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Evaluation of Plasma Fibrinogen Level, Platelet Count & Lipid Profile as Predictors of Cardiovascular Disease among Bangladeshi Healthy Male Smokers

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Background: Smoking represents a substantial global health challenge, correlating with heightened rates of mortality and morbidity, notably including the onset of cancer. Within tobacco smoke are carcinogenic substances capable of perturbing cellular mechanisms and immune responses, thereby potentially influencing coagulation metrics and lipid profiles.
Objective: This study aimed to investigate the plasma fibrinogen level, platelet count & lipid profile as predictors of cardiovascular disease among Bangladeshi healthy male smokers.
Methods: A cross-sectional analytical study was conducted at the Department of Physiology, Sir Salimullah Medical College (SSMC) in Dhaka, Bangladesh, from July 1, 2018, to June 30, 2019. Seventy male participants aged 20 to 40 years were enrolled, comprising 35 healthy non-smokers (Group A) and 35 male smokers (Group B). Smokers were further categorized into two groups based on pack year (5-15 pack year for B_1 & >15 pack year for B_2). Coagulation parameters including plasma fibrinogen and platelet count and lipid profile were assessed.
Results: The study comprised 70 subjects, evenly divided into Group A and Group B, with comparable mean ages of 33.17 ± 2.91 years and 34.11 ± 3.18 years, respectively, and similar mean body mass index (BMI) values of 24.36 ± 2.28 kg/m^2 and 24.68 ± 2.33 kg/m^2. Plasma fibrinogen levels were significantly higher in Group B (315.55 ± 67.79 mg/dL) compared to Group A (222.49 ± 23.03 mg/dL), as were platelet counts (285.14 ± 34.33 x10^9/L in Group B vs. 235.20 ± 46.83 x10^9/L in Group A). Further stratification of Group B revealed higher fibrinogen levels in both subgroups, B_1 and B_2, compared to Group A, with B_2 exhibiting the highest fibrinogen levels. Platelet counts followed a similar trend, with both B_1 and B_2 having significantly higher counts than Group A. Plasma fibrinogen level was positively correlated with pack-years of smoking, while platelet counts showed a positive but statistically non-significant correlation. Smokers exhibited elevated total cholesterol (TC), triglycerides (TG), and low-density lipoprotein (LDL) levels, along with decreased high-density lipoprotein (HDL) levels compared to non-smokers. Moreover, there was a significant positive correlation between pack-years of smoking and TC, TG, and LDL levels, while HDL levels exhibited a significant negative correlation. These findings underscore the complex interplay between smoking, coagulation parameters, and lipid profiles, emphasizing the multifaceted impact of smoking on cardiovascular health.
Conclusion: In conclusion, the study highlights the intricate relationship between smoking, coagulation parameters, and lipid profiles in a cohort of 70 subjects. Smokers exhibited elevated plasma fibrinogen levels and platelet counts compared to non-smokers, with a significant positive correlation observed between pack-years of smoking and these coagulation parameters. Additionally, smokers demonstrated higher levels of total cholesterol, triglycerides, and low-density lipoprotein, alongside lower levels of high-density lipoprotein, indicative of dyslipidemic state in the direction of increased risk for coronary artery disease. Furthermore, the discovered alterations in plasma fibrinogen, platelet, and lipid profiles serve as early predictors of cardiovascular disease, advocating for proactive management strategies in individuals with a smoking history.

Keywords: Smoking; coagulation parameters; plasma fibrinogen; platelet count; lipid profile.

1. INTRODUCTION

Smoking has deleterious effects on many organ system mainly respiratory and cardiovascular system [1]. Smoking decreases lung function by constricting airways and raises the risk of myocardial infarction and stroke by obstructing blood flow to the heart and brain, respectively [2]. Smoking cigarettes has a wide range of negative consequences on health, including changes to the primary hemostatic systems through disruptions in the functions of platelets, coagulation factors, and endothelial cells [3]. Smoking has been shown to induce hypercoagulability and a hyperthrombotic state possibly by increased platelet aggregation and adhesiveness due to nicotine content in the smoke. The risk of cardiovascular illnesses is

increased by hypercoagulability, which is a risk factor for coronary thrombosis and thromboembolic episodes [4,5,6,7].

Platelets are essential for hemostasis and endothelial repair. Smoking increases activation of platelets which causes significant increase in blood clots leading to enhanced risk of thrombosis [8]. Evidences from the literatures suggest that platelet counts are elevated in smokers [9-11]. However some authors reported decreased platelet count in smokers [12,13].

Coagulation is an important function of platelets. It is the process of vascular damage followed by the successive adhesion of platelets to the sites of injury, thereby initiating the coagulation cascade [14]. Platelet activation and blood clotting are interdependent and interacting processes [15]. The complicated interactions between blood vessels, platelets, plasma coagulation factors, and fibrinolytic proteins determine the balance of clotting and dissolution of clots [16]. Any disruption in this complicated system leads to hemostatic dysfunction leading to pathologic thrombosis or vascular occlusion by thrombus fragments [17].

Fibrinogen is the primary coagulation protein in blood, from which fibrin clots originate. Fibrinogen connects platelet receptors, causing platelet aggregation and promoting hypercoagulability, as well as endothelial damage, disorganization, and malfunction [18]. Fibrinogen as a classical positive acute phase reactant protein acts as an independent predictor of coronary heart disease events. Increased plasma fibrinogen levels are linked to cardiovascular disease. Low plasma fibrinogen levels, on the other hand, have been linked to an increased risk of bleeding due to impaired primary and secondary hemostasis. If the platelet count and plasma fibrinogen levels are abnormally low, bleeding is impaired [19]. High fibrinogen level may increase the blood viscosity which further enhances the risk of thrombus formation at an atherosclerotic plaque. Thus fibrinogen may play an important part in the early evolution of stroke [20]. Higher fibrinogen in plasma constitute a state of hypercoagulability and moderate elevation contributes to plaque growth [21]. Takajo et al. reported that each cigarette stick smoked per day increases mean plasma fibrinogen by 0.35 g/L [22].

Furthermore, other studies discovered that smoking cigarette affects the coagulation state and promotes vessel wall damage by modifying the lipid content of circulating blood [23]. Burning et al. reported lower HDL levels in smokers, indicating high risk of developing cardiovascular disease among smokers [24].

From the above studies it has been revealed that long term smoking results in alteration of plasma fibrinogen level, platelet count and lipid parameters among smokers predisposing the smokers to various life threatening complications. So the present study has been designed to determine plasma fibrinogen level, platelet count & lipid profile as predictors of cardiovascular disease among Bangladeshi healthy male smokers.

1.1 Objective

General objective: The purpose of this study is to investigate the plasma fibrinogen level, platelet count & lipid profile as predictors of cardiovascular disease among Bangladeshi healthy male smokers.

Specific objective:

- To estimate plasma fibrinogen, platelet count and lipid profile in apparently healthy male cigarette smokers and non-smokers.
- To compare all those above-mentioned parameters in apparently healthy male cigarette smokers and non-smokers.
- To correlate plasma fibrinogen, platelet count and lipid profile with pack year of smoking duration

2. METHODOLOGY

Study type: Cross sectional analytical study.

Study Place and Period: Department of Physiology, Sir Salimullah Medical College (SSMC), Dhaka. The study was conducted from from 1st July 2018 to 30th June 2019.

Sample size: A total number of seventy (70) male subjects age ranged from 20 to 40 year.

Sampling technique: Consecutive purposive sampling.

Grouping of the subjects:

Group A: Comparison group

Consisted of thirty-five (35) apparently healthy non-smoker male subjects.

Group B : Study group

Consisted of thirty-five (35) apparently healthy male cigarette smokers. They were subdivided again into 2 groups according to the pack-years of smoking history.

Group B_1 : smokers with 5-15 pack-years of smoking history. Consisted of twenty one (21) apparently healthy male cigarette smokers.

Group B_2 : smokers with > 15 pack-years of smoking history. Consisted of fourteen (14) apparently healthy male cigarette smokers.

Selection criteria:

Inclusion criteria: Comparison group were apparently healthy non-smoker male subjects. Inclusion criteria for study group were apparently healthy male regular cigarette smokers taking at least 10 sticks per day for 10 years or ≥ 5 pack-years of smoking history (1 pack-year = 20 cigarettes per day for 1 year).

Exclusion criteria:

For both groups: Subjects with any of the following were excluded from the study.

- History of preexisting hypertension, diabetes mellitus, heart disease, liver disease, renal disease, thyroid disorder, peripheral vascular disease, inflammatory disorder, malignancy, infection or debilitating illness.
- History of drug addiction or alcoholism
- History of taking aspirin, NSAID, lipid lowering drugs and other drugs affecting platelet function 10 days prior to collection of blood.
- Any coagulopathy.

Study parameters:

- Plasma fibrinogen
- Platelet count
- Lipid profile

Study procedure: A total number of seventy male participants, aged 20 to 40 years, were included in this study, selected through consecutive purposive sampling from the hospital staff members of Sir Salimullah Medical College (SSMC) and Mitford hospital and Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka and also from personal contact. After proper counselling the aim, objectives, risk and procedure of the study were explained in details to the subjects. They were encouraged for voluntary participation and were allowed to withdraw themselves from the study even after participation whenever they like. Smokers were interviewed about duration of smoking and average number of cigarette sticks smoked per day to determine their smoking exposure by estimation of pack-year. Prior to blood collection, participants underwent detailed medical assessments and physical examinations which were recorded in a data information sheet.

Blood was collected from each participants for estimation of biochemical and hematological tests. First all the blood samples were analyzed for glucose, creatinine, and ALT levels to rule out underlying health issues. Then their cardiovascular risk were assesed by estimation of platelet count, plasma fibrinogen level and lipid profile.

Statistical analysis: Data were presented as mean ± SD (standard deviation). Statistical analysis was done by using Statistical Package of Social Science (SPSS) windows version-22. ANOVA test was performed for comparison among the groups and then Bonferroni test was done to compare between the groups. Unpaired 't' test and Pearson's Correlation test were done to compare the data as applicable. p value ≤ 0.05 was considered as level of significance.

3. RESULTS

In both groups, subjects had almost similar mean (± SD) ages of 33.17 ± 2.91 and 34.11 ± 3.18 years for group A and group B respectively, with no statistically significant difference observed. Additionally, the mean (± SD) BMI values were 24.36 ± 2.28 and 24.68 ± 2.33 kg/m^2 for group A and group B respectively, with no statistically significant difference, indicating successful age and BMI matching across all study subjects.

Table 1. Age and BMI in both groups (N=70)

Variable	Group A (n=35)	Group B (n=35)	p-value
Age (years)	33.17 ± 2.91 (25.00 – 37.00)	34.11 ± 3.18 (24.00 - 39.00)	0.200
BMI (kg/m^2)	24.36 ± 2.28 (20.02 - 29.05)	24.68 ± 2.33 (19.00 - 29.06)	0.564

Table 2. Plasma fibrinogen level and platelet count in both groups (N=70)

Variable	Group A (n=35)	Group B (n=35)	p-value
Fibrinogen (mg/dL)	222.49 ± 23.03 (190.00 - 284.60)	315.55 ± 67.79 (170.70 - 437.10)	<0.001***
Platelet count(×10^9/L)	235.20 ± 46.83 (170 - 370)	285.14 ± 34.33 (220 - 400)	<0.001***

Table 3. Plasma fibrinogen level and Platelet count in different groups (N=70)

Variable	Group A (n=35)	Group B_1 (n=21)	Group B_2 (n=14)
Fibrinogen (mg/dL)	222.49 ± 23.03 (190.0 - 284.6)	287.62 ± 67.52 (170.7 - 437.1)	357.46 ± 43.07 (270.0 - 400.0)
Platelet count(10^9/L)	235.20 ± 46.83 (170 - 370)	278.81 ± 37.61 (220 - 400)	294.64 ± 27.28 (240 - 330)

ANOVA test was done following Bonferroni test

	Fibrinogen	Platelet count
	p value	p value
A vs B_1 vs B_2	0.000***	0.000***
A vs B_1	0.000***	0.001**
A vs B_2	0.000***	0.000***
B_1 vs B_2	0.000***	0.800ns

Table 4. Correlation of coagulation parameters with pack-year in study group (n=35)

	r value	p value
Fibrinogen (mg/dL)	+0.498	0.002**
Platelet count(10^9/L)	+0.298	0.082ns

In this study, the mean (± SD) plasma fibrinogen level of the subjects were 222.49 ± 23.03 and 315.55 ± 67.79 mg/dL in group A and group B respectively, with a statistically significant (p<0.001) mean (± SD) higher plasma fibrinogen level observed in group B in comparison to that of group A. Moreover, the mean (± SD) platelet count of the subjects were 235.20 ± 46.83 and 285.14 ± 34.33 x10^9/L in group A and group B respectively with a significant (p<0.001) higher mean (± SD) platelet count in group B in comparison to that of group A.

The mean (± SD) plasma fibrinogen level of the subjects were 222.49 ± 23.03, 287.62 ± 67.52 and 357.46 ± 43.07 mg/dL in group A, B_1 and B_2 respectively with a significantly increased plasma fibrinogen level observed in group B_1 (p<0.001) and B_2 (p<0.001) in comparison to that of group A. Again group B_2 exhibited a significantly (p<0.001) higher mean (± SD) plasma fibrinogen level than B_1. The mean (± SD) platelet count of the subjects were 235.20 ± 46.83, 278.81 ± 37.61 and 294.64 ± 27.28 x10^9/L in group A, B_1 and B_2 respectively with a significantly increased mean (± SD) platelet count found in group B_1 (p<0.01) and B_2 (p<0.001) in comparison to that of group A. Again no statistical significant difference was observed in mean (± SD) platelet count between group B_1 and B_2.

In this study, plasma fibrinogen was positively correlated (r = + 0.498) with pack-year of smoking duration in the study group. The relationship was statistically (p<0.01) significant. Moreover, platelet count was positively correlated (r = + 0.298) with pack- year of smoking duration in the study group. But the relationship was not statistically significant.

In this study, TC (total cholesterol), TG (triglycerides), and LDL (low-density lipoprotein) levels were significantly higher (p<0.001) in smokers than in non-smokers, while HDL (high-density lipoprotein) was significantly lower (p<0.001) in smokers than in non-smokers.

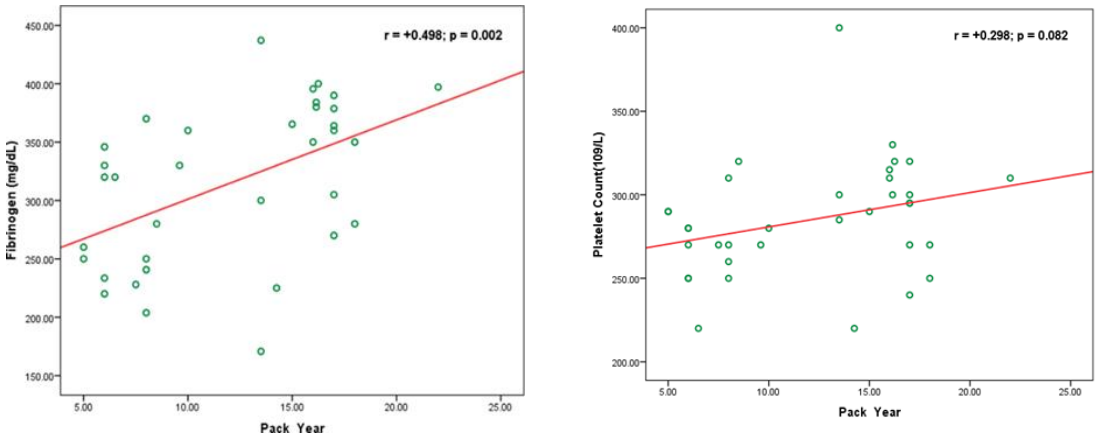

Fig. 1a and 1b. Correlation of plasma fibrinogen and platelet count with pack-year in study group (n=35)

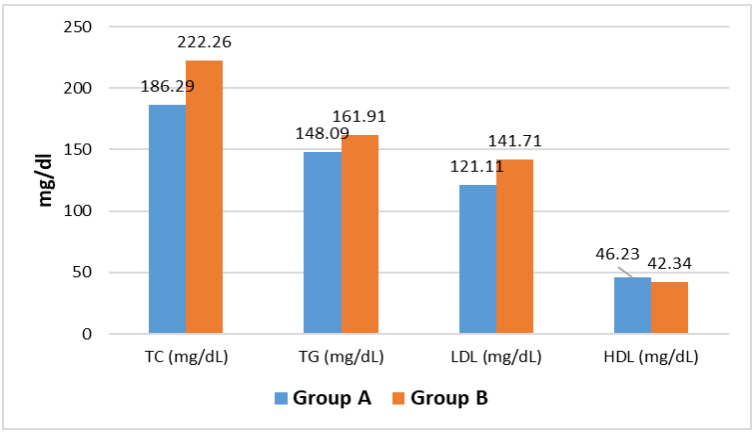

Fig. 2. Lipid profile status in both groups (N=70)

Table 5. Lipid profile status in different group (N=70)

	Group A (n=35)	Group B_1 (n=21)	Group B_2 (n=14)
TC (mg/dL)	186.29 ± 8.26	211.71 ± 18.63	238.07 ± 47.85
TG (mg/dL)	148.09 ± 8.89	157.38 ± 9.50	168.71 ± 22.82
LDL (mg/dL)	121.11 ± 13.07	132.52 ± 16.74	155.50 ± 23.89
HDL (mg/dL)	46.23 ± 2.03	43.05 ± 1.80	41.29 ± 1.59

ANOVA test was done following Bonferroni test

	TC	TG	LDL	HDL
A vs B_1 vs B_2	<0.001***	<0.001***	<0.001***	<0.001***
A vs B_1	0.001**	0.035*	0.049*	<0.001***
A vs B_2	<0.001***	0.041*	<0.001***	<0.001***
B_1 vs B_2	0.007**	<0.001***	0.001**	0.026*

There were significant differences observed in the levels of TC (total cholesterol), TG (triglycerides), LDL (low-density lipoprotein) and HDL (high-density lipoprotein) between non-smokers and smokers with low pack year history, as well as between smokers with high pack-year history and non-smoker also between smokers with low pack-year history and smoker with high pack-year history.

There was significant positive correlation of pack year with TC, TG and LDL whereas significant negative correlation with HDL observed among the smokers.

Table 6. Correlation of lipid profiles with pack year in study group (n=35)

	r	p-value
TC	**+0.471**	**0.004****
TG	**+0.379**	**0.025***
LDL	**+0.367**	**0.030***
HDL	**-0.488**	**0.003****

Pearson correlation coefficient test was done

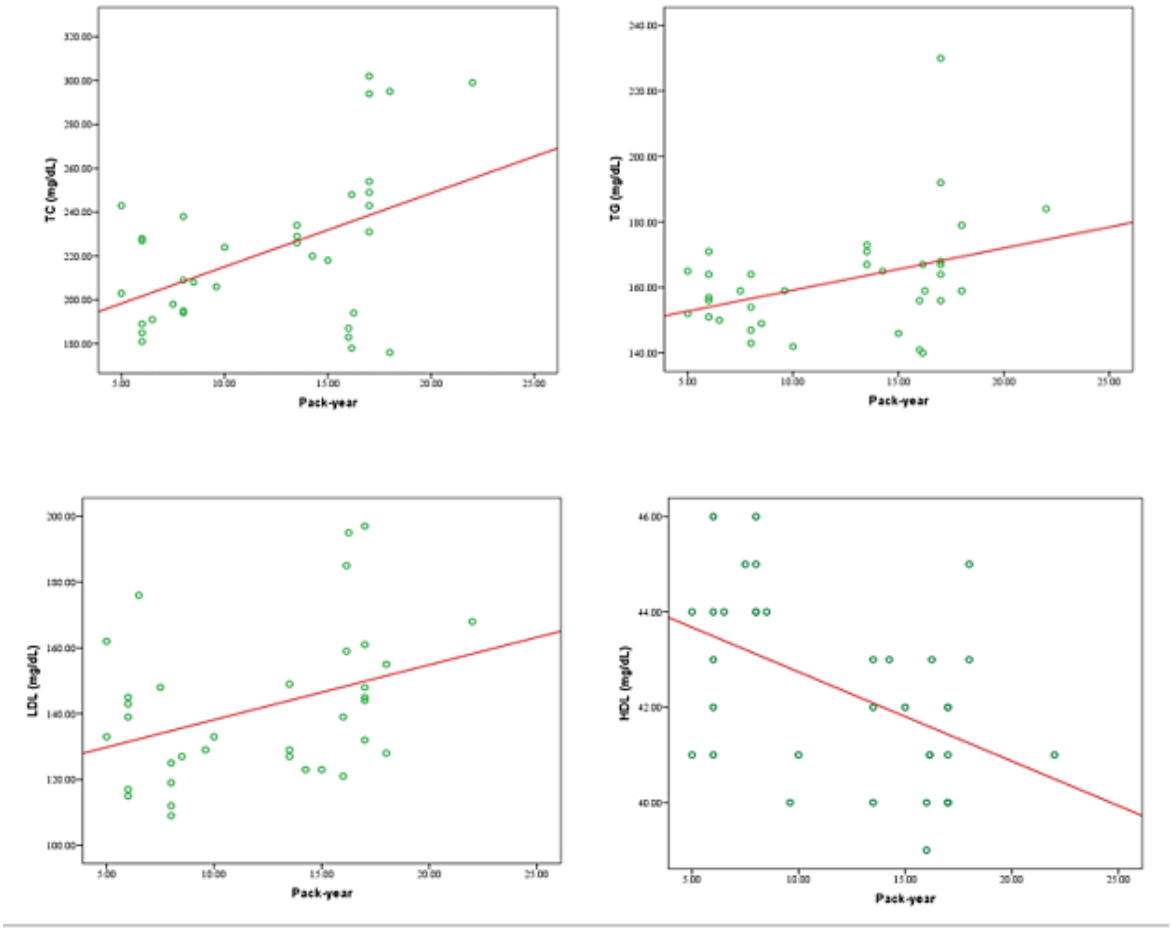

Fig. 3a, 3b, 3c and 3d. Correlation of total cholesterol (TC), triglycerides(TG), low-density-lipoprotein(LDL) and high-density-lipoprotein(HDL) with pack-year in study group

4. DISCUSSION

In this study, mean plasma fibrinogen level was significantly (p< 0.001) higher among smokers compared to that of non-smokers. Similar findings were reported by other researchers [18,25-27].Moreover, when the smokers were further compared based on the duration of smoking, higher plasma fibrinogen level were more pronounced in the smokers with > 15 pack-years of smoking history. This findings were in consistent with the study of other researchers [28,29].

On the contrary, some other researchers found that mean plasma fibrinogen level was significantly lower among smokers in comparison to that of non- smokers [9,29]. This discrepancy might be due to variation of the age of the subjects, geography and method of estimation. Whereas, another study found non-significantly higher plasma fibrinogen level among smokers than that of non-smokers [30].

Plasma fibrinogen levels show a dose-dependent increase in smokers; following smoking cessation, levels decrease towards similar values

in those who have never smoked as evidenced by some researchers [31]. High plasma fibrinogen among smokers constitute a greater risk for development of Myocardial infarction (MI) and stroke. Chronic exposure to tobacco smoke causes inflammatory injury to vascular intima also causes high plasma fibrinogen in addition to other acute phase proteins such as α_1-antitrypsin, haptoglobin etc [32,33].

In this study, mean platelet count was significantly ($p<0.001$) higher among smokers in comparison to that of non-smokers which was in agreement with that of other researchers [10,34-36]. On the contrary, some other researchers found that mean platelet count was significantly lower among smokers than that of non-smokers [37-39]. This discrepancy might be due to large sample size, variation in the age and sex of the subjects and pattern of smoking habit etc. Whereas, some researchers found no significant difference in the platelet count between smokers and non-smokers [1,39].

Smokers were shown to have raised platelet counts as a result of the fact that one or more chemical constituents in cigarette smoke stimulates the bone marrow to increase the production of certain blood elements, including WBC and platelets [34]. Elevation in the platelet count among smokers implies that these blood components have an early role in the pathogenesis of arteriosclerosis as reported by some researchers. Thus smokers are at more risk of developing thromboembolic incidents than non-smokers [10]. Moreover chronic smokers have higher circulating thrombopoietin levels which is a humoral growth factor that primes platelet activation and production [36].

In this study, plasma fibrinogen level was positively correlated with pack-year of smoking duration among the smokers. This relationship was statistically ($p<0.01$) significant. Similar observation was reported by other researchers [18,25]. On the contrary, some researchers reported negative correlation between plasma fibrinogen level and pack-year of smoking duration [12,29].

In this study, platelet count was positively correlated with pack- year of smoking duration among the smokers. But the relationship was not statistically significant. Almost similar finding was reported by other study [9]. On the contrary, some researchers found negative correlation between platelet count with pack-year of smoking duration among the smokers [13,37]. Whereas, other study observed no correlation between platelet count with pack-year of smoking duration [40].

In our current investigation, we found that TC (total cholesterol), TG (triglycerides), and LDL (low-density lipoprotein) levels were significantly higher ($p<0.001$) in smokers compared to non-smokers, while HDL (high-density lipoprotein) levels were significantly lower ($p<0.001$) in smokers than in non-smokers. Almost similar findings were reported by some other researchers who reported a notable increase in mean levels of TC (total cholesterol), TG (triglycerides) and LDL (low-density lipoprotein) in smokers alongside a significant decrease in HDL (high-density lipoprotein) levels among smokers compared to non-smokers [41-43]. Moreover, there was a significant positive correlation between pack-years of smoking and TC, TG, and LDL levels, while HDL levels exhibited a significant negative correlation. It was also revealed from our study that there were significant differences observed in the levels of TC (total cholesterol), TG (triglycerides), LDL (low-density lipoprotein) and HDL (high-density lipoprotein) between non-smokers and smokers with low pack year history, as well as between smokers with high pack-year history and non-smoker also between smokers with low pack-year history and smoker with high pack-year history. There is an increased risk of developing coronary artery disease, peripheral vascular disease and stroke in smokers due to increased mean TC(total cholesterol) and LDL (low-density lipoprotein) value as evidenced by some other researchers [44,45]. Moreover, reduction in HDL levels by 3-8mg/dl in smokers were also reported, which further declines with prolonged smoking duration [45]. Stampfer et al. reported an inverse association of HDL with myocardial infarction and stated HDL as a powerful predictor of the risk of myocardial infarction [46]. Besides other report suggest that cigarette smoking adversely affects HDL-C by lowering its level, which further increases the risk for developing coronary heart disease [47]. In addition stroke risk is known to be increased by smoking. As compared to those who continue to smoke, those who give up smoking have a much longer life expectancy. Chronic cigarette smoking has been shown to affect the macrophages' ability to remove cholesterol [48]. Moreover according to ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease guideline it was

suggested that, all adults should be assessed at every healthcare visit for tobacco use, and those who use tobacco should be assisted and strongly advised to quit [49].

5. CONCLUSION

In conclusion, this investigation elucidates the intricate interplay among smoking habits, coagulation parameters, and lipid profiles among smokers. Smokers manifested heightened levels of plasma fibrinogen and platelet counts relative to non-smokers, exhibiting a statistically significant positive correlation with the duration of smoking, as measured by pack-years, and these coagulation metrics. Moreover, smokers displayed elevated concentrations of total cholesterol, triglycerides, and low-density lipoprotein, concomitant with diminished levels of high-density lipoprotein, indicative of dyslipidemic state in the direction of increased risk for coronary artery disease. So, it is strongly recommended to avoid smoking for the sake of cardiovascular health. Importantly, the discovered alterations in plasma fibrinogen, platelet, and lipid profiles function as early indicators of cardiovascular disease, underscoring the necessity for preemptive management strategies among individuals with a history of smoking.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

CONSENT

It is not applicable.

ETHICAL APPROVAL

The ethical permission was taken from the Institutional Ethics Committee (IEC) of Sir Salimullah Medical College (SSMC).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. 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.
2. Kharb S, Singh GP. Effect of smoking on lipid profile, lipid peroxidation and antioxidant status in normal subjects and in patients during and after acute myocardial infarction. Clinica chimica acta. 2000, Dec 1;302(1-2):213-9.
3. Barua RS, Ambrose JA, Eales-Reynolds LJ, DeVoe MC, Zervas JG, Saha DC. Dysfunctional endothelial nitric oxide biosynthesis in healthy smokers with impaired endothelium-dependent vasodilatation. Circulation. 2001, Oct 16;104(16):1905-10.
4. Smith CJ, Fischer TH. Particulate and vapor phase constituents of cigarette mainstream smoke and risk of myocardial infarction. Atherosclerosis. 2001, Oct 1;158(2):257-67.
5. Tawila HA, Abu, AA, Thabet. prevalence of smoking among patients attending cardiac clinic in Gaza Strip. Journal of Advances in Medicine and Medical Research. 2015;8(10):848-54.
   Available:https://doi.org/10.9734/BJMMR/2015/16770.
6. Manafa PO, Okoye O, Ekuma- Okereke O, Ebugosi RS, Chukwuma GO, Ibeh NC, Chukwuanukwu RC, Manafa VI, Nwene KE, Onah CE, Ogbuowelu OS. Levels of adiponectin and GDF-15 in adult male cigarette smokers in nnewi metropolis. Asian Journal of Cardiology Research. 2020;3(1):25-34.
   Available:https://journalajcr.com/index.php/AJCR/article/view/25.
7. de Padua Mansur A, Caramelli B, Vianna CB, Chamone D, Ramires JA. Smoking and lipoprotein abnormalities on platelet aggregation in coronary heart disease. International journal of cardiology. 1997, Nov 20;62(2):151-4.
8. 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.
9. Ngozi SC, Ernest NE. Long-term smoking results in haemostatic dysfunction in chronic smokers. Nigerian Medical Journal. 2014, Mar 1;55(2):121-5.

10. Gitte RN. Effect of cigarette smoking on plasma fibrinogen and platelet count. Asian Journal of Medical Sciences. 2011;2(3): 181-4.
11. 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 Medical Journal. 2015, Jul;36(7):847.
12. Sivagangailakshmi V, Rajkumar D. Effects of cigarette smoking on coagulation profile among smokers. IAIM. 2017, Aug 1;4(8):116-20.
13. Elkhalifa AM. Effects of cigarette smoking on coagulation screening tests and platelet counts in a Sudanese male adults population. Saudi Medical Journal. 2018, Sep;39(9):897.
14. Triplett DA. Coagulation and bleeding disorders: Review and update. Clinical Chemistry. 2000, Aug 1;46(8):1260-9.
15. Heemskerk JW, Bevers EM, Lindhout T. Platelet activation and blood coagulation. Thrombosis and Haemostasis. 2002; 88(08):186-93.
16. York MJ. Clinical pathology. InA comprehensive guide to toxicology in nonclinical drug development. Academic Press. 2017, Jan 1;325-374.
17. Weitz JI, Eikelboom JW. Advances in thrombosis and hemostasis: an introduction to the compendium. Circulation Research. 2016, Apr 29;118(9): 1337-9.
18. Subratty AH, Beerbul M. Is fibrinogen a reliable haemostatic marker for monitoring possible risks of thromboembolic events in smokers?. University of Mauritius Research Journal. 1999;3:103-8.
19. Lowe GD, Rumley A, Mackie IJ. Plasma fibrinogen. Annals of Clinical Biochemistry. 2004, Nov 1;41(6):430-40.
20. Wilhelmsen L, Svärdsudd K, Korsan-Bengtsen K, Larsson BO, Welin L, Tibblin G. Fibrinogen as a risk factor for stroke and myocardial infarction. New England journal of medicine. 1984, Aug 23;311(8):501-5.
21. Tuut M, Hense HW. Smoking, other risk factors and fibrinogen levels: Evidence of effect modification. Annals of Epidemiology. 2001, May 1;11(4):232-8.
22. Takajo Y, Ikeda H, Haramaki N, Murohara T, Imaizumi T. Augmented oxidative stress of platelets in chronic smokers: mechanisms of impaired platelet-derived nitric oxide bioactivity and augmented platelet aggregability. Journal of the American College of Cardiology. 2001, Nov 1;38(5):1320-7.
23. Bhatt JV. IMPACT of tobacco smoking on coronary risk factor profile. Indian Journal of Applied Basic Medical Sciences. 2003;5(1).
24. Buring JE, O'Connor GT, Goldhaber SZ, Rosner B, Herbert PN, Blum CB, Breslow JL, Hennekens CH. Decreased HDL2 and HDL3 cholesterol, Apo AI and Apo A-II, and increased risk of myocardial infarction. Circulation. 1992, Jan;85(1):22-9.
25. Vyssoulis GP, Karpanou EA, Kyvelou SM, Adamopoulos DN, Vlachopoulos CB, Cokkinos DV, Stefanadis CI. The effect of smoking on inflammation, prothrombotic state and endothelial dysfunction in patients with essential hypertension. High Blood Pressure & Cardiovascular Prevention. 2009, Jun;16:47-53.
26. Liu J, Liang Q, Frost-Pineda K, Muhammad-Kah R, Rimmer L, Roethig H, Mendes P, Sarkar M. Relationship between biomarkers of cigarette smoke exposure and biomarkers of inflammation, oxidative stress, and platelet activation in adult cigarette smokers. Cancer Epidemiology, Biomarkers & Prevention. 2011, Aug 1;20(8):1760-9.
27. Ernst E, Matria A, Schmölzl CH, Magyarosy I. Dose—effect relationship between smoking and blood rheology. British Journal of Haematology. 1987, Apr;65(4):485-7.
28. Bazzano LA, He J, Muntner P, Vupputuri S, Whelton PK. Relationship between cigarette smoking and novel risk factors for cardiovascular disease in the United States. Annals of Internal Medicine. 2003, Jun 3;138(11):891-7.
29. Chizoba OO, Ebuka EH. Effects of cigarette smoking on some coagulation parameters of smokers in Nnewi metropolis. J Environ Occup Sci. 2017; 6(1):13.
30. Hunter KA, Garlick PJ, Broom I, Anderson SE, Mcnurlan MA. Effects of smoking and abstention from smoking on fibrinogen

synthesis in humans. Clinical science. 2001, Apr 1;100(4):459-65.

31. Lowe GD. Why do smokers have higher plasma fibrinogen levels than non-smokers?. Clinical Science. 2001, Aug 1;101(2):209-10.
32. Chao FC, Tullis JL, Alper CA, Glynn RJ, Silbert JE. Alteration in plasma proteins and platelet functions with aging and cigarette smoking in healthy men. Thrombosis and Haemostasis. 1982;47(03):259-64.
33. Dotevall A, Kutti J, Teger-Nilsson AC, Wadenvik H, Wilhelmsen L. Platelet reactivity, fibrinogen and smoking. European Journal of Haematology. 1987, Jan;38(1):55-9.
34. Tell GS, Grimm Jr RH, Vellar OD, Theodorsen L. The relationship of white cell count, platelet count, and hematocrit to cigarette smoking in adolescents: The Oslo Youth Study. Circulation. 1985, Nov;72(5):971-4.
35. Aghaji MAC, Nnabuko REE, Uzuegbunam C, Oyeka IC. The relationship of white blood cell and platelet counts to cigarette smoking in adult Nigerians. Central African Journal of Medicine. 1990, Nov 1;36(11):273-8.
36. Lupia E, Bosco O, Goffi A, Poletto C, Locatelli S, Spatola T, Cuccurullo A, Montrucchio G. Thrombopoietin contributes to enhanced platelet activation in cigarette smokers. Atherosclerosis. 2010, May 1;210(1):314-9.
37. Varol E, Icli A, Kocyigit S, Erdogan D, Ozaydin M, Dogan A. Effect of smoking cessation on mean platelet volume. Clinical and Applied Thrombosis/Hemostasis. 2013, Jun;19(3): 315-9.
38. Almarshad HA, Hassan FM. Alterations in blood coagulation and viscosity among young male cigarette smokers of Al-Jouf region in Saudi Arabia. Clinical and Applied Thrombosis/Hemostasis. 2016, May;22(4):386-9.
39. Shenwai MR, Aundhakar NV. Study of effect of cigarette smoking on platelet count and platelet aggregability in young male smokers. International Journal. 2012;3(5):125.
40. Sultana S, Afsar N, Jawad M, Hazari MA. Effects of cigarette smoking on erythrocyte sedimentation rate, platelet count, total and differential leucocyte counts in adult male smokers: Blood parameters effected by cigarette smoking in males. Annals of Medical Physiology. 2019, Mar 28;3(1):14-8.
41. Sahu R, Singh R, Giri R. A study of lipid profile in young smokers and non-smokers. International Journal of Advances in Medicine. 2022, May;9(5): 556.
42. Rastogi R, Shrivastava SS, Mehrotra TN, Singh VS, Gupta MK. Lipid profile in smokers. The Journal of the Association of Physicians of India. 1989, Dec 1;37(12):764-6.
43. Kannan N, Kumar RA, Ramaprabha P, Kumar MS, Shaker IA. Lipid profile, plasma fibrinogen, and platelet count as markers of cardio vascular disease in smokers due to free radical generation.
44. Krishnaswami S, Richard J, Prasad NK, Alexander T, Thomas CS. Association between cigarette smoking and coronary arterial disease in patients in India: how quantitative is it? An assessment by selective coronary arteriography. International journal of cardiology. 1991, Jun 1;31(3):305-11.
45. Rosenson RS. Low level of HDL-cholesterol (Hypoalphalipoproteinemia). An approach to management. Arch Intern Med. 1993;153(13):1528-40.
46. Stampfer MJ, Sacks FM, Salvini S, Willett WC, Hennekens CH. A prospective study of cholesterol, apolipoproteins, and the risk of myocardial infarction. New England Journal of Medicine. 1991, Aug 8;325(6): 373-81.
47. Batić-Mujanović O, Zildzić M, Beganlić A, Kusljugić Z. The effect of cigarette smoking on HDL-cholesterol level. Medicinski Arhiv. 2006, Jan 1;60(6 Suppl 2):90-2.
48. Parmar MP, Kaur M, Bhavanam S, Mulaka GS, Ishfaq L, Vempati R, Kandepi HV, Rajagopal ER, Sahu S, Davalgi S. A systematic review of the effects of smoking on the cardiovascular system and general health. Cureus. 2023, Apr;15(4).
49. Arnett DK, Blumenthal RS, Albert MA, et al. ACC/AHA guideline on the primary prevention of cardiovascular disease: Executive summary: A report of

the american college of cardiology/american heart association task force on clinical practice guidelines. J Am Coll Cardiol. 2019;74(10):1376-1414.
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