–92.
6. Asif M, Karim S, Umar Z, Malik A, Ismail T, Chaudhary A, Hussain Alqahtani M, Rasool M. Effect of cigarette smoking based on hematological parameters: comparison between male smokers and non-smokers. Turkish Journal of Biochemistry/Turk Biyokimya

Dergisi. 2013;38(1):75–80.
7. Aula FA, Qadir FA. Effects of cigarette smoking on some immunological and hematological parameters in male smokers in Erbil City. Jordan Journal of Biological Sciences. 2013;6(2):147–50.
8. Batool F, Malik K, Meraj L, Tariq KM, Iqbal T, Zaka N. Frequency of raised mean platelet volume in patients with acute coronary syndrome in HIT Hospital Taxila. Journal of Rawalpindi Medical College. 2023;27(2):216–9.
9. Bhadarge G, Ambad R, Bankar N, Kotecha R. Study of cigarette smoking on haematological parameters and lipid profile in Vidharbha region, India. Journal of Pharmaceutical Research International. 2021;33(43B):213–7.
10. Boehm RE, Arbo BD, Leal D, Hansen AW, Pulcinelli RR, Thiesen FV, Balsan AM, Onsten TG, Gomez R. Smoking fewer than 20 cigarettes per day and remaining abstinent for more than 12 hours reduces carboxyhemoglobin levels in packed red blood cells for transfusion. PLOS ONE. 2018;13(9):e0204102.
11. Çiftçiler R, Guven A, Haznedaroğlu İ, Aksu S. Effects of smoking on hematological parameters and ferritin levels. Haseki Tip Bulteni – Medical Bulletin of Haseki. 2019;57(4):291–6.
12. Doll R, Peto R, Hall E, Wheatley K, Gray R. Mortality in relation to consumption of alcohol: 13 years' observations on male British doctors. BMJ. 1994;309(6959):911–8.
13. Eiras S, Teijeira-Fernández E, Shamagian LG, Fernandez AL, Vazquez-Boquete A, Gonzalez-Juanatey JR. Extension of coronary artery disease is associated with increased IL-6 and decreased adiponectin gene expression in epicardial adipose tissue. Cytokine. 2008;43(2):174–80.
14. Elisia I, Lam V, Cho B, Hay M, Li MY, Yeung M, Bu L, Jia W, Norton N, Lam S. The effect of smoking on chronic inflammation, immune function and blood cell composition. Scientific Reports. 2020;10(1):19480.
15. Ernst E. Smoking, a cause of back trouble? Rheumatology. 1993;32(3):239–42.
16. Fernández JAF, Prats JM, Artero JVM, Mora AC, Fariñas AV, Espinal A, Méndez JAG. Systemic inflammation in 222,841 healthy employed smokers and nonsmokers: white blood cell count and relationship to spirometry. Tobacco Induced Diseases. 2012;10:1–8.
17. Gitte RN. Effect of cigarette smoking on plasma fibrinogen and platelet count. Asian Journal of Medical Sciences. 2011;2(3):181–4.
18. Hussain MS, Hamid NM, Al-Ani MQ, Muden BK, Hamad-Allah MJ, Sweed OH, Sabbar SS. Hematological changes in blood of smokers of cigarettes and nargyle. Indian Journal of Forensic Medicine and Toxicology. 2020;14(2):1771–6.
19. Inal B, Hacıbekiroglu T, Cavus B, Musaoglu Z, Demir H, Karadag B. Effects of smoking on healthy young men's hematologic parameters. Northern Clinics of Istanbul. 2014;1(1):19–22.
20. Islam MM, Amin MR, Begum S, Akther D, Rahman A. Total count of white blood cells in adult male smokers. Journal of Bangladesh Society of Physiologist. 2007;2:49–53.
21. Jaafar NS. The effect of cigarette smoking on blood and biochemical parameters: A comparative study among male smokers and non-smokers in Baghdad City. Iraqi Journal of Science. 2020;727–31.
22. Karam GA, Rashidinejad HR, Aghaee MM, Ahmadi J, Rahmani MR, Mahmoodi M, *et al*. Opium can differently alter blood glucose, sodium and potassium in male and female rats. Pakistan Journal of Pharmaceutical Sciences. 2008;21(2):180–4.
23. Khan MS. Relationship of smoking with alteration in body physiology. Biomedical Letters. 2022;8(2):177–83.
24. Kume A, Kume T, Masuda K, Shibuya F, Yamazaki H. Dose-dependent effects of cigarette smoke on blood biomarkers in healthy Japanese volunteers: observations from smoking and non-smoking. Journal of Health Science. 2009;55(2):259–64.
25. Liang X, Liu R, Chen C, Ji F, Li T. Opioid system modulates the immune function: a review. Translational Perioperative and Pain Medicine. 2016;1(1):5.
26. Liu Z, Li X, Zhang M, Huang X, Bai J, Pan Z, *et al*. The role of Mean Platelet Volume/platelet count Ratio and Neutrophil to Lymphocyte Ratio on the risk of Febrile Seizure. Scientific Reports. 2018;8(1):15123.
27. Malenica M, Prnjavorac B, Bego T, Dujic T, Semiz S, Skrbo S, *et al*. Effect of cigarette smoking on haematological parameters in healthy population. Medical Archives. 2017;71(2):132.
28. Mjøs OD. Lipid effects of smoking. American Heart Journal. 1988;115(1):272–5.
29. Mohamed SE, Eid HA, Moazen EM, El-Fattah A, Doaa A. Impact of chronic cigarette smoking on blood count indices, erythrocyte sedimentation rate and C-reactive protein as inflammatory markers in healthy individuals. Journal of Recent Advances in Medicine. 2023;4(1):74–85.
30. Monti M, Monti A, Murdolo G, Di Renzi P, Pirro MR, Borgognoni F, *et al*. Correlation between epicardial fat and cigarette smoking: CT imaging in patients with metabolic syndrome. Scandinavian Cardiovascular Journal. 2014;48(5):317–22.
31. Okafor I, Okoroiwu H. Effects of tobacco cigarette smoking on some hematological parameters of male cigarette smokers in Southern Nigeria. Asian Journal of Medicine and Health. 2017;5(3):1–6.
32. Al-temimi SQ. The effect of cigarette smoking on some blood parameters, blood pressure and renal function test. Journal of Kerbala University. 2017;13(1):1–10.
33. Raupach T, Shahab L, Baetzing S, Hoffmann B, Hasenfuss G, West R, *et al*. Medical students lack basic knowledge about smoking: findings from two European medical schools. Nicotine and Tobacco Research. 2009;11(1):92–8.
34. Sajadian S, Vatankhah M, Majdzadeh M, Kouhsari SM, Ghahremani MH, Ostad SN. Cell cycle arrest and apoptogenic properties of opium alkaloids noscapine and papaverine on breast cancer stem cells. Toxicology Mechanisms and Methods. 2015;25(5):388–95.
35. Saqib MAN, Rafique I, Qureshi H, Munir MA, Bashir R, Arif BW, *et al*. Burden of tobacco in Pakistan: findings from global adult tobacco survey 2014. Nicotine and Tobacco Research. 2018;20(9):1138–43.
36. Schuler M, Muehlbauer P, Guzzie P, Eastmond D. Noscapine hydrochloride-induced numerical aberrations in cultured human lymphocytes: a comparison of FISH detection methods and multiple end-points.

Mutagenesis. 2003;18(3):235–42.
37. Stefanadis C, Tsiamis E, Vlachopoulos C, Stratos C, Toutouzas K, Pitsavos C, *et al*. Unfavorable effect of smoking on the elastic properties of the human aorta. Circulation. 1997;95(1):31–8.
38. Swaminathan A, Amitkumar K, Ganapathy S, Ayyavoo S. Evaluation of the impact of cigarette smoking on platelet parameters. National Journal of Physiology, Pharmacy and Pharmacology. 2015;5(5):427.
39. Tarazi IS, Sirdah MM, El Jeadi H, Al Haddad RM. Does cigarette smoking affect the diagnostic reliability of hemoglobin $\alpha_2\delta_2$ (HbA_2)? Journal of Clinical Laboratory Analysis. 2008;22(2):119–22.
40. Torres de Heens G, Kikkert R, Aarden LA, Van Der Velden U, Loos BG. Effects of smoking on the ex vivo cytokine production in periodontitis. Journal of Periodontal Research. 2009;44(1):28–34.
41. Tsai M, Byun MK, Shin J, Crotty Alexander LE. Effects of e-cigarettes and vaping devices on cardiac and pulmonary physiology. The Journal of Physiology. 2020;598(22):5039–62.
42. Tulgar Y, Cakar S, Tulgar S, Dalkilic O, Cakiroglu B, Uyanik B. The effect of smoking on neutrophil/lymphocyte and platelet/lymphocyte ratio and platelet indices: a retrospective study. European Review for Medical and Pharmacological Sciences. 2016;20(14).
43. Wannamethee SG, Lowe GD, Shaper AG, Rumley A, Lennon L, Whincup PH. Associations between cigarette smoking, pipe/cigar smoking, and smoking cessation, and haemostatic and inflammatory markers for cardiovascular disease. European Heart Journal. 2005;26(17):1765–73.
44. World Health Organization. WHO report on the global tobacco epidemic 2011: warning about the dangers of tobacco. eScholarship, University of California. 2011.
45. Yılmaz M, Kayançiçek H. A new inflammatory marker: elevated monocyte to HDL cholesterol ratio associated with smoking. Journal of Clinical Medicine. 2018;7(4):76.