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Original Article

Effect of Smoking on Red Blood Cell Parameters: A Cross-sectional Study in a Divisional City of Bangladesh

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Abstract

Background: Several metabolic and biochemical processes, hormone secretion, and the haematological system are all affected by smoking. Numerous studies have found that smoking is associated with higher levels of haemoglobin concentration (Hb%), total red blood cell count (RBC), and red cell distribution width (RDW). ***Objectives:*** To study the RBC parameters in healthy male smokers and non-smokers among adults. ***Methodology:*** This research was carried out in the Department of Physiology of Sylhet MAG Osmani Medical College, from July, 2021 to June, 2022. A total of 200 participants were included with healthy adult smokers and age-matched healthy adult non-smokers. History and physical examinations were used to evaluate each individual. We measured height and weight, and calculated body mass index of the subjects. Calculations were made on cigarette smoking intensity and duration. Blood was collected to determine RBC parameters, such as total RBC count, haemoglobin level, haematocrit, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) and red cell distribution width (RDW) by using Sysmex 500i automatic haematology analyzer (Japan). ***Results:*** Among the 200 participants, 100 were adult smokers and another 100 age-matched healthy adult non-smokers. The RBC indices were significantly elevated in smokers compared to non-smokers group: mean haemoglobin concentration (g/dl)± standard deviation (SD) were 14.17 ± 2.13 versus 13.27 ± 1.39 respectively with $p<0.001$, mean haematocrit (HCT) (percent) ± SD were 41.60 ± 6.88 versus 39.13 ± 5.46 respectively with $p=0.005$, mean corpuscular volume (MCV) (fl) ± SD 91.13 ± 8.86 versus 88.33 ± 5.58 respectively with $p=0.033$, mean corpuscular hemoglobin (MCH) (pg) ± SD 31.16 ± 3.26 versus 30.05 ± 3.0 respectively with $p=0.016$ and mean red cell distribution width (RDW) (percent)+ SD 14.74 ± 1.63 versus 14.00 ± 1.57 respectively with $p=0.001$. However, RBC count ($\times 10^6/\mu l$) (4.60 ± 0.80 versus 4.46 ± 0.60; $p=0.143$) and mean corpuscular haemoglobin concentration (MCHC) (g/dl) (34.23 ± 2.11 versus 34.11 ± 2.32; $p=0.707$) did not differ significantly between smoker and non-smoker groups. There was no statistical difference between mild, moderate, and severe smokers, according to the study's variables. ***Conclusion:*** MCV, MCH, RDW, haematocrit, and haemoglobin concentration were all significantly higher in smokers.

Key Words: Smoker, RBC, Haemoglobin, Red cell distribution with, Haematocrit

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Introduction:

The act of smoking involves burning tobacco and inhaling the resulting smoke using various devices, including cigarettes, cigars, biris, and pipes.[1] Smoking is a well-known health risk and one of the leading causes of death. Over 8 million fatalities occur globally each year as a result of tobacco usage.[2] The World Health Organization (WHO) predicts that tobacco use will cause 10 million deaths annually by the decade 2020–2030, with 70% of these fatalities will occur in the developing world. According to the same document of the WHO, around 2.4 billion individuals worldwide have consumed tobacco through smoking, chewing, snuffing, or dipping.[3]

A person, who has smoked 100 or more cigarettes in their lifetime and presently smokes every day or occasionally, is considered to be a current smoker if they are 18 years or older. Overall, men were found to smoke more cigarettes currently than the women.[4]

It is assumed that irregularities in blood rheology, infections and inflammation, oxidative stress, and changes to the antithrombotic and fibrinolytic system are responsible for health hazards in smokers.[5,6]

It has long been proven that smoking has an impact on a number of metabolic and biological processes. Haematological components develop in peripheral blood after starting to grow in the bone marrow. As a result, they are impacted by cigarette smokes' free radicals and peroxides, which harm peripheral blood and bone marrow and contribute to the pathogenesis of a number of illnesses, such as inflammatory processes, atherosclerosis, and carcinomas.[5,7,8] Moreover, smoking has been found linked to higher levels of haemoglobin concentration (Hb%), total red blood cell (RBC) count, and red cell distribution width (RDW).[6,7] It has been demonstrated that higher RDW in smokers is a strong predictor of mortality in individuals with coronary artery disease.[9,10] Smoking tobacco may also alter RBCs' morphology, which lowers the blood's ability to carry oxygen.[11]

Previous research found that smoking causes pulmonary gaseous exchange abnormalities that result in secondary polycythemia, which is demonstrated by an increase in the number of RBCs, haemoglobin levels, and haematocrit, as well as by low serum erythropoietin levels.[12]

With a slight decrease in daily cigarette use, the negative effects of smoking on haematological parameters improve. A study observed that when chronic smokers stop smoking, the majority of RBC-related indicators quickly revert to baseline.[13]

The purpose of this study was to evaluate the effects of smoking on RBC parameters among healthy smoker and non-smoker males.

Methodology

This study was conducted in the Department of Physiology, Sylhet MAG Osmani Medical College, Sylhet. The study design was a cross-sectional and carried out from July, 2021 to June, 2022. Convenient sampling method was applied for data collection. By using Guilford and Frucher's formula ($n=z^2pq/d^2$),[14] the calculated sample size was 143. But in this study, we took 100 sample in each two groups. Hundreds of them were healthy adult smokers and age-matched another 100 healthy adult non-smokers were selected. Healthy adult individuals of Kajolshah of Sylhet City, Bangladesh, were selected to participate in this study. Informed written consent was obtained from each participant after explaining the purpose of the study. All the participants were assessed through history and physical examination. Height and weight were measured and body mass index (BMI) was calculated. Intensity and duration of cigarette smoking was calculated for smokers by using the following formula: Pack-years = (number of cigarettes smoked per day × number of years smoked)/20.[15]

With all aseptic precautions, 5 ml venous blood was collected from each of the cases from the antecubital vein by a plastic disposable syringe with minimum stasis. The blood specimens were stored in an EDTA tube. Study variables were total RBC count, Haemoglobin level, Haematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular Haemoglobin (MCH), mean corpuscular Haemoglobin concentration (MCHC) and red cell distribution width (RDW). All RBC indices were measured by using Sysmex 500i Automatic Haematology Analyzer (Biotech limited, Japan) and estimated in the Department of Pathology, Sylhet MAG Osmani Medical College, by the researchers.

Data were collected by using a semi-structured questionnaire designed for the study. After data collection, they were processed and analyzed with the help of Statistical Package for Social Science (SPSS) version 25.0. The comparison was made by using student's unpaired 't' test and ANOVA test. Qualitative data were expressed as frequency and percentage, and comparison was done by using Chi-Square (χ^2) test. The p-value <0.05 was considered as statistically significant.[16]

Results

Majority of the participants among smokers (32, 32.0%) and non-smokers (38, 38.0%) were from 21-30 years age group. (Table I)

Table I: Table-1 Distribution of participants by age (N=200)

Age	Study groups		p-value
	Smoker (n=100)	Non-smoker (n=100)	
Up to 20 years	2 (2.0%)	5 (10.0%)	
21 to 30 years	32 (32.0%)	38 (38.0%)	
31 to 40 years	28 (28.0%)	28 (28.0%)	p= 0.569*
41 to 50 years	19 (19.0%)	14 (14.0%)	
51 to 60 years	19 (19.0%)	15 (15.0%)	

*Statistical analyses were done by Chi-Square (χ^2) test

The mean ± standard deviation (SD) body mass index (BMI) was 19.44 ± 1.49 (Kg/m²) in smoker group and 19.07 ± 1.27 (Kg/m²) in non-smoker control group; body mass index did not differ significantly (p=0.569) between two groups. (Figure 1)

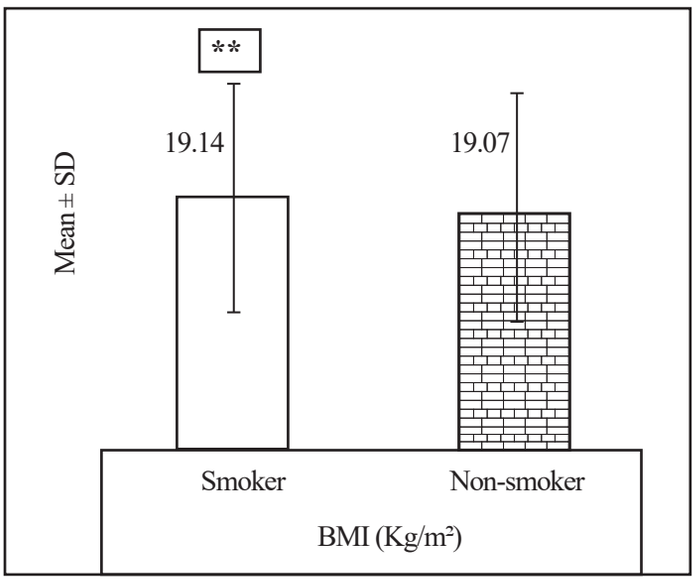

Figure 1: Body Mass Index of the study subjects (n=200)

The mean RBC count ± SD was 4.60 ± 0.80 ×10⁶/µl in smokers and 4.46 ± 0.60 ×106/µl in non-smokers; difference was not statistically significant (p=0.143). (Figure 2)

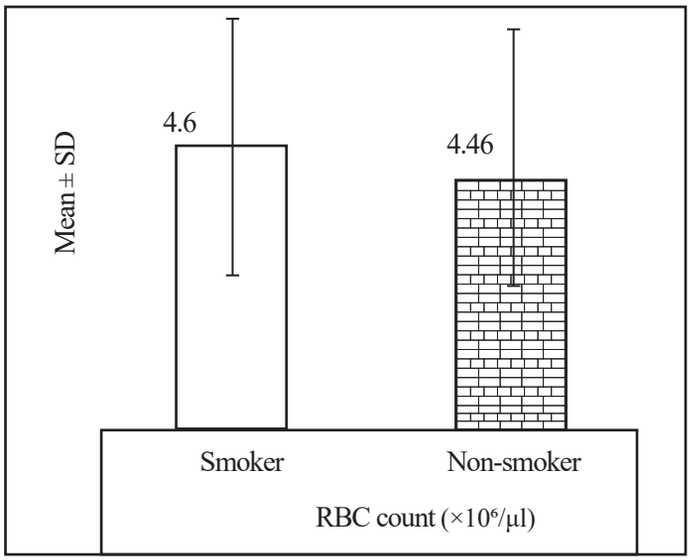

Figure 2: Mean RBC count among smokers and non-smokers

The mean haemoglobin (g/dl) was 14.17 ± 2.13 g/dl in smokers and 13.27 ± 1.39 g/dl in non-smokers; difference was statistically significant (p<0.001) (Figure 3).

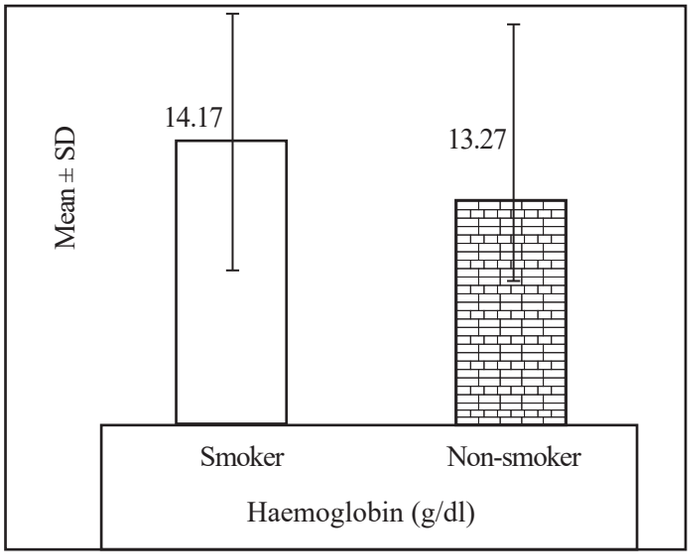

Figure 3: Mean haemoglobin concentration between smokers and non-smokers

The mean HCT was 41.60 ± 6.88 % in smoker and 39.13 ± 5.46 in non-smoker; difference was significant (p=0.005). The mean MCV was 91.13 ± 8.86 fl in smoker and 88.33 ± 5.58 fl in non-smoker; difference was significant (p=0.033). The mean MCH was 31.16 ± 3.26 pg in smoker and 30.05 ± 3.22 pg in non-smoker; difference was significant (p=0.016). The mean MCHC was 34.23 ± 2.11 g/dl in smoker and 34.11 ± 2.32 g/dl in non-smoker; difference was not significant (p=0.707). The mean RDW was 14.74 ± 1.63 % in smoker group and 14.00 ± 1.57 % in non-smoker control group; difference was significant (p=0.001). (Table II)

Table-II: Comparison of RBC parameters between study groups

RBC parameters	Study groups		p-value
	Smoker (n=100)	Non-smoker (n=100)	
HCT (%)	41.60 ± 6.88	39.13 ± 5.46	p=0.005
MCV (fl)	91.13 ± 8.86	88.33 ± 5.58	p=0.033
MCH (pg)	31.16 ± 3.26	30.05 ± 3.22	p=0.016
MCHC (g/dl)	34.23 ± 2.11	34.11 ± 2.32	p=0.707
RDW (%)	14.74 ± 1.63	14.00 ± 1.57	p=0.001

Independent sample 't' test was used to analyze the data. Haematocrit (HCT); mean corpuscular volume (MCV); mean corpuscular haemoglobin (MCH); mean corpuscular haemoglobin concentration (MCHC) and red cell distribution width (RDW); fl- femtoliter; pg-picogram.

There was no statistically significant difference in the mean RBC count, haemoglobin concentration, HCT, MCV, MCH, MCHC, or RDW amongst mild, moderate, and heavy smokers (p>0.05) (Table 3).

Table 3: Distribution of RBC parameters according to intensity of smoking

RBC parameters	Intensity of smoking			*p*-value*
	Mild (n=22)	Moderate (n=63)	Severe (n=15)	
RBC count ($\times 10^6$/µl)	4.42 ± 0.83	4.67 ± 0.81	4.56 ± 0.54	p=0.419
Haemoglobin (g/dl)	13.80 ± 1.88	14.37 ± 2.39	13.92 ± 0.99	P=0.501
HCT (%)	41.00 ± 6.69	42.16± 7.28	40.15 ± 5.34	p=0.541
MCV (fl)	94.43 ± 9.68	90.71 ± 8.67	88.08 ± 7.35	p=0.082
MCH (pg)	31.94 ± 3.74	31.00 ± 3.24	30.71 ± 2.49	p=0.431
MCHC (g/dl)	33.82 ± 2.11	34.19 ± 1.89	34.99 ± 2.83	p=0.251
RDW (%)	15.03 ± 1.69	14.81 ± 1.57	13.99 ± 1.67	p=0.147

One way ANOVA* test was used to analyze the data. µl- microliter; Hematocrit (HCT); mean corpuscular volume (MCV); mean corpuscular hemoglobin (MCH); mean corpuscular hemoglobin concentration (MCHC) and red cell distribution width (RDW); fl- femtoliter; pg-picogram.

Discussion

Several researches had suggested that smoking has negative consequences on the human body.[17, 18]

Smoking is one of the risk factors for developing a variety of medical conditions, including cancer, chronic obstructive pulmonary disease, pancreatitis, metabolic syndro mes, periodontal disease, and gastrointestinal disorders.[19]

There was no significant difference in the age groups of the participants between the two study groups (p=0.569). Similar findings were observed in Arbab et al.[20] The body mass index (BMI) did not differ significantly between the two groups (p=0.057). This finding was supported by Herath et al[8] who found that the difference was not significant (p=0.143). This result was consistent with Lakshmi as reported in 2018[21] Sharma and Agrawal in 2020,[22] who observed that smokers' RBC counts were significantly higher than those of non-smokers, and their findings were statistically significant. High RBC levels were reportedly linked to blood viscosity and clotting in smokers. High RBC count is referred to as polycythemia, and extremely high RBC count restrict blood flow and raise the risk of intravascular clotting, coronary vascular resistance, decreased coronary blood flow, and a propensity for thrombosis.[23]

There was statistically significant difference between the smoker and non-smokers were observed (p<0.001). This outcome was supported by several studies.[21-24] Carbon monoxide exposure is thought to be the mediator of increased haemoglobin concentration in smokers. A compensating mechanism, according to some investigators, may explain why smokers' blood haemoglobin levels were higher.[5] When carbon monoxide binds to haemoglobin, carboxyhaemoglobin is produced, an inactive form of haemoglobin that is incapable of transporting oxygen. The ability of haemoglobin to carry oxygen to the tissues is reduced when carboxyhaemoglobin shifts the Hb dissociation curve to the left.[25] Smokers maintain higher levels of haemoglobin concentration than non-smokers do in order to compensate the reduced ability of haemoglobin to carry oxygen.[21]

The mean HCT (%) significantly (p=0.005) differed between the smoker and non-smoker groups. This result was concordant with the studies of Lakshmanan and Saravanan 2014[24] and Lakshmi.[20] Smokers had higher haematocrit levels, and these increases were most likely compensatory for carbon monoxide exposure.

Hypoxia brought on by carboxy-haemoglobin results in enhanced production of erythropoietin, enhancing erythropoiesis can be used to explain an increase in the number of erythrocytes and levels of haematocrit. Moreover, by reflecting a rise in haematocrit value, carbon monoxide lowers plasma volume and, as a result, mimics polycythemia by increasing capillary permeability.[26]

The mean MCV (fl) values were significantly (p=0.033) different between the two groups. Acik et al[7] and Bashir et al[27] had similar findings in their studies. High MCV levels in our study participants suggested that they may have megaloblastic, haemolytic, pernicious, or macrocytic anemia, which is typically brought on by iron and folic acid deficiencies.

The mean MCH (pg) was significantly (p=0.016) different between two groups. Asif et al found that MCH did not differ significantly between the smoker group and non-smoker group.[23]

The mean MCHC did not differ significantly (p=0.707) between the study subjects. This result was consistent with the study of Malenica et al[5] But Asif et al found that MCHC was significantly higher in the smoker group compared to the non-smoker group.[23]

The mean red cell distribution width (RDW) (%) smoker and non-smoker difference was significant (p=0.001). This result was supported by the study of Ciftciler et al.[6] But Asif et al[23] found that RDW did not differ significantly between the two groups. There was no significant difference in the distribution of RBC parameters according to the intensity of smoking was observed (p>0.05).

In this study, haematological parameters were compared also according to status and intensity of smoking in smokers by ANOVA test. The mean RBC count, haemoglobin concentration, HCT, MCV, MCH, MCHC, RDW had no statistically difference among mild, moderate and severe smokers. But Alvi et al found that mean RBC count, haemoglobin concentration, HCT, MCV, MCH and MCHC were increased significantly with the intensity of cigarette smoking.[28]

Conclusion

The levels of the RBC parameters were found considerably higher in smokers compared with non-smokers. Elevated RBC parameters may develop cardiovascular accidents. For this reason, social awareness should develop and regular checking of these parameters for smokers should ensure.

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Conflict of interest: None

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