

# Original Article: The Effect of Cigarette Smoking on Lung Capacity in Active, Previous, and Passive Student Smokers



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## ABSTRACT

**Background:** Cigarette smoke predisposes a person to a lot of preventable diseases; this study aimed at comparing Lung Function in active, previous and non-smokers in students using the ratio of Forced Vital Capacity, to Forced Expiratory Volume measurement in one second called the Tiffeneau-Pinelli Index.

**Materials and Methods:** A cross-section of 77 students from the St. James School of Medicine, Anguilla campus in the Caribbean who are active smokers, previous smokers or non-smokers were randomly sampled with consent using questionnaire based study and measurement of Forced Expiratory Volume (FEV)/Forced Vital Capacity (FVC) ratio was done.

**Results:** The results showed that the mean FEV/FVC ratio for Smokers was lower than that for non-smokers and Ex-smokers in both test 1 and 2. The FEV/FVC ratio by sex was higher in females for both test 1 and 2. There were significant differences among the races with Caucasians having the lowest mean value of 86.04 and 85.88 for test 1 and 2 respectively. Higher ratio of more than 0.7 for smokers, ex-smokers and non-smokers was recorded for mean FEV/FVC ratio.

**Conclusion:** The FEV/FVC ratio was lower in smokers compared to non-smokers and Ex-smokers though not statistically significant.

## Introduction

The continuous exposure of tissues of the respiratory tract to abundant concentrations of radicals, reactive oxygen and nitrogen species trigger a pleiotropic adaptive response aimed at restoring tissues homeostasis [1]. Numerous studies have identified transcription factor NF-E2-related factor 2 (Nrf2) as a regulator of cellular antioxidant response in defending

tissues against the damaging components present in cigarette smoke [1].

Chronic exposure of tissues of the lungs to cigarette smoke leads to respiratory diseases such as Chronic Obstructive Pulmonary Disease (COPD), emphysema, chronic bronchitis and lung cancer [2]. Epidemiologic studies show smoking causes about 90% of all lung cancer deaths in men and women and more women die from lung cancer each year than from breast cancer

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where as 80% of all deaths from COPD are caused by smoking [3].

Second hand smoke also contains toxic chemicals that can cause severe asthma and respiratory infections in adults and children alike [4]. Cigarette smoke predisposes a person to a lot of preventable diseases, our study objective is to compare Lung Function in active, previous and non-smokers using the ratio of Forced Vital Capacity, to Forced Expiratory Volume in one second called the Tiffeneau-Pinelli Index. Our hypothesis is cigarette smoking would affect the total Lung capacity in active smokers and previous smokers.

## Materials and Methods

### Study design, setting and participants

A cross-section of 77 students from the St. James School of Medicine, Anguilla campus in the Caribbean who are active smokers, previous smokers or non-smokers were randomly sampled with consent using questionnaire based study and measurement of FEV<sub>1</sub>/FVC ratio was done. The study protocol was approved by the Research in Health and Medicine committee of the St. James School of Medicine, Anguilla, campus. Participants in the study were recruited from the Doctor of Medicine (MD) 2 and (MD) 3 class of summer 2014 and eligibility included students who are active, previous and non-smokers. Among the 77 participants, 34 were males and 43 were females aged between 20 and 49 years. Questionnaires that inquired about their demographics, smoking habits, respiratory symptoms, history of respiratory diseases, surgeries, and other respiratory medications was administered to each selected student.

### Measurements

Each subject was self-classified as a non-smoker, ex-smoker or current smoker. Vital statistic such as gender, height, age, race, weight and length of exposure to cigarette smoke were vital input that determined their respiratory requirements. A minimum of three acceptable expiratory maneuvers was obtained [5]. During each test, three FEV<sub>1</sub>-FVC measurements were recorded and the one corresponding to maximum FEV was selected [6]. The measurements were repeated approximately one month apart using the Winspiro PRO 5.2 Spirometer. The Spirometer test was repeated approximately one month apart to verify if there was any significant change in the FVC, FEV and hence the FEV/FVC ratio.

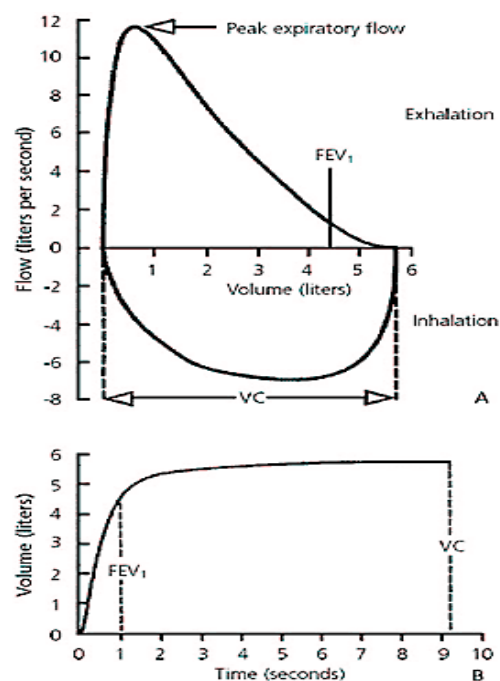
The Spirometer measures the rate at which the lung changes volume during forced breathing maneuvers. Participants started with full inhalation, followed by a forced expiration that rapidly emptied the lungs until a plateau in exhaled volume was reached. These efforts were recorded and graphed from which the FVC, FEV, FEV/FVC ratio and TLC were obtained as exemplified in Figure 1 [6].

### Statistical analysis

The results obtained were analyzed using Epi-info version 7. Frequency distribution for the variables was estimated and linear regression analysis was used to analyze the independent and dependent variables; Fisher's test (F-test) was used to test the statistical significance. Analysis of Variance (ANOVA) was used to test means of variables in multivariate analysis.  $P < 0.05$  was considered significant.

## Results

The FEV/FVC ratio was group into ranges to make the data manageable. The frequency shows the number of people that corresponded to the given ranges. The Ex-smoker "NO" frequency corresponds to active smokers



**Figure 1.** Normal spirometric flow diagram

(A) Flow-volume curve; (B) Volume-time curve; FEV<sub>1</sub>: Forced Expiratory Volume in one second; FVC/VC: Forced Vital Capacity; TLC: Total Lung Capacity.

**Table 1.** Frequency of ex-smoker & smoker status for FEV<sub>1</sub>/FVC ratio in test 1

FEV <sub>1</sub> /FVC FEV/FVC Range	Ex-Smoker Frequency			Smoker Frequency		
	No	Yes	Total	No	Yes	Total
75-84	17	2	19	12	7	19
85-94	36	11	47	39	8	43
95-104	11	0	11	8	3	11
Total	64	13	77	59	18	77
P	0.8			0.1		



**Table 2.** Frequency of ex-smoker & smoker status for FEV<sub>1</sub>/FVC ratio in test 2

FEV <sub>2</sub> /FVC FEV/FVC range	Ex-Smoker Frequency			Smoker Frequency		
	No	Yes	Total	No	Yes	Total
75-84	18	2	20	13	7	20
85-94	40	10	50	42	8	50
95-104	6	1	7	4	3	7
Total	64	13	77	59	18	77
P	0.35			0.16		



and non-smokers whereas the ex-smoker "YES" frequency corresponds to participants that have actually stopped smoking. Table 1 shows the frequency distribution of ex-smokers and smokers with respect to their FEV/FVC ratio in the first experiment (Test 1).

Table 2 shows the frequency distribution of ex-smokers and smokers with respect to their FEV/FVC ratio in the Second experiment (Test 2).

Table 3 and 4 shows the comparative frequency distribution of females and males with respect to their

FEV/FVC ratio for the first and second experiment (Test 1 and 2).

Table 5 and 6 shows the comparative frequency distribution of smokers, ex-smokers and nonsmokers with respect to their FEV/FVC ratio for the first and second experiment (Test 1 and 2).

### Discussion

Our analysis revealed that FEV/FVC ratio had a mean of 86.6 for smokers, 89.1 for non-smokers and 88.9 for ex-smokers for test 1 and 85.9 for smokers, 88.5 for non-

**Table 3.** Frequency of females & males for FEV/FVC ratio in tests 1 & 2

FEV/FVC FEV/FVC Range	Females		Males	
	Test 1	Test 2	Test 1	Test 2
75-84	7	7	12	13
85-94	29	33	18	17
95-104	7	3	4	4
Total	43	43	34	34



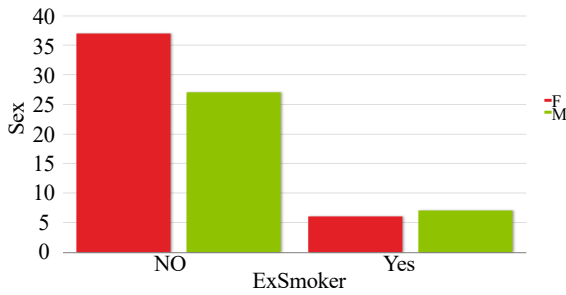


Figure 2. Frequency of Ex-smoker status against Sex

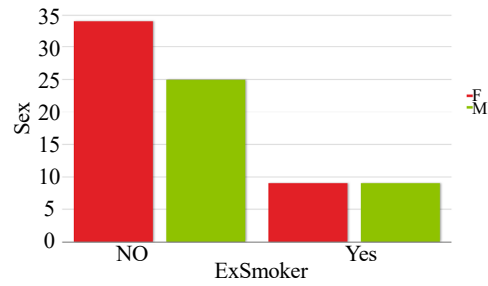


Figure 3. Frequency of Smoker status against Sex



Table 4. Means of FEV/FVC ratio vs. race in Test 1 & 2

Race	Test 1	Test 2
Race 1 (Caucasians)	86.04	85.88
Race 2 (African decent)	89.5	88.2
Race 3 (Asians)	89.9	89.41
P	0.01	0.02



smokers and 89.8 for ex-smokers for test 2. The mean FEV/FVC ratio for Ex-smokers was slightly lower than that for non-smokers in tests 1 with no significant difference but higher than both smokers and non-smokers in test 2. Thus Ex-smokers in test 2 had a better recovery of lung function than non-smokers after stopping smoking. Chiappa et al. reported that co-effect of smoking with asthma or COPD or combined asthma and COPD has more severe impact on ageing than smoking, asthma, COPD or combined asthma and COPD alone; furthermore, it reported that the rate of decline of lung function is faster in smokers with emphysema than in ex-smokers

with emphysema [7]. The P=0.8 for ex-smokers "No" and ex-smoker "Yes" for test 1 and P=0.1 for smoker "No" and smoker "Yes" was not statistically significant in our study (P>0.05 at 95% confidence interval for all our results). The same trend was observed for test 2 with ex-smokers "No" and ex-smoker "Yes" having a P=0.35 and P=0.16 for smoker "No" and smoker "Yes" respectively. The P-value was also statistically not significant. The FEV/FVC ratio by sex was higher in females for both test 1 and 2 (Figure 2 and 3). Our results were consistent with that by Stanjevic et al. who found sex differences are apparent, with females having greater pre-

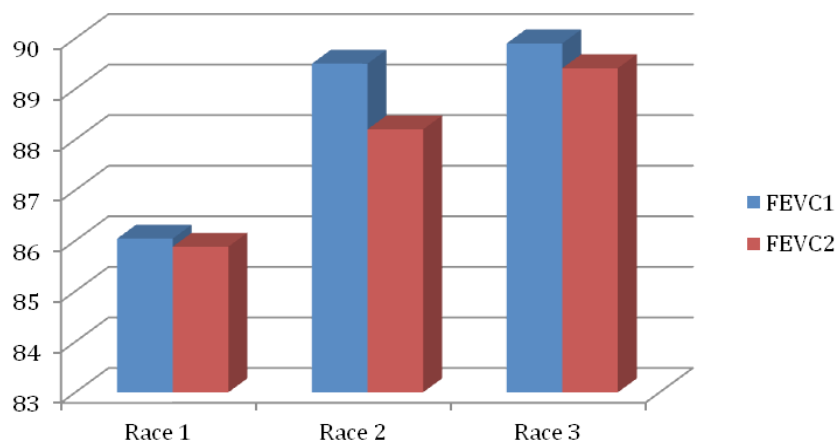


Figure 4. Bar chart of means of FEV/FVC ratio vs. race in Test 1 & 2 (FEVC 1 & 2)



**Table 5.** Frequency of smokers, ex-smokers and nonsmokers vs. FEV<sub>1</sub>/FVC ratio for test 1

Test 1	Smoker	Ex-Smoker	Nonsmoker
FEV <sub>1</sub> /FVC range			
75-84	7	2	12
85-94	8	11	39
95-104	3	0	8
P	0.20		



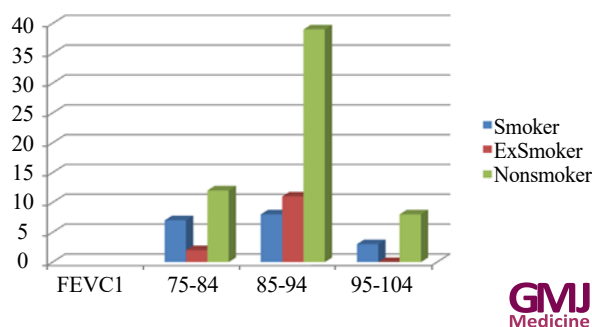
dicted values of FEV/FVC than males at all ages and most marked in late puberty [8].

There were significant differences among the races with Caucasians having the lowest mean value of 86.04 and 85.88 for test 1 and 2 respectively and participants of African descent came next with a mean of 89.5 and 88.2 for test 1 and 2 respectively (Figure 4). Asians scored the highest among the races with a mean reading of 89.9 and 89.41 for test 1 and 2 respectively. This finding is contrary to that found by Barreiro et al. with Caucasians having a greater FEV and FVC than blacks and Asians but our results is consistent with Agaku et al. which showed that Asians smoked less compared with Blacks and Whites [6, 9].

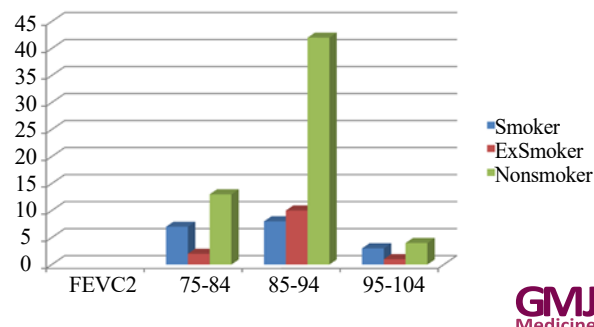
The mean FEV<sub>1</sub>/FVC ratio was higher with more than 0.7 for smokers, ex-smokers and non-smokers (Figure 5 and 6). In restrictive diseases, the absolute FEV/FVC ratio may be normal or increased whiles the FEV and FVC are decreased in obstructive diseases. The ratio varies based on age, sex, height and weight [7]. In our study the mean ratios for FEV/FVC were higher than 0.7 for all smoking habits investigated. Other studies show that the FEV/FVC of 0.7 is not attained until around 50 years of age in males and considerably later in females, but is considerably higher during childhood and lower in the elderly [6]. The P-values for the smoke status showed no statistically significant differences among the smoke status at a 95% confidence interval therefore, we reject our hypothesis and we are unable to accept the alternative because of insufficient data, time and other confounding

**Table 6.** Frequency of smokers, ex-smokers and nonsmokers vs. FEV<sub>1</sub>/FVC ratio for test 2

Test 2	Smoker	Ex-Smoker	Nonsmoker
75 - 84	7	2	13
85 - 94	8	10	42
95 - 104	3	1	4
P	0.13		



**Figure 5.** Bar chart showing frequency of smokers, ex-smokers and nonsmokers vs. FEV<sub>1</sub>/FVC ratio for test 1



**Figure 6.** Bar chart showing frequency of smokers, ex-smokers and nonsmokers vs. FEV<sub>1</sub>/FVC ratio for test 2.

factors that may be present in the research. Particulate matter in cigarette with numerous chemicals like reactive oxygen and nitrogen species, promote cellular apoptosis, increase inflammation and necrosis, which might leads to respiratory diseases like COPD, emphysema and asthma [10].

## Conclusion

The FEV/FVC ratio may be normal or increased in restrictive ventilator impairment while the FEV and FVC are decreased in obstructive diseases. In our study, the FEV/FVC ratio was lower in smokers compared to non-smokers and ex-smokers though not statistically significant. There was a higher ratio for females than males and Asians scored the highest absolute FEV/FVC ratio among the races.

## Ethical Considerations

### Compliance with ethical guidelines

Approval for the study was obtained from the Saint James School of Medicine Research Committee.

### Funding

Provided by the Saint James School of Medicine Research Committee.

### Authors' contributions

Designing the study and making professional content to the manuscript: Danil Hammoudi; Writing the first draft of the manuscript and managing the literature searches: Dina Adofo and Ivan Antoine; Analyzing the study: Adekunle Sanyaolu; Making corrections to manuscript and preparing final draft for submission: Adekunle Sanyaolu and Danil Hammoudi; and Reading and approving the final manuscript: All authors.

### Conflict of interest

The authors declared no conflict of interest.

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