

# The Effect of Exercise on Electrocardiographic Variations and Cardiovascular Parameters in Smoker and Non-Smoker Medical Students

Ambreen Tauseef<sup>1</sup>, Tehreem Fatima<sup>2</sup>, Alveera Akmal<sup>3</sup>, Sahar Javed<sup>4</sup>, Farida Hafeez<sup>5</sup>, Haroon Rashid<sup>6</sup>

<sup>1</sup>Associate Professor, Department of Physiology, CMH, Lahore Medical College & IOD, Lahore.

<sup>2</sup>House Officer, CMH, Lahore.

<sup>3</sup>3<sup>rd</sup> Year Medical Student, MBBS, CMH, Lahore Medical College & IOD, Lahore

<sup>4</sup>Assistant Professor, Department of Biochemistry, CMH, Lahore Medical College & IOD, Lahore

<sup>5</sup>Professor & Head, Department of Physiology, CMH, Lahore Medical College & IOD, Lahore

<sup>6</sup>Vice Principal and Associate Professor, Department of Community Medicine, CMH, Lahore Medical College & IOD, Lahore.

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## ABSTRACT

**Background:** Nicotine, the main tobacco ingredient, increases blood coagulation, which in turn increases heart rate, blood pressure, and the vulnerability to ventricular fibrillation. The present study was conducted to assess the electrophysiological and cardiovascular variations in the heart and circulation. **Objective:** The objective of this study was to compare the effect of exercise on ECG variations and cardiovascular parameters in a healthy smoker and non-smoker male medical students. **Methods:** This cross-sectional comparative study recruited and equally divided a total of 100 healthy, aged 20 - 25-year smokers (using an average of 10-15 cigarettes per day for at least five years) and non-smokers male medical students. All the subjects were asked to abstain from smoking and caffeine beverages, 48 hours before the recording of all parameters. Baseline pulse and blood pressure were taken, whereas ECG parameters were recorded by using BIOPAC in both groups in the department of physiology, CMH-LMDC. All these parameters were measured again after performing 30 minutes of exercise on a standard ergometer. A p-value  $\leq 0.05$  was considered significant. **Results:** After exercise, the ECG variations showed significant increase in pulse rate by 7.1% ( $p = 0.001$ ), systolic blood pressure by 9.7% ( $p = <0.001$ ), diastolic blood pressure by 11.25% ( $p = <0.001$ ), heart rate by 17.3% ( $p = 0.015$ ) ST-segment by 2% ( $p = <0.001$ ) and QTc interval was prolonged by 2.9% ( $p = 0.001$ ). Whereas, a significant decrease in QRS complex was noticed by 20.0% ( $p = <0.001$ ) among smokers as compared to non-smokers. However, a negative correlation was seen between systolic, diastolic blood pressure, and pulse rate with ECG variations. **Conclusion:** It is concluded that smoking causes major changes in ECG and cardiovascular parameters after exercise, indicating cardiovascular risk. So in earlier stages, abstinence from smoking can revert the cardiovascular changes to nearly normal. Physicians may use this as a tool for counseling smokers to stop smoking as early as possible.

**Keywords:** Blood pressure, Exercise, Electrocardiography, Smoking.

## INTRODUCTION

Tobacco consumption in the form of cigarettes is a significant cause of preventable deaths globally.<sup>[1]</sup> In Pakistan, cigarette consumption has been rising per capita for most of the past two decades, and over 100,000 deaths are attributed to tobacco use each year.<sup>[2,3]</sup> Smoking has both short- and long-term effects on the body. It is a significant risk factor for ischemic heart diseases, causing adverse cardiovascular effects by binding of CO to hemoglobin and decreasing its oxygen supply to tissues as well as the formation of clots in the blood vessels.<sup>[4,5]</sup> This increase in blood coagulation, in turn, increases heart rate and blood pressure and other electrocardiogram variations. Hence, quitting smoking leads to a substantial decrease in cardiovascular diseases.<sup>[7,8]</sup>

Previous studies have shown the link between smoking and altered cardiovascular parameters in middle-aged and older people with inconsistent results.<sup>[9,10]</sup> Smoking is a detriment to physical fitness even among relatively young, fit individuals with lower physical endurance than non-smokers.<sup>[11]</sup> Hence we intended to study the same in the young population where the smoking pattern, frequency, and associated factors are different. This study aimed to determine the effects of exercise on cardiovascular and ECG parameters in young, healthy male smokers and non-smokers.

## MATERIALS AND METHODS

This cross-sectional comparative study recruited a total of 100 smokers and non-smoker male medical students, aged 20 to 25 years after receiving Institutional Ethical Review Board approval. We obtained informed written consent from all the participants and equally divided all the subjects into two groups, i.e., Group A (smokers) and Group B (non-smokers). We excluded participants who were hypertensive, diabetic, drug/energy drink users, or

### Name & Address of Corresponding Author

Dr. Ambreen Tauseef,  
Associate Professor,  
Department of Physiology,  
CMH, Lahore Medical College & IOD, Lahore.

suffering from any pulmonary disease. All the subjects were asked to abstain from smoking and caffeine beverages, 48 hours prior to the recording of all study parameters. This study was conducted in the Department of Physiology, CMH-LMDC, where baseline pulse and blood pressure were taken, whereas ECG parameters were recorded by using BIOPAC in both groups. The data were entered and analyzed by using IBM SPSS Statistics for Windows, Version 20.0. All quantitative variables were expressed as mean ± SD, whereas qualitative variables were described using frequencies and percentages. Mann-Whitney U test was used for comparison between two groups. Spearman rank correlation was used to see the relation of change in pulse rate and systolic, diastolic blood pressures with the change in parameters of ECG. p-value ≤ 0.05 was considered significant.

### RESULTS

The study was conducted with 50 smokers and 50 non-smokers with a mean age of 24±4 and 24±3 with no significant difference and body mass index of 23.40±3.02 and 22.38±3.38, respectively. [Table 1]

The main ECG parameters were not significantly different between smokers and non-smokers before exercise except QRS and RR interval, which were significantly higher among smokers with p-values 0.032 and 0.043, respectively. [Table 2]

After exercise, the QRS decreased in smokers significantly with p-value <0.001, QT interval, and ST-segment were significantly higher in smokers as compared to non-smokers with p-values <0.001. The systolic and diastolic blood pressure and pulse rate all increased in smokers significantly as compared to

non-smokers with p-values <0.001, <0.001, and 0.001, respectively. [Table 2]

The true comparison was made between all groups by comparing the change for all parameters during exercise (by taking a difference between before and after exercise values). The change in P-wave and PR interval were not significantly different between the two groups. The QRS, T-wave, and RR interval decreased among smokers significantly as compared to non-smokers with p-values <0.001, 0.012, and 0.011, respectively. The QT interval and ST-segment increased significantly with p-values <0.001 and 0.002, respectively. The increase in systolic blood pressure was 16.0±12.48 mm Hg among smokers as compared to 5.33±8.99 mm Hg among non-smokers and was significantly different with p-value <0.001. Similarly, the increase in diastolic blood pressure and pulse rate was also significantly higher among smokers as compared to non-smokers with p-values 0.027 and 0.028. [Table 3]

The change in systolic blood pressure had a significant negative correlation with the change in P-wave, QRS, T-wave, and RR interval with coefficients of -0.266, -0.461, -0.318 and -0.417 and p-values 0.040, <0.001, 0.013 and 0.001 respectively. The change in diastolic blood pressure had only significant and an inverse relationship with change in RR interval with r= -0.331 and p-value 0.010. The change in T-wave had a significant inverse correlation of -0.411 with a change in pulse with p-value 0.001. [Table 4]

**Table 1: Age and BMI for participants of the study**

Parameters	Smokers	Non-smokers	p-value
Age	24 ± 4	24 ± 3	0.381
BMI	23.40 ± 3.02	22.38 ± 3.38	0.201

**Table 2: ECG parameters and blood pressure for two groups before and after exercise**

Parameters	Before exercise			After exercise		
	Smokers	Non-smokers	p-value	Smokers	Non-smokers	p-value
P Wave	0.12 ± 0.01	0.11 ± 0.02	0.085	0.11 ± 0.01	0.11 ± 0.02	0.050
QRS	0.10 ± 0.02	0.09 ± 0.01	0.032	0.08 ± 0.01	0.10 ± 0.02	<0.001
T wave	0.21 ± 0.03	0.19 ± 0.04	0.099	0.18 ± 0.03	0.19 ± 0.03	0.132
PR interval	0.16 ± 0.02	0.15 ± 0.03	0.675	0.16 ± 0.02	0.16 ± 0.02	0.905
QT interval	0.34 ± 0.02	0.34 ± 0.02	0.740	0.35 ± 0.05	0.34 ± 0.03	<0.001
RR interval	0.85 ± 0.10	0.78 ± 0.09	0.043	0.75 ± 0.15	0.78 ± 0.11	0.097
ST segment	0.07 ± 0.01	0.06 ± 0.02	0.095	0.08 ± 0.01	0.06 ± 0.01	<0.001
SBP	120 ± 6	119 ± 5	0.394	136 ± 11	124 ± 8	<0.001
DBP	76 ± 15	78 ± 6	0.780	89 ± 10	80 ± 7	<0.001
Pulse	77 ± 7	75 ± 4	0.881	90 ± 8	84 ± 11	0.001

**Table 3: Comparison between all groups by comparing the change for all parameters during exercise**

Parameters	Smokers	Non-smokers	p-value
P wave	0.00 ± 0.01	0.00 ± 0.02	0.733
QRS	-0.02 ± 0.02	0.01 ± 0.02	<0.001
T wave	-0.04 ± 0.04	0.00 ± 0.04	0.012
PR interval	0.00 ± 0.02	0.01 ± 0.03	0.144
QT interval	0.02 ± 0.04	0.00 ± 0.04	<0.001
RR interval*	-0.10 ± 0.13	0.00 ± 0.14	0.011
ST segment	0.01 ± 0.02	0.00 ± 0.02	0.002
SBP	16.00 ± 12.48	5.33 ± 8.19	<0.001
DBP	9.50 ± 24.37	1.67 ± 8.24	0.027
Pulse*	13.83 ± 8.67	8.13 ± 10.77	0.028

All p-values are calculated by using Mann Whitney U test except with a \* calculated by using independent sample t-test

**Table 4: Correlation of blood pressures and pulse rate with ECG parameters**

Parameters		SBP	DBP	Pulse
SBP	r		0.272*	0.324*
	P-value		0.036	0.012
DBP	r	0.272*		-0.012
	P-value	0.036		0.930
Pulse	r	0.324*	-0.012	
	P-value	0.012	0.930	
P wave	r	-0.266*	0.186	-0.173
	P-value	0.040	0.154	0.186
QRS	r	-0.461**	-0.213	-0.169
	P-value	0.000	0.102	0.195
Twave	r	-0.318*	-0.089	-0.411**
	P-value	0.013	0.499	0.001
PRinterval	r	-0.103	-0.114	-0.076
	P-value	0.436	0.385	0.562
QTinterval	r	0.135	0.238	-0.011
	P-value	0.303	0.067	0.936
	N	60	60	60
RRinterval	r	-0.417**	-0.331**	-0.190
	P-value	0.001	0.010	0.147
STsegment	r	0.123	0.045	0.129
	P-value	0.350	0.734	0.327

\*. Correlation is significant at the 0.05 level (2-tailed).  
 \*\*. Correlation is significant at the 0.01 level (2-tailed).

**DISCUSSION**

Our study determined the effects of exercise on ECG variations and cardiovascular parameters showing an increase in QTc interval, ST segment, pulse rate, systolic, and diastolic blood pressure, whereas the decrease in QRS, T wave, and RR interval in smokers after exercise.

Smoking is the most important risk factor for cardiovascular disease by exerting its deleterious effects. Nicotine, an important constituent of tobacco, by releasing catecholamines causes vasoconstriction, thus an increase in heart rate and the vulnerability to ventricular fibrillation and arrhythmias.<sup>[12]</sup> Our results are consistent with the results of previous studies who also observed an increase in QTc interval, ST-segment, and pulse rate in smokers.<sup>[13-15]</sup> Similarly, a study carried out by Siddiqui SS et al. in 2013, who also found a significant decrease in the QRS complex. However, they found no significant change in the QTc interval.<sup>[16]</sup>

In the present study, an increase in blood pressure is in accordance with the results of Viridis A et al.<sup>[17-19]</sup> and GropPELLI A et al. This increase in systolic and diastolic blood pressure is attributed to stimulation of sympathetic nervous system and arterial wall stiffness.

Smokers showed a significant decrease in QRS complex, T wave, and RR interval after exercise. These findings in the present study are in agreement with the previous findings by Devi MR et al. They found a highly significant increase in heart rate as well as decreased RR interval but found no significant exercise-induced shortening in QRS complex in smokers in contrast to present study.<sup>[20]</sup>

Our findings are in contrast to the findings as observed by PapatHasiou G et al. They did not find

any statistically significant exercise-induced an increase in blood pressure in smokers as compared to non-smokers.<sup>[21]</sup> Similarly, another study carried out by Srivastava A et al. found no significant change seen in P-wave, P-R interval, and QTC interval among both groups.<sup>[22]</sup>

**CONCLUSION**

Smokers are more prone to cardiovascular diseases by showing variations in ECG and cardiovascular parameters in smokers after exercise. By quitting smoking at an early age will reduce the risk of coronary artery diseases in the future.

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