



## Original Research Article

# Effects of cigarette smoking on erythrocyte sedimentation rate, platelet count, total and differential leucocyte counts in adult male smokers

Safia Sultana<sup>1</sup>, Nabila Afsar<sup>2</sup>, Mohammed Jawad<sup>1</sup>, Mohammed Abdul HannanHazari<sup>3</sup> <sup>1</sup>Graduate Student, <sup>2</sup>Department of Pathology, <sup>3</sup>Department of Physiology; Deccan College of Medical Sciences, DMRL 'X' Road, Kanchanbagh, Hyderabad-500058, Telangana, India.

## Article history

Received 05 March 2019  
Revised 26 March 2019  
Accepted 27 March 2019  
Online 28 March 2019  
Print 31 March 2019

## Keywords

Platelet count  
Smoking  
Total leucocyte count

## Abstract

Smoking is one of the leading causes of death worldwide. Smokers have higher risk for coronary heart disease, atherosclerosis, acute myocardial infarction, hypertension, clotting disorders, inflammation, respiratory diseases, cancers, etc. A cigarette smoker is exposed to a number of harmful substances. In this study we hypothesized that smoking causes inflammatory reactions and induces hyperthrombic state in the body which may be reflected in erythrocyte sedimentation rate (ESR), total leucocyte count (TLC), differential leucocyte count (DLC) and platelet count values. The purpose of the study was to study the effects of cigarette smoking on erythrocyte sedimentation rate, total leucocyte count and platelet count in adult male smokers and to compare the results with non-smokers and to establish a relationship between the duration and quantity of smoking with the change in ESR, TLC, DLC and platelet count. A cross sectional study was conducted in the department of Pathology on 86 healthy male subjects (smokers=43 and non-smokers=43). ESR was estimated using Westergrens method. TLC, DLC and platelet counts were estimated using HORIBA Pentra ES60 auto-analyzer. TLC and basophil counts were significantly higher in smokers than in non-smokers ( $p < 0.05$ ). The mean value of ESR was higher among smokers than non-smokers but it was statistically insignificant. Platelets counts showed no significant difference between smokers and non-smokers. No correlation was observed in various blood parameters and smoking (in pack years). We conclude that smoking initiates an inflammatory response as evidenced from raised TLC, monocyte and basophil counts.

## Introduction

Smoking is amongst the leading causes of death worldwide. In India, 24.3% of the adult men are tobacco smokers [1]. 1 to 1.5 million people die every year in India due to consequences of smoking. Cigarette smoke contains a number of

harmful substances like carbon monoxide, tar, nicotine, etc. which exert effects on many systems of the body. Smokers are at increased risk for coronary artery disease (CAD), atherosclerosis, acute myocardial infarction, hypertension (HTN),

## Corresponding author

Ms. Safia Sultana

Graduate Student,

Deccan College of Medical Sciences,  
DMRL 'X' Road, Kanchanbagh, Hyderabad-500058,  
Telangana, India.

Phone: +91-9966196410

Email: [sultanasafia2013@gmail.com](mailto:sultanasafia2013@gmail.com)DOI: <https://doi.org/10.23921/amp.2019v3i1.35185>

Print ISSN: XXXX-XXXX

Online ISSN: 2456-8422

Copyright © 2019. Quench Academy of Medical Education and Research (QAMER).



This is an open access article licensed under a Creative Commons Attribution 4.0 International License.

clotting disorders, inflammation, respiratory diseases, cancers, etc.

Previous studies have found that smoking causes oxidative stress by releasing free radicals like hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) and nitric oxide (NO). These free radicals cause endothelial damage leading to increased whole blood viscosity, rouleaux formation and inflammatory reactions. This can be reflected by change in erythrocyte sedimentation rate (ESR) [2,3,4,5]. Previous studies have reported that smoking can effect total leucocyte counts (TLC). Smoking has an irritant effect on respiratory system with resultant inflammation, releasing inflammatory cytokines which can influence growth, differentiation and activation of leucocytes [6,7,8]. Leucocyte counts are considered as an independent risk factor for various cardiovascular diseases [9]. Studies on effects of smoking on differential leucocyte counts (DLC) have shown conflicting results.

In smokers, hyperthrombic state could be due to increased platelet activity which may be reflected in platelet count. Increased platelet activity may trigger clotting cascade that can cause occlusive vascular disease. Previous studies on platelet count have reported inconclusive results. Some studies reported platelet count increases due to smoking [10] whereas others have reported no significant change [5]. In view of these published literature, we hypothesized that smoking causes inflammatory reactions and induces prothrombic / procoagulant state in the body which may be reflected in ESR, TLC, DLC and platelet count.

## Materials and methods

A cross-sectional study was conducted in the department of Pathology of our medical college between May and June 2016. A total of 86 male subjects (smokers: 43; non-smokers: 43) in the age group of 18-40 years were included in the study. Ethics approval was obtained from Institutional Review Board (IRB number: 2016/11/003) before the start of this study.

### Selection of subjects

**Inclusion criteria:** Apparently healthy smokers (n=43) in the age group 18-40 years who smoke one or more cigarette per day and healthy non-smokers (n=43) of the age group 18-40 years were included in the study.

**Exclusion criteria:** Male subjects suffering from coagulation disorders, hypertension, diabetes, infections, acute or chronic respiratory illness or debilitating illness have been excluded from the study. Male subjects taking non-steroidal anti-inflammatory drugs (NSAIDs) or any other anti-platelet aggregation drugs were excluded from this

study. Non-smokers who are subjected to passive smoking were also excluded from the study.

### Methodology

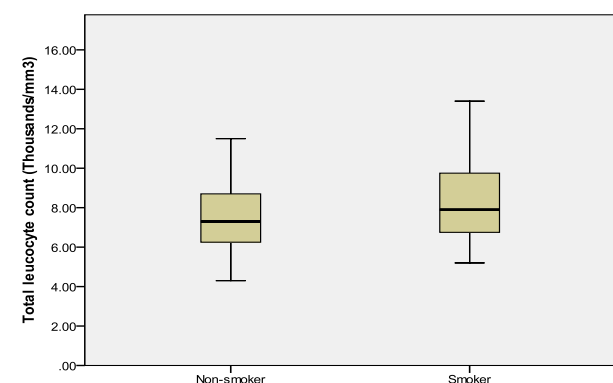
The subjects were divided into 2 groups i.e. smokers (n=43) and non-smokers (n=43). Informed consent was obtained from each subject. The particulars of the subjects and required history were taken from all the subjects. Under aseptic precautions, 4ml venous blood sample was collected from the median cubital vein using a 5ml disposable syringe. 2ml of blood was mixed in K3 EDTA containing vacutainer for estimation of red blood cell (RBC) count, hemoglobin (Hb) concentration, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), red cell distribution width (RCDW), total leucocyte count (TLC), differential leucocyte count (DLC) i.e. counts of neutrophils, eosiniphils, basophils, lymphocytes and monocytes; platelet count, plateletcrit, mean platelet volume (MPV), platelet distribution width (PDW) using HORIBA Pentra ES60 auto-analyzer. Additional parameters documented were atypical lymphocytes and large immature cells. 2ml of blood was mixed in 3.8% trisodium citrate (in the ratio of 1:4) containing vacutainer for estimation of erythrocyte sedimentation rate by Westergren's method. The samples were evaluated within 1 hour of sample collection.

Manual confirmation of platelet count was done in few samples by making blood smear and staining with Leishman's stain and examination under microscope. Controls were used prior to testing on auto-analyzer for quality control.

### Statistical analysis

Data collected was analyzed using independent sample 't' test and partial correlation available in SPSS 17.0 statistical software (SPSS Inc., Chicago, USA).

## Results



**Figure 1.** Differences in TLC between smokers and non-smokers

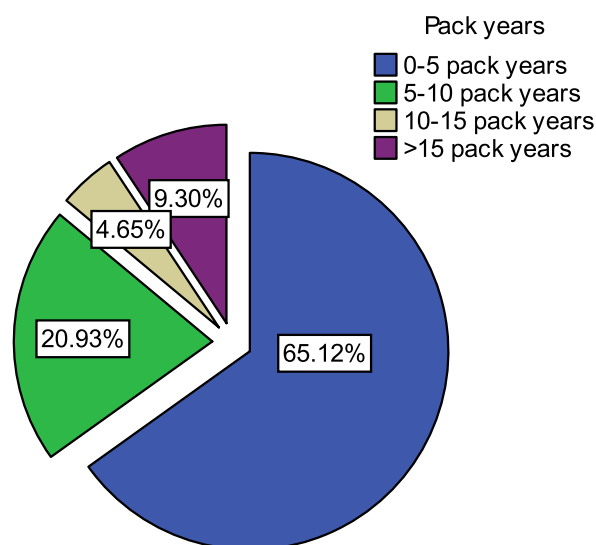
**Table 1:** Differences in hematological parameters between smokers and non-smokers

	Non-smokers (n=43)	Smokers (n=43)	p value
Age (years)	21.49±4.54	26.02±6.48	0.000*
No. of cigarettes (per day)	-	8.35±7.65	
Duration of smoking (years)	-	8.09±6.22	
ESR (mm/1 <sup>st</sup> hour)	6.47±4.70	10.51±12.58	0.053
TLC (thousands/mm <sup>3</sup> )	7.41±1.63	8.44±2.28	0.019*
Platelet count (lakhs/mm <sup>3</sup> )	2.67±0.64	2.65±0.57	0.909
RBCs (millions/mm <sup>3</sup> )	5.36±0.39	5.24±0.44	0.173
Hemoglobin (gm/dl)	15.11±0.98	14.77±2.05	0.320
Hematocrit (%)	45.82±2.86	44.74±3.73	0.136
MCV (fl)	85.65±5.04	85.72±6.24	0.955
MCH (pg)	28.27±2.05	28.72±2.57	0.363
MCHC (%)	32.99±0.68	33.50±0.91	0.004*
RCDW (%)	12.28±1.02	12.37±1.53	0.772
Neutrophils (thousands/mm <sup>3</sup> )	4.10±0.98	4.54±1.67	0.135
Lymphocytes (thousands/mm <sup>3</sup> )	2.52±0.65	2.72±0.70	0.171
Monocytes (thousands/mm <sup>3</sup> )	0.53±0.18	0.62±0.20	0.021*
Eosinophils (thousands/mm <sup>3</sup> )	0.23±0.16	0.27±0.17	0.292
Basophils (thousands/mm <sup>3</sup> )	0.16±0.12	0.28±0.31	0.023*
Atypical lymphocytes (%)	0.06±0.03	0.07±0.04	0.439
Large immature cells (%)	0.06±0.03	0.08±0.07	0.070
MPV (fl)	7.99±0.75	7.87±0.80	0.461
Plateletcrit (%)	6.77±42.51	0.21±0.04	0.317
PDW (%)	13.18±2.45	12.70±2.07	0.329

Data is presented as Mean±SD. \*Statistically significant

**Table 1** shows the mean values of hematological parameters. ESR was higher in smokers than non-smokers but the difference was not statistically significant. Total leucocyte count (TLC) was significantly higher ( $p=0.019$ ) in smokers than in non-smokers (**Figure 1**). Counts of monocytes ( $p=0.021$ ) and basophils ( $p=0.023$ ) were significantly higher among smokers. RBC count, hematocrit and hemoglobin concentration was not significantly different between the two groups. Among RBC indices, only MCHC was significantly different between smokers and non-smokers. Platelet counts, plateletcrit and platelet indices showed no significant difference between smokers and non-smokers.

Also there was no significant linear relationship observed between various hematological parameters and cigarette smoking (in pack years). **Figure 2** shows the distribution of smokers into groups based on pack years.

**Figure 2:** Distribution of smokers according to pack years

## Discussion

The present study was done to document any change in total leucocyte count (TLC), differential leucocyte count (DLC), platelet count and erythrocyte sedimentation rate (ESR) among smokers and non-smokers and to evaluate any relationship between hematological values and duration/intensity of smoking among smokers. As the previous studies did not delve into the effect of chronicity of smoking and the intensity of smoking on the TLC, platelet count and ESR, this is the newer dimension in this study.

Total leucocyte count was significantly higher in smokers than non-smokers in this study which was consistent with the results of Oke et al [5], Shenwai et al [6], Asif et al [7], Ahmed [11], Nadia et al [12], Iqbal et al [13] and Fadiel et al [14]. It was conflicting with the study conducted by Khand et al [15]. Smoking has an irritant effect on the respiratory tree which can cause chronic inflammation. It causes increased release of inflammatory cytokines from the epithelial cells, these influence the activation and differentiation of leucocytes. This could be the reason of leucocytosis. Another mechanism proposed is that nicotine increases release of catecholamines which can increase the total leucocyte count [16]. Monocyte and basophil counts were significantly higher in smokers than non-smokers. High basophil counts indicate an ongoing inflammatory process in the body. This can increase the risk of atherosclerosis, cardiovascular disorders, chronic lung diseases and cause increased morbidity and mortality in smokers.

In this study, no significant correlation was obtained between smokers and non-smokers with respect to erythrocyte sedimentation rate. This was in contrast to the results of Nisa et al [2], Sharma et al [3], Islam et al [4] and Oke et al [5] who found that the erythrocyte sedimentation rate was increased in smokers when compared to non-smokers. This increase was independent of the number of cigarettes smoked per day [3,4].

There have been conflicting results in previous studies on the effect of smoking on platelet counts. In this study we found that platelet counts were similar amongst smokers and non-smokers. It is consistent with the results of Oke et al [5], Shenwai et al [6], Asif et al [7], Mohammed et al [17], Nadia et al [12] and Khand et al [15]. The results obtained were in contrast to some other studies. Ghahremanfard et al [10] and Ahmed [11] found that platelet counts were significantly increased in smokers when compared to non-smokers whereas Sandhya et al [18] concluded that the platelet counts of chronic smokers were significantly lower than that of non-smokers and

decreased significantly with increase in duration of smoking.

## Limitations of the study

Sample size was relatively small for such type of case-control study. Since the hematological parameters are having wide range of normalcy, the differences in many parameters was not evident.

## Conclusion

We found no statistically significant difference in erythrocyte sedimentation rate and platelet count of smokers and non-smokers. There was a significant increase in total leucocyte count, basophil count and monocyte count in smokers when compared to non-smokers which indicate inflammation in the body. As these changes are occurring in young healthy men with no other risk factors, smoking cessation can reduce the risk of developing cardiovascular and respiratory problems in future.

## Acknowledgement

The authors thank all the subjects who have voluntarily participated in the study. We also thank the technical staff of the Department of Pathology for all help extended in hematological study. We also thank Dr. Mehnaaz Sameera Arifuddin, Associate Professor, Department of Physiology, for critical review of the manuscript.

## Source of funding

This study was partly supported by Indian Council of Medical Research (ICMR) (Crossref Funder ID: 10.13039/501100001411) through Short-term Studentship (STS) program (Reference ID: 2016-02818).

**Conflict of interest:** None

## References

1. World Health Organization. WHO report on the global tobacco epidemic, 2017: monitoring tobacco use and prevention policies. Geneva: World Health Organization, 2017.
2. Nisa M, Zaman S. Study of erythrocyte sedimentation rate (ESR) values and serum lipids in young cigarette smokers. Proc S.Z.P.G.M.I. 2003; 17(2):71-3.
3. Sharma A, Yadav B, Pathak R, Singh AK, Hussein M, Singh S. Effects of smoking on erythrocyte sedimentation rate, bleeding time and clotting time of young adults. Natl J Med Allied Sci. 2014; 3(1):19-23.
4. Islam MM, Amir MR, Rahman MA, Akhter D. Erythrocyte sedimentation rate (ESR) in male adult smokers. Dinajpur Med Coll J. 2013 Jul; 6(2):180-4.
5. Oke OT, Nsa NB, Oyewole OS, Olufemi A, Aderemi AO. Evaluation of haemorheological parameters in cigarette smokers in western Nigeria. Greener J Med Sci. 2012 Dec; 2(6):146-51.
6. Shenwai MR, Aundhakar NV. Effect of cigarette smoking on various hematological parameters in young male

- smokers. *Indian J Basic Applied Med Res.* 2012 Dec; 5(2):386-92.
7. Asif M, Karim S, Umar Z, Malik A, Ismail T, Chaudhary A, Alqahtani MH, Rasool M. Effect of cigarette smoking based on hematological parameters: comparison between male smokers and non-smokers. *Turkish J Biochem.* 2013 Apr; 38(1):75-80. DOI: 10.5505/tjb.2013.49369
  8. Iyer RA, Joshi AR, Esmail H. Effect of cigarette smoking on leucocytes count in human adult males. *Int J Physiol.* 2014; 2(1):107-11. DOI: 10.5958/j.2320-608X.2.1.023
  9. Madjid M, Awan I, Willerson JT, Casscells SW. Leucocyte count and coronary heart disease: implications for risk assessment. *J Am Coll Cardiol.* 2004 Nov; 44(10):1945-56. PMID: 15542275 DOI: 10.1016/j.jacc.2004.07.056
  10. Ghahremanfard F, Semnani V, Ghorbani R, Malek F, Behzadfar A, Zahmatkesh M. Effects of cigarette smoking on morphological features of platelets in healthy men. *Saudi Med J.* 2015 Jul; 36(7):847-50. PMID: 26108590 DOI: 10.15537/smj.2015.7.11026
  11. Ahmed OA. Effects of smoking cigarette on white blood cell and platelet parameter on a sample of normal subject in Rania city. *Imperial Journal of Interdisciplinary Research.* 2016; 2(9): 887-892.
  12. Nadia MM, Shamseldein HA, Sara AS. Effects of cigarette and shisha smoking on hematological parameters: An analytic case-control study. *International Multispecialty Journal of Health.* 2015 Dec; 1(10): 44-51.
  13. Iqbal Z, Khan NM, Nisar M, Mazhar R, Asadullah, Bashir S, Syed AM. Effect of cigarette smoking on erythrocytes, leucocytes and haemoglobin. *Journal of Medical Sciences.* 2003; 3(3): 245-50. DOI: 10.3923/jms.2003.245.250
  14. Fadiel FE, Hasan HM. A comparative study on some hematological parameters of some smokers and non-smokers blood samples. *World Journal of Pharmaceutical Research.* 2016; 5(2):146-54.
  15. Khand F, Shaikh SS, Ata MA, Shaikh SS. Evaluation of the effect of smoking on complete blood counts, serum C-reactive protein and magnesium levels in healthy adult male smokers. *J Pak Med Assoc.* 2015 Jan; 65(1):59-61. PMID: 25831676
  16. Armitage AK. Effect of nicotine and tobacco smoke on blood pressure and release of catechol amines from the adrenal glands. *Br J Pharmacol Chemother.* 1965 Oct; 25(2):515-26. PMID: 5866729 DOI: 10.1111/j.1476-5381.1965.tb02069.x
  17. Mohammed AE, Ahmed MA, Ibrahim IK, Ali EW. Study of platelet count and indices in smokers and ex-smokers. *European Academic Research.* 2016 Feb; 3(11):12081-88.
  18. Sandhya M, Satyanarayana U, Mohanty S, Basalingappa DR. Impact of chronic cigarette smoking on platelet aggregation and coagulation profile in apparently healthy male smokers. *Int J Clin Exp Physiol.* 2015; 2(2):128-33. DOI: 10.4103/2348-8093.161547