Comparative Study of Cardiorespiratory Functions in Tobacco Smokers and Non-Smokers among Healthy Adults in Hadoti Region

Ganesh Patel[1], Suman Khangarot[2], Akash Shrikhande[3], J.K. Choudhary[4]

[1, 4] Department of Pulmonary Medicine, LSLAM Government Medical College, Raigarh, Chattisgarh, India. [2]Department of Pulmonary Medicine, Government Medical College, Kota, Rajasthan, India. [3]Department of Pulmonary Medicine, People's College of Medical Sciences and Research Centre, Bhopal, Madhya Pradesh, India.

ABSTRACT

BACKGROUND
There are approximately 120 million smokers in rural and urban India using cigarettes, bidis, pipes, cigars, hookah and some other forms of tobacco. It is an important modifiable risk factor for respiratory and cardiac diseases. A younger group of subjects was considered not only to assess the impact of smoking on cardiorespiratory functions but also to convey the message that smoking is injurious to health. Aim of the study was to evaluate the influence of smoking on cardio-respiratory functions.

METHODS
This is an analytical cross-sectional study. We used non-probability criteria convenience sampling method. Smokers and non-smokers groups were registered, and the comparisons were made between the groups for the cardiorespiratory parameters in the two groups. Subjects were in the age group 20 to 55 years. Subjects with more than two years history of smoking and continued smoking five or more cigarettes per day at the time of inclusion in study formed the Smokers group. Detailed clinical history, vitals recording, ECG and Spirometry were done in all the study subjects.

RESULTS
In the smoker group, the Forced Vital Capacity (FVC), Forced Expiratory Volume 1 (FEV1), the ratio of Forced Expiratory Volume 1: Forced Vital Capacity, FEF 25 – 75 % and PEFR declined as compared to non-smokers group. Duration of smoking and the number of cigarettes smoked in a day were the criteria responsible for a decline in the values of all the five parameters mentioned above.

CONCLUSIONS
Adverse effects of smoking on lung function and cardiac function start before the onset of any symptoms. This study will be useful in creating awareness among the youth regarding the harmful effects of smoking.

KEYWORDS
Smoking, ECG, Spirometry

BACKGROUND

Smoking is a common social evil and a widely prevalent habit among the Indian population in both urban and rural areas. There are approximately 120 million smokers in India using cigarettes, bidis, pipes, cigars, hookah and some other forms of tobacco. The concern is that it harms nearly every organ with irreversible long - term damage producing many diseases of the organ systems. Though smoking increases the risk of cardio - respiratory diseases, it is an important alterable risk factor. People smoke for several reasons, some smoke for enjoyment or social reinforcement and some to alleviate stress.

The frequency and duration of smoking has a significant effect in determining the extent of harm caused in the cardio - respiratory system.[1] Effects of smoking on the cardiovascular system are varied.[2] The heart rate, blood pressure and carboxyhaemoglobin concentration increase after smoking tobacco, the coronary arteries vasoconstrict; and exercise tolerance diminishes.[3] The hemodynamic and physiologic changes ultimately decrease the systemic oxygen transport and increase the chances of coronary ischaemia.[4] Smoking tobacco produces significant adverse effects on respiratory physiology and accounts for many respiratory illnesses, specifically chronic bronchitis, emphysema, and carcinoma of the bronchus.[5] Smoking causes lung disease by damaging airways and capillaries endothelium.

HR and blood pressure are very important, non-invasive and easy to measure index of myocardial work.[6] A high resting HR (HR rest) and abnormal HR responses during or after exercise may be the precursors for cardiac and vascular diseases and may help in detecting the persons at high risk in early stages. Spirometry records the functional capacity of lungs. Forced vital capacity (FVC), Forced expiratory volume in 1 second (FEV1) and FEV1/FVC ratio are the usual parameters measured.

Youngsters need public awareness on smoking and hence in this study a younger group of subjects were considered not only to assess the impact of smoking on cardio-respiratory functions but also to convey the message of smoking is injurious to health.

Objectives
1. To determine the effects of smoking on the heart rate and blood pressure in a resting state.
2. To determine the effects of smoking on lung function.
3. To determine if the number of cigarettes smoked per day and the duration of smoking have a relationship to the decline in lung function.

METHODS

Source Design
Analytical Cross-sectional Study.

Study Population
People above 20 years attending routine spirometry camp at Government Medical College, Kota, from August 2014 to July 2015. We were running a free spirometry clinic every weekly. In small pilot study we observed that per week about 20 to 25 people inflow. Out of that we calculated approximately 5 to 6 will be eligible for study. Based on feasibility observed we had selected 100 smoker males and 100 non - smoker males. We used non - probability criteria convenience sampling method - smokers and non - smoker groups were registered, and the comparisons made between the groups for the cardiorespiratory parameters in the two groups. Informed consent was obtained from every individual.

Criteria of Inclusion
Subjects within age group 20 to 55 years. The inclusion criteria for smokers group was duration of smoking more than two years and continuing to smoke five or more than five cigarettes per day.

Criteria of Exclusion
1. Subjects having cardiovascular diseases.
2. Subjects having chronic respiratory illness.

It was done on healthy volunteers who came to routine health check up in the spirometry clinic (OPD) of the department of respiratory medicine GMC Kota.

A detailed history was obtained and recorded from the control and the study group in the prescribed proforma. Height (in cm), Weight (in kg) was recorded. Resting pulse rate and blood tests were carried out by using the computerized pressure recorded in sitting position. Pulmonary function Spirometer. The data was collected in predestined and peer - validated proforma by the research team. The study was implemented after the approval of the Institutional Ethics committee. The participants were registered after they signed the informed written consent. ECG done in all to rule out cardiac abnormality. Smokers were divided into subgroups based on the duration of smoking and also on the number of cigarettes smoked per day. The differences between the mean value of every parameter between smokers and non - smokers and the difference in each parameter in smokers based on smoking duration and the cigarettes smoked per day were analysed and discussed.

Variables recorded : FVC (forced vital capacity), FEV1 (forced expiratory volume at the end of first second), FEV1 / FVC, FEF25 − 75 % (forced expiratory flow in 25 − 75 % of vital capacity), PEFR (peak expiratory flow rate), pulse rate at rest; systolic, diastolic, and mean blood pressure.

Statistical Analysis
Descriptive statistics including Mean ± Standard Deviation and range values were used. Comparisons were performed using student's t - test for 2 group comparisons and one way

ANOVA (Analysis of Variance) for multiple groups. Statistical calculations were done using Microsoft Excel 2007 tools and analysed by calculators from www.graphpad.com, Microsoft word and Excel have been used to create text documents, graphs, tables etc. The p value< 0.05 was taken as statistically significant.

100 participants in a sound state of health but who practised smoking and an equal number of matched controls in the age group of 20 - 55 years were studied. Results are arranged in tables for various variables. The data were analysed using the Unpaired T - test.

RESULTS

Groups	N	Age (Yrs.)		Height (Meters)		Weight (Kgs)		BMI	
		Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
Non- Smokers	100	18 - 52	31.4 ± 10.3	1.52 – 1.83	1.68 ± 0.08	47 - 110	68.2 ± 11	17.3 – 34	24.04 ± 2.91
Smokers	100	22 - 54	33.6 ± 9.91	1.57 - 1.8	1.71 ± 0.058	52 - 98	66.2 - ± 10.7	17.36 - 31.28	23.12 ± 3.58

Table 1. Physical Characteristics of Subjects

Groups	N	HR Rest		SBP		DBP		MBP	
		Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
Non Smokers	100	69-85	78.96 ±4.39	114-130	121.36±4.32	72-88	79.56 ±3.64	86.00 – 101.33	93.49 ± 3.26
Smokers	100	73-83	79.84 ±3.03	114-128	119.8± 3.71	72-86	78.92 ± 3.39	85,67-98.67	92.55 ±2.84
Significance	t	1.6574		2.7395		1.2867		2.1741	
	p	>0.050, NS*		<0.005, HS**		>0.050, NS*		<0.005, HS**	

Table 2. Comparison of Resting Heart Rate, SBP, DBP and MBP

*Not significant, **Highly significant

Groups	N	FVC Actual Value (L)		FVC % Predicted		FEV1 Actual Value (L)		FEV1 % Predicted	
		Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
Non Smokers	100	2.65 - 5.25	3.95 ± 0.61	61.2 - 124.42	93.63 ± 12.25	1.23 - 4.91	3.61 ± 0.7179	35.45 - 127.86	99.13 ± 17.09
Smokers	100	2.33 - 5.25	3.31 ± 0.69	54.78 ± 20.37	77.85 ± 17.3	2.22- 4.74	3.07 ± 0.59	62.01 - 124.54	84.91 ± 16.69
Significance	t	6.9491		7.4441		5.8112		5.9528	
	p	<0.001,HS		<0.001,HS		<0.001,HS		<0.001,HS	

Table 3. Comparison of FVC and FEV1 between Non-Smokers and Smokers

Groups	N	FEV1/FVC Actual Value		% Predicted		FEF 25-75 Actual Value (L)		% Predicted		PEFR Actual Value (L)		% Predicted	
		Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
Non Smokers	100	82.18 – 100	92.66 ± 5.72	2.69 - 7.98	5.17 ± 1.236	2.69 – 7.98	5.17 ± 1.236	59.81- 149.72	100.55 ± 21.81	3.99 – 11.57	8.24 ± 1.58	41.7 – 136	85.71 ± 16.3
Smokers	100	83- 99.1	90.10 ± 4.39	2.62- 7.3	5.04 ± 1.29	2.62- 7.3	5.04 ± 1.29	51.78 – 139.05	99.49 ± 24.43	4.79 – 13.2	8.122 ± 1.74	49.3- 131	82.78 ± 16.4
Significance	t	3.5504		2.455		0.7277		0.3231		0.5021		1.2672	
	P	<0.05,S		< 0.05, S		0.050, NS*		0.050, NS		0.050, NS		0.050, NS	

Table 4. Comparison of FEV1 / FVC, FEF25-75 and PEFR between Non-Smokers and Smokers

Duration (Yrs.)	N	FVC	FEV1	FEV1/FVC	FEF25-75	PEFR
2-4	35	97.45 ± 14.19	102.75 ± 14.35	110.30 ± 5.6	96.40 ± 18.7	83.21 ± 19.93
5-7	35	70.12 ± 8.1	77.24 ±8.3	108.95 ± 5.34	96.20 ±12.6	82.95 ±26.3
8-10	38	65.19 ± 6.6	73.69 ± 7.9	107.62 ± 5.32	95.87 ± 27.3	81.70± 11.9
ANOVA	F	49.24	37.82	1.068	1.585	0.042
	P	<0.001, HS	<0.001, HS	>0.050, NS	>0.050, NS	>0.050, NS

Table 5. Comparison of Lung Function Parameters with Relation to Duration of Smoking

Cig / Day	N	FVC	FEV1	FEV1/FVC (% P)	FEF25-75% (% P)	PEFR
5-7	6	102.56 ± 8.9	110.35 ± 9.5	111.40 ± 6.2	109.81 ± 27.9	89.98 ± 12.4
8-10	18	86.81 ± 15.8	91.62 ± 14.9	107.96 ± 5.0	102.99 ± 20.5	82.98 ± 17.8
11-13	13	66.76 ± 7.8	75.12 ± 7.7	107.59 ± 6.3	102.33 ± 21.0	79.30 ± 19.4
14-16	13	65.45±7.5	73.43±8.7	73.43±8.7	95.20±23.1	78.67±15.5
ANOVA	f	21.981	19.911	1.296	1.863	1.565
	p	<0.001, HS	<0.001, HS	>0.050, NS	>0.050, NS	>0.050, NS

Table 6. Comparison of Lung Function Parameters with Relation to Cigarettes Smoked per Day

DISCUSSION

Tobacco smoking causes undesirable effects on the respiratory and cardiovascular system. Our study showed significant derangement in respiratory and cardiac parameters. We observed in the study that in the smokers group the levels of Forced Vital Capacity declined remarkably as compared to the group with the non - smoker participants. Further, it was observed in our study that the level of forced vital capacity decreased significantly with an increase in the length of past smoking and the increased consumption of cigarettes smoked in a day. Our findings are similar to the findings by Danuser B etal.[7]

FEV1

In our study there was a remarkable decline in the FEV1 levels in the smokers group as compared to the non - smoker group. We observed that as the duration of smoking and the per day cigarettes smoked increased the values of FEV1 dropped. In the study of Tashkin DP etal,[8] Camilli AE et al,[9]

Hogg CJ et al,[10] Kerstjens et al[11] comparable findings were observed. The chronic cigarette smoking produces irreversible long-term damage to the lung parenchyma leading to loss of lung elastic recoil pressure, which results in a considerable drop down in the force required to expel out the air from the lung parenchyma. This mechanism partially explains the decrease in FEV1 associated with chronic cigarette smoking. It was shown that bronchial reactivity increases in smokers. This may also affect the FEV1 in smokers.

We observed in our study a significant reduction of the ratio of FEV1 / FVC in the smokers and this decline was directly proportional to the duration of smoking and the number of cigarettes smoked per day. Walter S et al,[12] Gold RD et al,[13] and Gorecka D etal[14] reported similar results of the decline in FEV1 / FVC ratio in the smokers and its relationship to the duration and dose of the smoking per day. FEV1 / FVC ratio is a more sensitive index of early disease. As mentioned above smoking leads to changes in FVC and also FEV1, Thus this ratio is also affected.

FEF25 – 75 % and PEFR : The level of forced expiratory flow (25 % and 75 % of FVC) or the average forced expiratory flow and PEFR were minimally reduced in smokers compared to non - smokers. This may be due to a disease process not yet started. FEF 25 – 75 % is an early predictor of small airway disease.

As it is shown in our study, all the parameters of lung function which are analysed showed a decrease in their value, with greater duration and the dose of smoking per day. Similar findings were found by Gold RD et al[14] and Isobel U et al.[15]

We observed that the harmful effect of smoking on lung parenchyma was to a greater extent dependent on duration and dose of smoking cigarettes per day. At tissue level there occurs accumulation of inflammatory exudates, excess mucus secretion, altered surface tension properties or possibly altered smooth muscle tone, which accounts for the mechanisms responsible for the respiratory airway insults and its resulting outcomes. The cellular mediators released in the airway escalates the airway obstruction. As shown by other studies such as Tashkin DP et al,[9] Camilli AE et al[10] and Gorecka et al that quitting smoking improves lung function. Hence the inflammatory changes in airways often reverse with cessation of smoking.

Cardiac Parameters / Heart Rate in a Resting State
It was observed in the study that in the smoker group, the baseline heart rate was one beat/min greater than in the non - smoker group. It was statistically not significant. In smokers resting heart rate is increased in this study and similar findings were also found by Roberto et al.[16] The continuous sympathetic nervous stimulation due to the effects of nicotine is accountable for the elevated heart rate. There was a marginal decline in the systolic, diastolic and mean blood pressure. Similar were the observations in the study of Manfred et al[17] Koichi et al[18]

The effects of smoking on the blood pressure is possibly explained by the following mechanisms. In the beginning phase of smoking the nicotine produces vasoconstriction of the arteries and in the chronic phase it has a depressant effect on blood vessels. Therefore, initially there is a transient increase in systolic blood pressure which in the later phase of smoking decreases. The rebound phenomenon and the adaptation process were suggested as reasons smokers showed lower blood pressure than non - smokers. We cannot disregard the possibility that our results were affected by these factors. However, it has been suggested that after the first few puffs of smoke, blood pressure increases abruptly and only returns to pre-smoking levels after 1 – 2 hours.[19]

CONCLUSIONS

Smokers exhibit a significant decline in the values of Forced Vital Capacity, Forced Expiratory Volume 1, ratio of FEV1 / FVC, FEF 25 – 75 % and PEFR as compared to the non - smokers. Decline in lung function is greater as the duration and the dose of smoking increases. Among all parameters, value of FVC, FEV1 decreased more, FVC decrease shows decreased growth of lung functions in young people. Decreased FEV1 indicates obstructive changes in the airways. Early insult of smoking on heart rate, blood vessels, and blood pressure later lead to major cardiac problems.

Individuals who smoke, in the initial few years develop airway narrowing resulting in adverse changes in pulmonary functions, which progressively worsen as the insult due to smoking continues. Smoking has hazardous effects on lung functions and also on the total health. Health awareness should be created among people about the ill effects of smoking. Health education on hazards of smoking and legislation on banning of smoking in public places should be encouraged.

REFERENCES

[1] Sugiishi M, Takatsu F. Cigarette smoking is a major risk factor for coronary spasm. Circulation 1993;87(1):76-79.

[2] Singh A, Ladusingh L. Prevalence and determinants of tobacco use in India: evidence from recent global adult tobacco survey data. PLoS One 2014;9(12):e114073.

[3] Cryer PE, Haymnnd MW, Santiago JV, et al. Norepinephrinc and epinephrine release and adrenergic mediation of smoking- associated hemodynamic and metabolic events. N Engl J Med 1976;295(11):573-537.

[4] Gidding SS, Xie X, Liu K, et al. Cardiac function in smokers and non-smokers: the CARDIA study. The coronary artery risk development in young adults study. JACC 1995;26(1):211-216.

[5] WHO. Legislative action to combat the world tobacco epidemic. 2nd edn. World Health Organization 1993: p. 47.

[6] Astrand PO, Rodahl K, Dahl HA, et al. Textbook of work physiology: physiological bases of exercise. Champagne, IL: Human Kinetics 2003: p. 134-176.

[7] Danuser B, Weber A, Hartmann AL, et al. Effects of bronchoprovocation challenge test with cigarette sidestream smoke on sensitive and healthy adults. Chest 1993;103(2):353-358.

[8] Tashkin DP, Clark VA, Coulson AH, et al. The UCLA population studies of chronic obstructive respiratory disease. VIII. Effect of smoking cessation on lung function: a prospective study of a free- living population. Am Rev Respir Dis 1984;130(5):707-715.

[9] Camilli AE, Burrows B, Knudson RJ, et al. Longitudinal changes in forced expiratory volume in one second in adults. Effects of smoking and smoking cessation. Am Rev Respir Dis 1987;135(4):794-799.

[10] Hogg JC, Wright JL, Wiggs BR, et al. Lung structure and function in cigarette smokers. Thorax 1994;49(5):473-478.

[11] Kerstjens HAM, Rijcken B, Schouten JP, et al. Decline of FEV_1 by age and smoking status: facts, figures and fallacies. Thorax 1997;52(9):820-827.

[12] Walter S, Richard J. Longitudinal study of lung function development in a cohort of Indian medical studies: interaction of respiration allergy and smoking. Indian J Physiol Pharmacol 1991;35(1):44-48.

[13] Gold DR, Wang X, Wypij D, et al. Effects of cigarette smoking on lung function in adolescent boys and girls. N Engl J Med 1996;335(13):931-937.

[14] Gorecka D, Bednarek M, Nowinski A, et al. Diagnosis of airflow limitation combined with smoking cessation advice increases stop- smoking rate. Chest 2003;123(6):1916-1923.

[15] Urruita I, Capelastegui A, Quintana JM, et al. Smoking habit, respiratory symptoms and lung function in young adults. Eur J Public Health 2005;15(2):160-165.

[16] Fogari R, Zoppi A, Lusardi P, et al. Cigarette Smoking and blood pressure in a worker population: a cross-sectional study. J Cardiovasc Risk 1996;3(1):55-59.

[17] Green MS, Jucha E, Luz Y. Blood pressure in smokers and non-smokers: epidemiologic findings. Am Heart J 1986;111(5):932-940.

[18] Handa K, Tanaka T, Shindo M, et al. Relationship of cigarette smoking to blood pressure and serum lipids. Atherosclerosis 1990;84(2-3):189-193.

[19] Li H, Tong W, Wang A, et al. Effects of cigarette smoking on blood pressure stratified by BMI in Mongolian population, China. Blood Press 2010;19(2):92-97.