Title: Effects of tobacco smoking on pulmonary function indices among undergraduate students

Authors: Babatunde O.A. Adegoke, PhD,[1], Ayodele A. Akinremi, PhD,[1], Adekemi E. Akintobi B.Sc[1]

[1]Department of Physiotherapy, College of Medicine, University of Ibadan, Ibadan, Nigeria

Corresponding author: Ayodele A. Akinremi, Department of Physiotherapy, College of Medicine, University of Ibadan, Ibadan, Nigeria;

E-mail: ogooluwa2@yahoo.com (2348026423988)

Abstract

Background: Tobacco smoking is a risk factor for chronic respiratory disorders. The tobacco epidemic is driven by adolescents and young adults. Tobacco-related morbidity rises with increasing years of smoking, and the increasing number of young smokers may have considerable future public health implications.

Objective: This study investigated the effect of tobacco smoking on pulmonary function indices among undergraduate students.

Methods: This is a cross sectional study involving 104 male undergraduate students between 18 and 30 years of age. They were recruited by snowball sampling and were grouped based on their smoking status (current smoker 52: non-smoker 52). Participants with signs of respiratory disease, thoracic spine deformity, or contraindication to spirometry were excluded from the study. Participants' forced vital capacity (FVC), forced expiratory volume in first second (FEV_1), both in litres, and forced expiratory ratio (FER) in percentage were assessed using standard protocols. Data were analyzed using mean, standard deviation, independent t-test and chi-square test with alpha level set at 0.05.

Results: The two groups were not significantly different in age, height and body mass index (BMI). Smokers had significantly reduced FVC (3.42±0.42 vs 3.87±0.4 litres) p=0.03; FEV_1 (2.39±0.37 vs 3.22±0.38 litres) p=0.001 and FER (%) (70.7±7.58vs82.3±4.05) p=0.01. Among the smokers, a relationship was observed between years and numbers of cigarettes smoked and lung function. The proportion of participants with FER below the age-matched reference was significantly higher among smokers than non-smokers (40.4%vs6.7%) at p=0.021.

Conclusion: Smoking reduced pulmonary function among undergraduate students. This may have important public health implications since continued smoking may accelerate lung function deterioration and consequently increase the future risk of developing lung disease.

Key Words: Tobacco smoking, undergraduates, pulmonary function indices

Introduction

Tobacco smoking is a major risk factor for developing several chronic diseases such as stroke, heart attack, chronic obstructive pulmonary disease (COPD) and a variety of cancers (WHO, 2011). It is estimated that there are over one billion smokers worldwide, with more than 80% of them living in low-and-middle income countries (Jha, 2009). Smoking causes cancer, heart disease, stroke, lung diseases (including emphysema, bronchitis, and chronic airway obstruction), and diabetes (US DHHS, 2014). Worldwide, tobacco use causes more than 5 million deaths per year, and current trends show that tobacco use will cause more than 8 million deaths annually by 2030 (Mathers and Loncar, 2006), with 80% of these deaths occurring in low-and-middle income countries. On average, smokers die 10 years earlier than nonsmokers (Jha et al, 2013). For every person who dies from a smoking-related disease, about 30 more people suffer with at least one serious illness from smoking (US DHHS, 2014). Each day, more than 3,200 persons younger than 18 years of age smoke their first cigarette, and each day, an estimated 2,100 youth and young adults who have been occasional smokers become daily cigarette smokers (WHO, 2011).

Smoking among young adults between ages 18 and 30 years continues to drive the tobacco epidemic globally, with an estimate in 2010 showing that 20% of 18-24 year olds were current smokers as compared to 19.6% among individuals who are 25 years and above (WHO, 2011). This trend does not appear to be different in sub-Saharan Africa (Townsend et al, 2006). Nnodu and Jamda (2006) found that one-third of the male students in a Nigerian university were current smokers.

Most studies conducted to determine the impact of smoking on lung function and other respiratory symptoms have been conducted among older individuals with a long history of smoking (Enright et al, 2002; Urrutia et al, 2005; Abbasi et al, 2012). Smoking among young adults reduces the rate of lung growth and accelerates normal lung function decline that is associated with ageing (GOLD, 2011). Smoking decreases the capacity of the lung, causes irritation of the airways resulting in airflow limitation and also causes the lung to age faster than in non-smoking, age-matched individuals. A smoking history of more than 4 years has been associated with respiratory symptoms and increased risk of cardiovascular and metabolic disease (WHO, 2011). While most studies investigating the effects of tobacco on lung function among older individuals usually involve symptomatic adults with comorbidities, data from such studies cannot be generalized to the asymptomatic young adult population.

Despite the considerable prevalence of smoking among young adults, there seems to be a dearth of published data on respiratory function of Nigerian undergraduate smokers. Determining the impact of smoking on the respiratory parameters of this population may be useful in formulating effective intervention strategies and policies. Hence, this study aimed at investigating the effect of tobacco smoking on forced vital capacity (FVC), forced expiratory volume in first second FEV_1 and forced expiratory ratio (FER) among undergraduate students.

Methods

Study Design: The study was a cross-sectional study.

Participant selection: One hundred and twenty-two males aged between 18 and 30 years were recruited from the undergraduate student population of the University of Ibadan, Nigeria using a snowball technique. Students were grouped based on their smoking status. Using the WHO classification criteria (WHO, 1998), a current smoker is someone who, at the time, of the study smokes a tobacco product either daily or occasionally whereas a non-smoker is someone who does not smoke a tobacco product at all. Prospective participants with known history of acute or chronic respiratory infections, tuberculosis, asthma, neuromuscular disease, malignancy, cardiopulmonary disease, thoracic spine deformity, previous abdominal or chest surgery and individuals on bronchodilators or with contraindications to spirometry such as myocardial infarction, eye or abdominal surgery within 6 weeks prior to the study period were excluded from the study, as these factors either adversely influence or contraindicate spirometry. Out of 122 eligible students who met the inclusion criteria, 18 individuals were excluded from the study based on factors listed in the exclusion criteria, and only 104 (85.2%) participated in the study: 52 tobacco smokers and 52 non-smokers.

Ethical review and consent: Ethical approval was obtained from the Institutional Health Research Committee of the University of Ibadan, and informed consent was sought and obtained from participants before commencement of the study.

Sample size estimation: To detect a difference of 400mls (0.4L) in FVC, with a study power of 80% and significance level of 5%, a minimum sample size of 50 participants was required for each group. Previous studies have shown that a difference of 400mls in FVC produces a significant reduction in lung capacity (GOLD, 2011).

Data collection and quality control: After obtaining informed consent, the procedure and purpose of the study was explained to all participants. Spirometry was conducted by a trained technician, who was blinded to the study protocol, using a digital spirometer microplus model made by MicroMedical, England.

Variables: The exposure variable for this study was the smoking status while the outcome variables were FEV_1, FVC and FER. All spirometeric parameters were conducted using European Respiratory Society/American Thoracic Society (ATS/ERS) guidelines (Miller et al, 2005). Spirometry was performed with the participants comfortably seated on a chair with armrest to ensure safety in case of dizziness. Participants were reassured with a careful explanation of the test procedure. The technician demonstrated the procedure and participants were given two trials to become familiar with the procedure, which uses a nose clip and non-compressible mouthpiece. The procedure is outlined as follows: 1) Breathe in fully; 2) Seal your lips around the mouthpiece; 3) Force the air out of the chest as hard and fast as you can until you feel your lungs are completely "empty" 4) Breathe in again and relax. Participants continued to exhale for a minimum of about 6 seconds or until they could no longer exhale air. A minimum of three acceptable trials were performed to minimize the errors. The highest values for both FEV_1 and FVC that did not vary by more than 5% or 150 mls, (whichever was greater) from the next value were recorded for data analysis. Data collection was guided by a documented and reviewed study manual, while quality of data was assured by strict compliance to the ERS/ATS spiormetry guidelines (Miller et al, 2005).

Data analysis: Data were analyzed using SPSS 16. Continuous variables of age, anthropometric indices (weight, height, body mass index (BMI)) and lung function indices (FEV_1, FVC and FER) were summarized as mean and standard deviation while data on categorical variables of smoking habit and airflow pattern were presented as frequency (n) and percentage (%). The independent t-test was applied to compare the means of continuous variables between the two independent groups, while a chi-square test was used to check for significant differences between proportions. A p value of <0.05 was considered statistically significant.

Results

Table 1. Physical characteristics of participants

Variables	Smokers (n = 52)	Non-smokers (n = 52)	p-value
Age (yrs)	24.18±3.06	24.33±3.04	0.51
Weight (kg)	70.48±10.26	69.24±10.94	0.11
Height (m)	1.74±0.08	1.75±0.08	0.32
BMI (kg/m^2)	23.7±3.3	22.29±2.7	0.09

There was no significant difference in age, weight, height and BMI between the groups (Table 1). Participants in this study were between the ages of 18 and 30 years, and all were within a healthy

BMI range (18 to 24.9). Smoking characteristics of smokers are shown in Table 2. About one-fifth of the smokers started smoking before 11 years of age, while over 50% had their first smoking experience after 14 years of age. Most of the smokers (52%) have been smoking for less than 7 years, another 42% had smoked more than 7 years but less than 13 years, while 6% had been smoking for more than 13 years. Two-thirds of participants who smoke reported smoking less than 10 cigarettes per day, and about a quarter (27%) smoked more than 10 but less than 19 cigarettes per day.

Table 2 Smoking habits of participants

Smoking habit	Mean±SD	n	%
Smoking debut, years	12.6±2.4		
6 - 10		10	19%
11 - 14		14	27%
≥14		28	54%
Smoking, years	8.5±2.2		
1 – 6		27	52%
7 – 12		22	42%
≥13		3	6%
Cigarettes, n/day	8.3±3.2		
1-9		32	61%
10 – 19		14	27%
>20		6	12%

Smokers had significantly lower pulmonary function than non-smokers with a mean difference of -830mls in FEV_1 p=0.001 and -450mls in FVC, p=0.03 (Table 3). A significant difference was also observed in FER between the two groups (p=0.01).

Table 3. Independent t-test for comparison of pulmonary function indices between tobacco smokers and non-smokers

Indices	Smokers (n=52)	Non-smokers (n=52)	p-value
FEV_1, litres	2.39±0.37	3.22±0.38	0.001
FVC, litres	3.42±0.42	3.87±0.4	0.03
FER, %	70.7±7.58	82.3±4.05	0.01

Lung function indices of smokers grouped by the years of smoking and number of cigarettes per day are shown in Table 4. Compared with the mean FEV_1 and FVC of non-smokers (3.22±0.38; 3.87±0.4, respectively), participants who have been smoking for less than 13 years had lost an average of 700mls of FEV_1 (p=0.01) and an average of 300mls of FVC (p=0.07), while those who have been smoking for more than 13 years have lost over 1litre in FEV_1 (p=0.001) and 760mls in FVC (p=0.02). Participants who smoked less than 10 cigarettes per day had an average of 670mls and 290mls less of FEV_1 and FVC values than non-smokers (p=0.03; p=0.21, respectively), while those who smoked between 10 and 19 cigarettes per day had 820mls and 420mls less of FEV_1 and FVC, compared with non-smokers (p=0.01; p=0.13, respectively). Those who smoked more than 20 cigarettes per day had lost an average of 870mls of FEV_1 (p=0.001) and 550mls of FVC (p=0.07) when compared with non-smokers.

Table 4. Lung function parameters of smokers classified by years of smoking and number of cigarettes per day

Smoking habit	n	FEV_1	p	FVC	p	FER	p
Smoking, years							
1 – 6	27	2.5±0.39	0.01	3.55±0.42	**0.12**	70.6±7.9	0.02
7 – 12	22	2.51±0.35	0.01	3.55±0.42	**0.07**	70.8±7.7	0.03
≥13	3	2.21±0.18	0.001	3.11±0.28	0.02	71.2±2.6	0.03
Cigarettes, n/day							
1-9	32	2.55±0.36	0.03	3.58±0.41	**0.21**	71.4±8.8	0.02
10 – 19	14	2.40±0.39	0.01	3.45±0.48	**0.13**	69.7±5.7	0.001
>20	6	2.35±0.32	0.001	3.32±0.33	**0.07**	70.6±4.5	0.001

Lung function parameters were compared with those of non-smokers (FEV1 = 3.22±0.38; FVC = 3.87±0.4; FER = 82.3±4.05)

Table 5: Airflow pattern among participants

FER, %	Smokers, n (%)	Non-smokers, n (%)	p-value
Normal (≥ 80%)	10 (9.6%)	45 (43.3%)	0.019
Airflow Limitation (≤ 80%)	42 (40.4%)	7 (6.7%)	0.021

[11] (NHLBI Guideline, 2007: for adults below 40 years normal FER is **0.8**)

The airflow pattern of participants in the study is shown in Table 5. Using the National Heart, Lung, and Blood Institute Guideline (NHLBI, 2007), which classifies a FER of less than 80% as an airflow limitation for adults below 40 years of age, a significantly higher proportion of smokers (40.4%) had a FER ratio suggestive of an obstructive pattern while only 6.7% had a normal FER (*p*=0.021). The proportion of non-smokers with a normal FER (43.3%) was significantly higher compared with that of smokers (9.6%) *p*=0.019.

Discussion

This study investigated the effect of tobacco smoking on lung function indices among male undergraduate students. We compared lung function indices (FEV_1, FVC and FEV_1/FVC) between undergraduate students who smoke and those who have never smoked. Participants in both groups were comparable in age, height and BMI. Our results show that undergraduate tobacco smokers had significantly reduced pulmonary lung function indices compared to age-matched non-smokers. We also found that the reductions in FEV_1 and FVC were more pronounced among those who have been smoking for more than six years, irrespective of the number of cigarettes smoked per day.

Spirometry detects change in lung function, even before the patient develops clinical symptoms (Prasad et al, 2003). As smoking duration and the number of pack years increase, deterioration of lung function parameters and severity of symptoms worsen (Rasamussen et al, 2005). FEV_1 and FER are the most affected lung function parameters, and are often regarded as the earliest spirometric indicators of airway obstruction and small airway disease in adult smokers (Urrutia et al, 2005). Significantly lower values of FVC and FEV_1 among the smokers suggests smaller lung volumes and airways, respectively, compared with the non-smokers, while the significantly lower FER is suggestive of early obstructive pulmonary impairment (Miller et al, 2005). This result is supported by the findings of Isabel et al, (2005) who conducted a cross-sectional survey among 20 to 40-year-old smokers and found that cigarette smoking was associated with deterioration in lung function and early onset of respiratory complaints. Our data further show a trend that suggests increased smoking duration/intensity is related to greater reductions in lung function. This is similar to the observation made by Cerveri et al, (2001) in a group of European subjects.

Tobacco smoking, with its attendant short- and long-term consequences, is becoming a public health problem among Nigerian youths (Nnodu and Jamda, 2006). The proportion of smokers with airflow limitation was significantly higher than that of non-smokers and non-smokers had healthier lungs than smokers. Smoking in young adults slows the rate of lung growth and causes early and rapid deterioration of lung function (GOLD, 2011). Smoking cessation at any age holds promise of slowing down the decline in lung functions and improves respiratory symptoms (Chaudhuri et al, 2006; Bohadana et al, 2006).

Education and integration of early detection of deterioration in lung function of undergraduate smokers into routine health screening might be effective in encouraging smoking cessation among this population that is most vulnerable to lung damage (Parkes et al, 2008).

This study is a cross-sectional study and cannot be used to establish a casual association between smoking and the extent of decline in lung functions, since other factors such as nutrition and physical activity may influence the role of smoking on lung function. We also acknowledge the limitations of unequal group size in analyzing the effect of years of smoking and number of cigarettes per day on lung function indices; this should be interpreted with caution as a larger sample size with equal group size may be required to validate the generalizability of this finding.

Conclusion

Tobacco smoking is associated with deterioration in FEV_1, FVC and FER among undergraduate smokers. Observations from this study highlight the early health consequences of smoking, such as reduced forced vital capacity and forced expiratory volume in first second and early onset of airflow limitation among young adults. Interventions are needed to educate and support young people to quit smoking as it may help retard the decline in lung function. Longitudinal studies are needed to identify risk factors associated with smoking among this population. Such studies may give additional insight about other factors relating to smoking that further worsens pulmonary function.

Conflict of interest: None declared

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