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Full Length Research Article

Peak Expiratory Flow Rate and Smoking Intensity of Cigarette Smokers Among Male Varsity Students Aged 17 to 30

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ABSTRACT
Cigarette smoking remains a significant public health concern associated with impaired respiratory function. Peak expiratory flow rate (PEFR) serves as an important indicator of airway obstruction. This study examined smoking intensity and PEFR difference between cigarette smokers and non-smokers among students of Ahmadu Bello University, Zaria. The cross-sectional study included 130 male students aged 17-30 years, with a smoking history categorized into three groups based on the number of cigarettes smoked per day. PEFR was measured using a Wright Peak Flow Meter. Data on body mass index (BMI) and demographic details were also collected. Statistical analysis was performed using SPSS version 28, with comparisons made between smokers and non-smokers using Student's t-test. Smokers demonstrated significantly *($p<0.05$)* low mean PEFR (306.40 ± 7.48 L/min) compared to non-smokers (368.10 ± 5.51 L/min). There was no significant *($p>0.05$)* difference in body weight, height and BMI of the smokers in comparison with the non-smokers. Cigarette smoking significantly *($p<0.05$)* impaired PEFR among the students. The study indicates that cigarette smoking, which impairs PEFR may compromise airway function. This underscores the adverse effects of smoking on respiratory health and highlights the need for targeted interventions to reduce smoking rates and promote lung health among young adults.

KEYWORDS: Peak expiratory flow rate, Cigarette smoking, Respiratory function, Smoking intensity, Ahmadu Bello University students, Body mass index, Weight, Height.

INTRODUCTION
Cigarette smoking constitutes a major preventable cause of global respiratory morbidity and mortality, contributing to over 8 million deaths annually (World Health Organization, 2023a). Chronic obstructive pulmonary disease (COPD) is a global burden that presents as a progressive condition characterized by irreversible airflow limitation, accounting for 3.2 million of these deaths (Van-Schayck and Williams, 2022). In Nigeria,17.3% of university students smoke tobacco regularly (National Bureau of Statistics, 2022), a statistic that underscores the urgency of understanding the pulmonary effects of early smoking in this high-risk demographic age group (Quanjer *et al*., 2021; Zwane and Mthembu, 2023).

Smoking intensity is the measure of how much tobacco is consumed, basically presented as the average number of cigarettes smoked per day. It can be taken as the measure of toxins from cigarettes inhaled into the lungs during smoking. Smoking intensity matters because of the potential health risk to the smoker, dose-dependent harm, as well as the public health disturbance/risk it causes to people who perceive the toxins from cigarette smoking (Abbasi-Dokht-Rafsanjani *et al*., 2023). Smoking intensity can also be measured using a biomarker like urinary cotinine to assess short-term (recent) exposure to smoke or by calculating pack-years for cumulative exposure. Others are cigarette per day (CPD), the most common method of directly asking smokers for the average number of cigarettes they smoke per day, as well as classification into heavy or light smoking, which is derived by the number of cigarettes smoked per day, such as 10 or more cigarettes per day versus fewer than 10. The factors that influence smoking intensity are age of initiation, gender, and socioeconomic status. For age at initiation, it is often held that people who start smoking at a younger age tend to become heavier smokers in the future. For gender, the male folk smoke cigarettes more than the females. For socioeconomic status, higher rates of smoking are often seen among lower socioeconomic groups (Manoochehri *et al*., 2022).

Peak expiratory flow rate (PEFR) is defined as the maximum airflow velocity during forced expiration and serves as a simple, non-invasive biomarker of large airway obstruction (Johnson *et al*., 2023). PEFR can be measured with the use of a peak flow meter, and it is also employed in monitoring and assessing the severity of asthma or other respiratory conditions (Wanner *et al*., 2022). PEFR finds clinical application in asthma monitoring to guide treatment decisions/options; for assessing bronchodilator response before and after using an inhaler to check for respiratory improvement, as well as occupational and work-related lung diseases (asthma) by checking PEFR at different times and locations. While spirometry remains the gold standard for COPD diagnosis (Sagher and Khanna, 2020), PEFR measurement via portable devices (e.g., Wright peak flow meters) offers a cost-effective screening tool for resource-limited settings (Patel and Nwafor, 2023). Empirical evidence confirms smokers exhibit 15-25% lower PEFR values than non-smokers, reflecting smoking-induced airway inflammation and remodeling (Alqahtani *et al*., 2022;

Cosio *et al*., 2020). Tanko *et al*. (2012a) assessed the cardio-pulmonary and cardiovascular status between smoking and non-smoking students of Ahmadu Bello University, Zaria, Nigeria. Other related studies bordered on limitations to African Data as most studies focused on Western/Asian populations (Ojo *et al*., 2023); youth-specific evidence on university students (a group vulnerable to smoking initiation - are underrepresented) (Zulkifli and Kadir, 2023); dose-response Uncertainty and the relationship between smoking intensity (cigarettes/day) and PEFR decline in young adults (Zhang and Wang, 2023). Tanko *et al*. (2012b) reported a decrease in the peak flow rate and basal metabolic rate in farmers located in Rafi Local Government Area, Niger State, Nigeria. Despite these reports, critical research gaps persist among varsity students of research-based age groups. This study, therefore, addresses these gaps among male students of ABU, Zaria by comparing PEFR between smokers and non-smokers; evaluation of smoking intensity-PEFR correlations, as well as control for confounders study via assessment of body weight, height, and body mass index (BMI).

MATERIALS AND METHODS

Materials Used

A Mini-Wright Peak Flow Meter (Model: SKU 45-6680) was used for the measurement of PEFR. Antiseptic (dettol) and hygiene protocols were followed. The updated infection control practices for spirometry equipment were adopted for the study (Miller *et al*., 2020). WHO (2023b) recommends alcohol-based wipes for reusable medical devices. Cotton Wool was used for cleaning the mouthpiece. Questionnaires were used as validated tools, like the Global Adult Tobacco Survey (GATS), and are widely adopted (WHO, 2022a). The weighing scale was employed for recording the body weight of the participants. Meter rule was utilized for measuring participants' height.

Study Location

The study was conducted at the social center of Ahmadu Bello University, Zaria, located in Kaduna State, Nigeria. This location was chosen due to its diverse student population and the feasibility of conducting the study within an academic setting.

Subjects

In an effort to determine the Peak expiratory flow rate of cigarette smokers, we carried out a case-control study that included 130 male students, comprising a total number 70 smokers and 60 non-smokers aged between 17 and 30 years. Each category would subsequently be referred to as smokers and controls in the text. Participants with a history of asthma or chronic obstructive airway disease were excluded to avoid confounding factors that could affect PEFR measurements (Vanhoutte *et al*., 2007). Participants' smoking history was recorded, categorizing them into three groups based on daily cigarette consumption: <10, <20, and >20 cigarettes per day. Data on passive smoking were also collected.

Criteria for Inclusion

Subjects picked for the study were male students of the Ahmadu Bello University, Zaria. Those aged 17 years and above. Students who were able to provide informed consent were used for the study, as well as those students who were present on the day of the survey.

Criteria for Exclusion

The persons who are not included within the Ahmadu Bello University, Zaria campus are students who are aged 17 years and below. Also, students who could not provide informed consent were excluded, as well as students who were not present on the day the survey took place.

Filling of Questionnaire

Sequel to providing informed consent, participants filled out a properly structured questionnaire. The questionnaire contains adequate information about smoking behaviours, which include frequency, duration, and cigarette type, and demographic features (age and academic level). This strategy followed the validated template of the Global Adult Tobacco Survey (World Health Organization, 2022b), with little adjustment for local context. Self-reported smoking data were collected using a procedure with high reliability as previously documented by Heatherton *et al*. (2020).

Measurement of PEFR

A Wright peak flow meter was used to measure PEFR following the method described by Miller *et al.* (2020). Briefly, the mouth of the flow meter was disinfected with 70% alcohol before every use by the subject In accordance with the American Thoracic Society (2021) and GOLD (2023b) instructions, the subjects were made to stand right, allowed to take inhale maximal air, with seal lips tightly around the mouthpiece and then maximally exhale the air quickly and forcefully after which the PEFR readings was taken directly using the meter scale. The apparatus was reset by switching the pointer to zero and was thereafter maneuvered to repeat the process several times. The PEFR experiment was conducted in replicates per subject, and mean values were recorded in liters per minute (L/min).

Measurement of Height

Measurement of height adopted the WHO (2023c) anthropometric standards with the following guidelines: (1) heels together against the wall; (2) head in Frankfort plane, and (3) deep inhalation during measurement. The height of participants was measured using a stadiometer fixed to the nearest 0.1 cm. Height measurement was recorded in meters.

Measurement of Weight

The weight of the subjects was measured in kg with a Calibrated Digital Scale (Precision ±0.1 kg) with participants wearing light clothes but no shoes. Measurement protocols followed the American Heart Association (Jensen *et al*., 2021) protocols, which stipulated the following guidelines: (1) centered standing on the measuring scale, (2) arms placed at sides; and (3) recording after scale stabilization.

Calculation of BMI

Body Mass Index was computed by adopting the standard formula:

$$\text{BMI} = \frac{Weight\ (kg)}{Height\ (\mathrm{m}^2)}$$

Statistical Analysis

Data are presented as mean ± SD of triplicate measurements. Analyses were performed using SPSS (Version 28; IBM Corp., 2023). BMI results obtained were interpreted using WHO (2023d) classifications: underweight: <18.5; normal: 18.5-24.9; overweight: 25-29.9, and obese: ≥30. Descriptive statistics (frequencies, percentages) summarized demographic data. Independent t-tests compared PEFR, height, weight, and BMI between smokers and non-smokers, with $p<0.05$ considered statistically significant (Lakens, 2022).

RESULTS

Categorization of Participants' Smoking History (Demographics of Participants)

In response to whether the participants smoke or not, it was observed that 54.7% of the participants are involved in smoking, while 45.3% do not smoke (Table 1a). Information on the year that participants started smoking, it was revealed that 45.73%, a greater part of the participants started smoking between 2013-2017, while the least percentage of the participants (4.3) was observed between 1998-2002 (Table 1b). For smoking intensity and age range of when participants started smoking, it was observed that 61.4% of the subjects started smoking between 17-22 years, while the least percentage of 5.7% started smoking between 10-16 years (Table 1c). It was observed that 40% of the smokers take 4-6 sticks of cigarettes per day, while the least percentage of 4.3 take 7-9 sticks of cigarettes per day (Table 1d). Percentage of subjects who have had a previous history of respiratory disease is zero (Table 1e). It was seen that 41.4% of the subjects smoke in the morning, afternoon, and evening, being the highest, while the least percentage of 1.4% of the subjects smoke only in the afternoon (Table 1f). There was no subject who showed any respiratory disease in the last week of carrying out the study (Table 1g).

Table 1a: Response as to whether the participant smokes

GROUP	YES		NO	
	Freq.	Perc. (%)	Freq.	Perc. (%)
Control Group	00	00	58	45.3
Smokers	70	54.7	00	00
TOTAL	70	54.7	58	45.3

X^2 = 128.000, df = 1, P = 0.000

Table 1b: The year participants started smoking

GROUP	1998-2002		2003-2007		2008-2012		2013-2017	
	Freq.	Perc. (%)	Freq.	Perc. (%)	Freq.	Perc. (%)	Freq.	Perc. (%)
Smokers	3	4.3	11	15.7	24	34.3	32	45.7

Table 1c: Smoking intensity by age range with details on the age at which subjects started smoking cigarettes

GROUP	10-16 YEARS		17-22 YEARS		23-28 YEARS	
	Freq.	Perc. (%)	Freq.	Perc. (%)	Freq.	Perc. (%)
Smokers	23	32.9	43	61.4	4	5.7

Table 1d: Number of sticks of cigarettes smoked per day

GROUP	1-3/DAY		4-6/DAY		7-9/DAY		10-ABOVE/DAY	
	Freq	Perc (%)	Freq	Perc (%)	Freq	Perc (%)	Freq	Perc (%)
Smokers	9	12.9	28	40.0	3	4.3	30	42.9

Table 1e: Percentage of subjects who have suffered from respiratory disease in the past

GROUP	YES Freq.	Perc. (%)	NO Freq.	Perc. (%)
Smokers	00	00.0	70	100

Table 1f: Time of the day that the subjects mostly smoke cigarette

GROUP	MORNING		AFTERNOON		NIGHT		MORNING & NIGHT		MORNING, AFTERNOON & NIGHT	
	Freq	Perc (%)	Freq.	Perc. (%)	Freq.	Perc. (%)	Freq.	Perc. (%)	Freq.	Perc. (%)
Smokers	2	2.9	1	1.4	10	14.3	28	40,0	29	41.4

Table 1g: Information on subjects who had any respiratory disease in the last week of carrying out the research study

GROUP	YES Freq	Perc. (%)	NO Freq.	Perc. (%)
Non-Smokers	00	00.0	58	45.3
Smokers	00	00.0	70	54.7
TOTAL	00	00.0	128	100

BMI Correlation between Smokers and Non-Smokers

The values obtained for BMI, which are derived from the body weight and height for smokers, are not significantly *(p>0.05)* different from their respective control (non-smoker) values (Table 2).

PEFR of Smokers and Non-Smokers among Selected Students in ABU, Zaria

The experimental group of smokers shows a significantly (*p<0.05*) decreased PEFR with an average value of 306.40±7.48 when compared with the non-smokers, which has a value of 368.10±5.51 (Figure 1). The values obtained for PEFR1 (300.14±8.63), PEFR2 (297.86±7.91), and PEFR3 (320.14±8.26) for smokers are substantially *(p<0.05)* lower when compared with their respective control (non-smokers) values. The overall results obtained and their corresponding statistical relationships are presented in Table 3.

Table 2: BMI comparison between smokers and non-smokers from independent students' *t*-test

GROUP	BMI (kg/m^2)
Non-Smokers (Control)	21.66±0.38
Smokers	22.59±0.35

p> 0.05= indicates no significant difference when compared with the control group. BMI = Body mass index

Table 3: Smokers PEFR1, PEFR2, PEFR3 and average PEFR values from independent student's *t* test

GROUP	PEFR1 (Lit/Min)	PEFR2 (Lit/Min)	PEFR3 (Lit/Min)	Average PEFR (Lit/Min)
Control (Non-Smokers	367.86±5.08	369.48±6.50	366.90±5.79	368.10±5.51
Smokers	300.14±8.63	297.86±7.9	320.14±8.26	306.40±7.48
P value	0.003	0.01	0.032	

p<0.05= * indicates significant difference as compared to the control group. PEFR = Peak expiratory flow rate

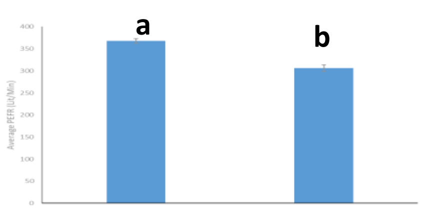

Figure 1: Comparison of mean PEFR between control (non-smokers) and smokers

Different superscript a,b indicates a significant *(p<0.05)* difference between the groups.

DISCUSSION

The assessment of PERF and smoking intensity, especially among young people provides useful information about the respiratory health status of this vulnerable population, and this is of public and environmental health importance as it helps in driving a few Sustainable Development Goals in terms of Good Health and Well-Being (SDG 3) as well as Sustainable Cities and Communities (SDG 11)

Smoking intensity is regarded as how much a person smokes cigarette, and this intensity can be measured by a plethora of methods including the number of cigarettes smoked per day (CPD), pack-years (usually for or long-term smoking intensity), nicotine dependent approach (indirect determination of smoking intensity) as well as the use of clinical biomarkers like cotinine in urine/blood/saliva (Ukoli and Ogunniyi, 2021). The high smoking intensity of 61.4% observed among subjects between the age range of 17-22 may result in immediate (short-term) respiratory health effects that could predispose to respiratory disorders, open oral health, and reduced immune response (WHO, 2023a). Since the brain is still developing till age 25, nicotine inhalation/exposure through cigarette smoking could lead to poor brain development by affecting and altering its normal structure and function, as well as its normal coordination. Apart from the increased risk of long-term addiction and effect on academic performance of the subjects, it could lead to long-term respiratory health diseases, including lung cancer, stroke, heart failure, chronic obstructive pulmonary disease (COPD), decreased life expectancy, as well as reproductive and infertility problems. The age range involved (17-22) could also be of public health concern as it may predispose to future respiratory disease burden and a high-risk population waiting to be endangered (Salvi *et al*., 2020; Smith and Lee, 2023).

Body Mass Index (BMI) is an assessment method that uses height and weight to determine the body fat percentage and can help estimate health risks, including lung disease, diabetes, heart disease, certain cancers, and high blood pressure (Jones *et al*., 2023; Upadhyay and Mistry, 2025). BMI is computed by dividing the weight in kilograms by the square of the height in meters. It is useful for assessing respiratory health risk, population health, as well as public health screening. The non-significant effect of BMI of the smokers when compared with that of the non-smokers may signify that cigarette smoking might not affect the body weight and height of the participants. The non-significant effect of BMI in smokers, observed in this study, may not predispose them to the development of obesity and accumulation of fat around the abdomen (Shaikh *et al*., 2021; Dey *et al*., 2025).

The peak expiratory flow rate (PEFR) is an easy and fast technique to measure how fast a person can forcefully exhale air from the lungs after taking a deep breath (Martinez *et al*., 2021). It is a protocol mostly employed in respiratory medicine to ascertain the degree of airway obstruction, particularly in conditions like mild-to-severe respiratory disorder and asthma (Hogg *et al*., 2021). PEFR gives an insight into how narrowed or obstructed the airways are for the passage of oxygen to the respiratory chambers (Igbokwe *et al*., 2018; Zhou and Li, 2022). The significantly low PEFR values among smokers, observed in this study, may suggest declined lung function, narrowed airways, reduced speed of exhalation, poor lung elasticity, as well as an early sign of developing chronic lung disease (Singh *et al*., 2022). The low PEFR values may result in chronic inflammation, loss of elastic recoil, destruction of the alveolar walls, airway obstruction causing cause chronic bronchitis and COPD (GOLD, 2023a) as well as cilia damage since smoking impairs the small hair-like structures (cilia) that help clear mucus and debris leading to airway blockage and further airflow limitation (Suleiman *et al*., 2018; Global Initiative for Asthma, 2023).

CONCLUSION

The high smoking intensity (17-30 years), non-significant BMI value, and significantly low PEFR among smoking university students, observed in this study, underscore the need for targeted interventions to preserve the respiratory health in this population. These findings will inform targeted anti-smoking interventions in Nigerian Universities and contribute to global data on early smoking-related pulmonary decline.

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