

**A COMPARATIVE STUDY OF
PULMONARY FUNCTIONS
BEFORE AND AFTER
CESSATION OR
MODIFICATION OF SMOKING
HABITS**

CORRESPONDING AUTHOR

1. Dr MALLIKARJUNA VANAGUNDI MD
ASSISTANT PROFESSOR
DEPARTMENT OF PHYSIOLOGY,
VIJAYANAGAR INSTITUTE OF MEDICAL
SCIENCES, BELLARY,
KARNATAKA, INDIA.

CONTACT ADDRESS :-

Dr MALLIKARJUNA VANAGUNDI
NO.71, EX-SERVICEMEN COLONY,
COWL BAZAAR, NEAR BELEGAL CROSS,
BELLARY, KARNATAKA

E-mail: mercury003@gmail.com
Phone number: 09844958455

CO-AUTHORS:-

2. Dr VIVEK BENEGAL MD
ADDITIONAL PROFESSOR OF PSYCHIATRY
DEADDICTION CENTRE
NATIONAL INSTITUTE OF MENTAL HEALTH
AND NEUROSCIENCES
BANGALORE, KARNATAKA, INDIA
e-mail : vbenegal@gmail.com

3. Dr PRASHANTH K SRINIVASAN MD
ASSISTANT PROFESSOR,
DEPARTMENT OF PHYSIOLOGY,
TRAVANCORE MEDICAL COLLEGE,
KOLLAM, KERALA.
e-mail : prashanthksdoc@rediffmail.com

ABSTRACT

Context :: Much is known about ill effects of smoking and tobacco use, but little about the beneficial effects that follow cessation or

reduction of smoking habit. Hence this study intends to explore the same.

Objectives:

1. To assess the improvement in pulmonary function after complete cessation or reduction of smoking
2. To examine the effect of factors such as age and duration of smoking on such improvement, if any.

Design: Serial prospective study

Setting: Smoking Cessation Clinic, National Institute of Mental Health And Neurosciences (NIMHANS), Bangalore.

Subjects: 65 healthy adult smokers presenting voluntary to undergo de-addiction.

Outcome measures:

FEV₁, FVC, FEV₁/FVC and PEF

Protocol: Baseline lung functions recorded and measured again at serial intervals of 4 weeks, till 12 weeks after onset of cessation program. Subjects grouped into quitters, modifiers and non quitters based on their response to the de-addiction program. Results statistically analyzed for significant differences in trend of above parameters.

Results: Following cessation or modification of smoking habit, a definite improvement in all the above lung function parameters was seen. In quitters, FEV1 increased by 382.14 mL ($p < 0.001$), FVC increased by 333.21 mL ($p < 0.001$), FEV1/FVC increased by 0.0412 ($p < 0.001$) and PEF increased by 0.64 L/sec ($p < 0.001$). In modifiers FEV1 increased by 162 mL ($p < 0.001$), FVC increased by 202.66 mL ($p < 0.001$), FEV1/FVC increased by 0.022 ($p < 0.01$) and PEF increased by 0.29 L/sec ($p < 0.001$). The same parameters did not show significant change in non-quitters. The improvement in quitters showed inverse relationship with age, BSA, and duration of smoking.

Conclusions: Cessation or significant reduction of smoking is followed by significant improvement in lung function. The improvement varied inversely with age and degree of exposure to smoking.

Abbreviations:

FEV1: Forced Expiratory Volume in first second

FVC: Forced Vital Capacity

PEFR: Peak Expiratory Flow Rate

INTRODUCTION

Smoking is a major cause of respiratory diseases, heart related ailments, cancer and a wide variety of other health related problems. The total number of tobacco users in the world has been estimated at 1.2 billion, which is

expected to rise to 1.6 billion by 2020. Tobacco use related deaths approximate 3.5 to 4 million people per year globally with numbers expected to increase to about 10 million by 2020. ¹

In India, a nation wide survey showed that 184 million used tobacco, of which 112 million were smokers. According to the Indian Council of Medical Research (ICMR) almost 2200 people die every day from tobacco related diseases, and that each patient suffering from a tobacco related disease costs the country Rs.2.5 million due to direct costs of treatment, absenteeism loss of income and premature death. ²

Despite the progress made in identification of the hazardous substances in tobacco smoke, it has not been possible to identify the chemical(s) whose removal may render tobacco safe. Thus the most effective preventive measure for control of tobacco related diseases is to avoid tobacco use.

Quitting completely is essential to regain good health & reverse adverse effects caused by smoking. The studies on the effects of smoking cessation have shown that it has clinical & physiological benefits for both men and women. In general, after cessation the exaggerated decline of lung function noted in smokers gradually becomes similar to that found in non-smokers. Whether reduction of smoking also has similar benefit has not been explored by many investigators. Also, how soon after cessation do the lung functions begin to change, and what other factors might affect the change, are

important considerations. The degree of improvement depends on the patient age, type of respiratory impairment at the time of quitting. Smokers who quit at later stages, above 10-15 years are likely to experience less improvement in their lung function. With 20 or more years of smoking induced damage, the abnormalities become permanent & include emphysematous destruction of lung parenchyma, chronic inflammation and distortion of pharyngeal air ways.³

Earlier work in the field by Buist et al⁴, Townsend et al⁵, Emmons et al⁶, Sherill et al⁷, and other workers have shown that smoking induced reduction in lung function is at least partially reversible and cessation of smoking results in improvement of lung function, or at least arrest of further decline of the same. Buist et al⁸ and Mc Carthy et al⁹ also found that significant reduction of smoking (at least by 25%) also resulted in improvement of lung function.

Little is known regarding the beneficial effects of cessation or modification of smoking in the Indian population. The current study examined a sample of treatment seeking smokers in Southern India to a] determine whether cessation or reduction of cigarette smoking resulted in significant improvement in lung function as compared to continued smoking; and b] examine the effect of factors like age and degree of exposure to smoke on improvement of lung function, if any.

MATERIALS AND METHODS

FORMATION OF STUDY SAMPLE:

This study was conducted at the National Institute of Mental Health and Neurosciences (NIMHANS), Bengaluru, India. The subjects comprised sixty five adult male smokers voluntarily seeking treatment for tobacco cessation at the out-patient Tobacco cessation clinic. Though patients with other forms of tobacco abuse also frequent the clinic, only those who smoked filter tipped "regular" cigarettes, between the age group of 25 – 50 years were chosen for the study. Socio demographic data was recorded from all subjects, who were then assessed using a semi-structured instrument which included assessment for Severity of dependence using the Fagerstrom Questionnaire [REF] and a screener for the presence of psychiatric disorders and other substance use. Information regarding history of smoking was obtained for each subject and recorded in terms of pack years a] <5, b] between 5 and 10 and c] >10 (One pack year = 20 cigarettes smoked per day for 1 year).

Subjects underwent a general physical examination and thorough clinical examination of respiratory system to rule out significant pre existing pathology which could influence the study parameters. Subjects' physical characteristics like height and weight were measured and recorded.

The exclusion criteria were: 1] History of established cardiac diseases; 2] Evidence suggestive of respiratory pathology; 3] Haemoptysis of any cause; 4] Conditions with increased intracranial pressure; 5] Recent surgery of thorax and abdomen; 6] Dependent use of alcohol or other psycho active substances; 7] Presence of psychiatric morbidity.

Written informed consent was obtained from all subjects and the study was cleared by the Institutional Ethics Board.

The spirometer used for this study was the Vitalograph 2120 Spirotrac IV. It is a small portable device and can be used for off-line testing at tobacco cessation clinics and also allows on-line testing. It is handy and easy to operate powered by a rechargeable battery which auto recharges on docking. It meets the ATS (American Thoracic Society) 1994, and ERS (European Respiratory Society) 1993 standards. It employs a Fleisch type pneumotachometer and works on flow detection principle.

BASELINE MEASUREMENT:

Base line lung function parameters, i.e., FEV₁, FVC and PEF were measured using the spirometer, and documented. The predicted values for FEV₁, FVC & PEF for each subject were obtained from pre-determined values for age, stature and race as per ERS 93 protocol incorporated in the Spirometer software.

SMOKING CESSATION PROGRAM

After initial assessment the subjects entered a smoking cessation program at the tobacco cessation clinic, NIMHANS. The program involved individual, group and family counseling and support meetings, conducted by trained psychiatric social workers. Multiple sessions were held over a period of few weeks, each session lasting for 20 to 30 minutes. The subjects were also required to attend follow up sessions for the next few weeks during which maintenance of cessation was assessed. Problems related to craving, peer pressure and withdrawal symptoms were recognized and addressed appropriately. The program did not involve use of any medication or nicotine supplements.

FOLLOW UP:

As the smoking cessation program continued, at regular intervals of 4 weeks, subjects underwent physical examination and lung function assessment. The same parameters as above were recorded at each follow- up, upto 12 weeks.

At the end of 12 weeks depending on the quitting performance, each subject was assigned to one of three groups- a] quitters, b] modifiers or c] non-quitters. **Quitters** were those subjects who were able to successfully maintain abstinence from smoking over the period of study, and non-quitters including those who either never stopped smoking or relapsed on smoking due to various reasons, without significant duration of abstinence. Those who did not quit smoking but reduced the number of

cigarettes smoked per day by at least 30% were assigned to modifier group. Thus 28 subjects were designated as quitters, 22 as non-quitters and 15 as modifiers. The various recordings of each subject obtained at different points of time were tabulated.

The trend of changes in various study parameters over the said period was noted. The three groups were compared with respect to the above changes and significance in differences observed was ascertained by application of statistical tests.

Statistical Methods: ANOVA was used to find the significance of difference in pulmonary function parameters between quitters, modifiers and non-quitters. Student T test (dependent) was used to find the significance of difference of Pulmonary function parameters between Baseline and Week 12 for each group. The Effect Size of Cohen was computed to find the effect of quitting, reducing and continued smoking, on Pulmonary function parameters. Pearson correlation co-efficient was used to find the relationship of Age and Number of pack years in relation to improvement (Week 12-Baseline) in FEV1, of quitters.

Statistical Package for the Social Sciences 11.0 and Systat 8.0 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

RESULTS

The study populations consisted of 65 male subjects: 28 quitters, 22 non-quitters and 15 modifiers of mean age 34.39 years, 35.14 years & 37.07 years respectively and mean BSA was 1.79 m², 1.80 m² and 1.78 m² respectively. The subjects in all the 3 groups were matched in terms of age and Body surface area (as seen in Table 1)

Table 1: Basic characteristics of the study between quitters, modifier & non-quitters

Basic characteristics	Quitters	Modifiers	Non-quitters	p value
Number	28	15	22	
Age in years (Mean ± SD)	34.39± 7.62	37.07± 8.21	35.14± 9.31	<0.05
Sex	Male= 100.0%	Male= 100.0%	Male= 100.0%	
BSA (m ²) (Mean ± SD)	1.79± 0.13	1.78± 0.11	1.80 ± 0.14	<0.05

Among quitters, 32.1 % had less than 5 pack-years, 35.7 % were between 6-10 pack-years and 32.1 % were between 11-15 pack-years. Among non-quitters 40.9 % were less than 5 pack-years, 27.3% were between 6-10 pack-years 31.8% were between 11-15 pack-years. Similarly among modifiers 40% had less than 5 pack-years, 20% were between 6-10 pack-years and 40% had more than 10 pack-years. The mean in the three groups was 7.89, 9.68 and 8.63 respectively.

Table 2, 3, 4 & 5 lists the differences observed in FEV1, FVC and PEF across the three groups across 12 weeks. Here week 0 represents the baseline value just prior to the onset of cessation program.

There was no significant difference in average FEV1 between the 3 groups at baseline, but quitters showed a significant increase in FEV1 by week 12, with a Cohen's effect size of 1.91 which indicates a very strong effect size. In modifiers, there was a moderate effect and non-quitters displayed a very mild effect size. Similarly, there was an observed significant improvement in FVC among quitters (strong effect size), improvement of moderate effect size among modifiers and very mild effect size among non-quitters. The FEV1/FVC ratio over 12 weeks showed improvement of moderate effect size among quitters and modifiers but insignificant effect size in non-quitters. PEF values improved significantly in quitters (i.e. 0.64L/sec representing a very large effect size). Among modifiers, the average improvement was 0.29L/sec & effect size was 0.76, indicating moderate effect. In non-quitters, the improvement was only 0.06L/sec and effect 0.11 (no effect).

Table 2: Comparison of FEV1 between three groups.

Study Period	FEV1 (ml)			P value
	Quitters (n=28)	Modifiers (n=15)	Non-quitters (n=22)	
Predicted	3318.21±256.15	3235.33±258.59	3310.45±330.95	P=0.636
Week 0	1868.57±199.88	1809.33±228.21	1819.09±299.06	P=0.679
Week 4	1990.71±211.96	1845.33±229.49	1837.73±288.99	P=0.057+
Week 8	2108.93±209.80	1902.67±229.08	1870.00±294.47	P=0.002**
Week 12	2250.71±200.16	1971.33±233.97	1898.18±300.42	P<0.001**
Avg difference (Wk 0 - Wk12)	382.14	162.00	79.09	-
Significance (Wk 0 - Wk12)	t=27.779 P<0.001**	t=36.935 P<0.001**	t=9.012 P<0.055	-
Effect size (d)	1.91	0.70	0.26	-
Avg difference (Pred- Week 12)	1067.50	1264.0	1412.27	

Results are presented in Mean ± SD (Min-Max)
 +Suggestive of significance;
 *Moderately significant;
 **Strongly significant

Table 3: Comparison of FVC between three groups

Study period	FVC (in ml)			P value
	Quitters (n=28)	Modifiers (n=15)	Non-Quitters (n=22)	
Predicted	3954.64±285.33	3874.00±277.66	3953.18±358.88	P=0.684
Week 0	2289.64±226.18	2164.67±253.06	2281.36±232.69	P=0.220
Week 4	2367.14±240.89	2208.00±254.06	2257.27±223.95	P=0.086+
Week 8	2481.43±221.54	2286.67±254.52	2311.82±196.36	P=0.008**
Week 12	2622.86±211.34	2367.33±256.14	2376.36±230.75	P<0.001**
Avg difference (Wk 0 - Wk12)	333.21	202.66	95.00	-
Significance (Wk 0 - Wk12)	t=9.381 P<0.001**	t=6.147 P<0.001**	t=3.584 P<0.054	-
Effect size (d)	1.47	0.80	0.41	-
Average difference (Predicted - Week 12)	1331.78	1506.7	1576.82	-

Table 4: Comparison of FEV1/FVC ratio between three groups

Study period	FEV1/FVC ratio			P value
	Quitters (n=28)	Modifiers (n=15)	Non-Quitters (n=22)	
Week 0	0.82±0.06	0.84±0.01	0.79±0.07	P=0.190
Week 4	0.84±0.06	0.84±0.02	0.81±0.06	P=0.073+
Week 8	0.85±0.05	0.83±0.02	0.81±0.08	P=0.020*
Week 12	0.86±0.05	0.84±0.04	0.80±0.07	P<0.001**
Average difference	0.0412	0.022	0.01	-
Significance (Wk 0 – Wk 12)	t=3.555 P=0.001**	t=0.043 P<0.01*	t=0.185 P=0.885	-
Effect size (d)	0.73	0.04	0.14	-

Table 5: Comparison of PEF between three groups

Study period	PEF L/Sec			P value
	Quitters (n=28)	Modifiers (n=15)	Non-Quitters (n=22)	
Predicted	9.09± 0.43	8.95± 0.44	9.88± 0.56	P=0.912
Week 0	2.40± 0.37	2.28± 0.38	2.23± 0.55	P=0.195
Week 4	2.58± 0.45	2.40± 0.39	2.13± 0.56	P=0.003**
Week 8	2.77± 0.53	2.43± 0.39	2.17± 0.56	P<0.001**
Week 12	3.04± 0.60	2.57± 0.39	2.17± 0.55	P<0.001**
Avg difference (Wk 0 – Wk 12)	0.64	0.29	0.06	
Significance (Wk 0 – Wk 12)	t=66.920 P<0.001 **	t=34.280 P<0.001**	t=0.876 P<0.06	-
Effect size (d)	1.73	0.76	0.11	-
Avg difference (Pred – Wk 12)	6.05	6.38	7.71	-

The mean improvement in FEV1 in quitters of age group 25-30 yrs was 400.91 ml, that in the middle age group 31-40 years was 380 ml and in the older age group, >40 years the improvement over twelve weeks is only

351.67 ml. indicating that mean improvement in FEV1 decreased with increasing age (p<0.05).

Duration of smoking appeared to be a factor in improvement in FEV1 among quitters: for those with less than 5 pack-years mean improvement was 397.78 ml, those between 5 and 10 pack-years showed an improvement of 375 ml and those with more than 10 pack-years showed an improvement of 365 ml (p<0.05).

There was a significant negative correlation between age and improvement in FEV1 (r=-0.218; p<0.05) and approached significance for the relationship between pack years and improvement in FEV1 (r=-0.103; p=0.05).

DISCUSSION

The cessation of smoking among the subjects definitely led to improvement in all parameters of lung functions. These changes began as early as the 4th week of cessation and increased to represent a significant improvement by 12 weeks.

Improvement appears to depend on age, (improvements in FEV1 decrease with increasing age of subjects). The duration and degree of exposure to cigarette smoke appeared to have a similar inverse effect on improvement of FEV1.

These findings imply that smoking cessation is followed by an observable improvement in lung functions which will in turn

have positive repercussions on overall physical, psychological and social well being.

Results obtained from current study were comparable with previous studies.

Thompson ¹⁰ observed that asthmatic smokers who quit smoking showed clinically significant improvement in lung function as early as 1 week of quitting with further improvement up to 6 weeks compared to those who continued to smoke.

The findings of the above study closely correlate with those of current study in terms of improvement in FEV1. The differences in the two studies are that our study population comprised of adult healthy smokers and no drug therapy is involved, while Thompson study involves asthmatics with associated use of corticosteroids, β – agonists, etc.

Imran et al.¹¹ in a similar study in Pakistan found that 6 weeks after quitting, the average FEV1 among quitters had improved to 65 % of predicted. The improvement was maintained at 12 weeks and was more than 65 % at 18 weeks. This finding correlates well with the findings of our study.

Sherrill et al.⁷ demonstrated that the beneficial effects of smoking cessation are maximum for younger individuals and higher the age at cessation, lesser was the improvement in FEV1 reaching nearly 0 at 80 years. Similarly, our study showed inverse relationship with

respect to age and improvement in FEV1 following smoking cessation.

A similar study conducted by Mc Carthy et al⁹ involved assessment of FEV1, FVC, PEF, closing volume and phase III of single-breath nitrogen curve over 48 weeks. It was found that cessation or more than 25 % reduction in the number of cigarettes smoked resulted in significant improvement in all the above parameters which is in agreement with our study findings.

Higgins et al¹² investigated the relationship between cigarette smoking & pulmonary function in elderly men and women. The main outcome measures were averages of FEV1, FVC and prevalence of low FEV1 levels. Smokers who quit before the age of 40 years had FEV1 levels similar to never smokers, but FEV1 levels were lower by 7 % and 14 % in smokers who quit at ages from 40 to 60 & after 60 respectively. Lung function was related inversely to pack-years of cigarette use.

Most of the other studies conducted towards similar objectives are long term studies ranging from 5- 20 years & all of them are designed to assess the difference in rate of decline of FEV1 in quitters and non-quitters, the typical finding is that an initial improvement in FEV1 of quitters is followed by decline in FEV1, in both the groups with age but the rate of decline in non-quitters is far more steeper while that in quitters is as experienced by non-smokers, due to natural aging process. Since

our study was a short term study it could only demonstrate the initial improvement but further long term changes in FEV1 and other lung parameters could not be assessed.

The other limitation in the current study design is that, how far abstinence was maintained by the subjects was not objectively tested by any laboratory parameters and designation of subjects as quitters and non-quitters was based only on subjects own report. Incorporation of one or more of such tests, though expensive will lead to more stringent assessment and hence more accurate results.

CONCLUSIONS:

With the following analysis and interpretation of the results, the following conclusions were drawn.

1. Cessation of smoking or significant reduction in smoking is followed by significant improvement in lung function parameters FEV1, FVC, FEV1/FVC and PEF.
2. The improvement in FEV1 following smoking cessation is greater for younger subjects.
3. Prolonged exposure to cigarette smoke results in less improvement in FEV1 following cessation.

It can be emphasized that effects of smoking on airways is at least partially reversible and smoking cessation is attended by definite improvement in lung functions. Earlier the cessation, better are the results.

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