ORIGINAL ARTICLE

SELF-REPORTED EXPOSURE TO SECOND-HAND TOBACCO SMOKE AND LUNG FUNCTION IN UNDERGRADUATE MALE MEDICAL STUDENTS IN PAKISTAN

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Background: Passive smoking, where an individual inhales tobacco smoke, has been associated with many health issues from asthma to cancer and is attributed to affecting pulmonary function tests like the peak expiratory flow rate of individuals. Keeping this in mind, the study was conducted to compare the peak expiratory flow rate of passive smokers with that of non-smokers. **Methods:** A cross-sectional comparative study was conducted from 2017 to 2019 in which 184 male undergraduate medical students enrolled in the study at the time of admission for each successive year after informed consent. Participants were recruited by non probability consecutive sampling technique and divided into two groups based on status of passive smoking, passive smokers (n=97) and non-smokers (n=87). Their height, weight, waist to hip ratio, and peak expiratory flow rate were recorded. The recorded data was analysed on SPSS-26. **Results:** The current study showed that 52.7% of the study participants were passive smokers and 47.3% were non-smokers. A significant difference (p<0.01) of peak expiratory flow rate was seen between non-smokers and passive smokers on the Mann-Whitney U Test. As observed by mean ranks, nonsmokers had a higher peak expiratory flow rate (109.86 L/min) than passive smokers (76.93 L/min) (p=0.01). Spearman's Rank Correlation Coefficient revealed a positive significant relationship between peak expiratory flow rate and height in passive smokers (rho=0.21, p=0.04). **Conclusion:** The peak expiratory flow rate of passive smokers is less than that of non-smokers and there is a positive significant relationship between height and peak expiratory flow rate.

Keywords: environmental tobacco smoke, passive smoking, peak expiratory flow rate, lung function test, second-hand smoke

Pak J Physiol 2021;17(3):32–5

INTRODUCTION

Passive smoking has been attributed to 1% mortality occurring worldwide.[1] It is a modifiable risk factor that is associated with a wide variety of preventable diseases.[2] Passive smoking, i.e., environmental tobacco smoke (ETS) or second-hand smoke (SHS), occurs involuntarily where an individual inhales the mainstream smoke that is expired by the smoker or the sidestream smoke that is diluted in the ambient air, released from burning tobacco.[3] In 2015, 4% of deaths resulting from chronic obstructive pulmonary disease (COPD) were attributed to SHS while 3% of deaths due to stroke were linked to SHS.[4]

Passive smoking not only causes adverse effects to an individual's health but also negatively impacts the economy in terms of production losses due to unavailable workforce and healthcare expenditures, these amounted to US$ 1436 billion in 2012.[5] In 2018, the economic burden of smoking related illnesses has been attributed to 192 billion rupees (equal to 1.3 billion dollars) in Pakistan.[6]

Second-hand smoke contains around 4,000–4,700 chemicals comprising of hazardous amines, nicotine, hydrocarbons, noxious particles, and metals among others[7], many of which are reported to be carcinogenic. These chemicals are irritants that cause stimulation of submucosal irritant receptors which consequently lead to an increment in airway resistance through vagally mediated smooth muscle constriction, impair ciliary movement, thereby decreasing mucociliary clearance, inhibit the function of alveolar macrophages[8], and cause mucus-secreting glands to undergo hyperplasia and hypertrophy.[9] They cause proteolytic enzymes to be released from polymorphonuclear leucocytes due to antiprotease inhibition thereby playing a significant role in lung parenchymal destruction and COPD pathogenesis.[10]

Passive smoking has even been suggested by a few studies to increase the risk of non-smokers developing heart disease by 25–30%.[11] Sudden infant death syndrome in children and infants, certain cancers, respiratory illnesses such as COPD, and cardiovascular diseases such as coronary artery diseases in adults are linked to passive smoking.[12]

Passive smoking induces pulmonary damage slowly, but unfortunately it may not show symptoms until pulmonary functions are compromised. In Pakistan, the prevelance of passive smokers has been estimated to be 69.1% as compared to 63% in Bangladesh.[13]

Peak Expiratory Flow Rate (PEFR) is defined as the maximum flow rate in forced expiration beginning from full inspiration, measured in liters per minute, taking place within the initial 200 ms of expiration.[14] PEFR varies with sex, age, and anthropometric indices such as height, weight, waist and hip circumference, waist/hip ratio, and body mass index (BMI). Race, ethnicity, and the individual's lifestyle such as smoking also influence PEFR.[15]

PEFR is useful to assess and monitor respiratory conditions such as restrictive and obstructive lung diseases.[16] It is an easy and non-invasive test that gives a rough estimate of the degree of disease extent. PEFR can be used to monitor lung capacity in the early stages of smoke exposure and hence can be used as a reliable tool to prevent lung damage in smokers.[17]

This study was designed with an objective to compare the PEFR in healthy male individuals who were exposed to passive smoke with that of non-smokers.

SUBJECTS AND METHODS

This cross-sectional comparative study was conducted at CMH Lahore Medical College and Institute of Dentistry from 2017 to 2019 to evaluate and compare the PEFR of passive smokers with nonsmokers. The Ethical Review Board's approval was obtained (case# 433/ERC/CMHLMC).

All male students inducted into 1st Year MBBS for three consecutive years (2017, 2018, and 2019) were requested to participate in the study voluntarily at the time of admission in MBBS. A non-probability consecutive sampling technique was used. Sample size of 184 was calculated using the Raosoft sample size calculator, keeping 5% margin of error, 95% confidence interval and 350 as the estimated population size with 50% response distribution.

Participants were interviewed after their informed consent. Boys who had a history of respiratory illness or who had recently suffered a respiratory infection were excluded from the study. Smokers were also excluded from the study. The inducted boys were then divided into two groups: Passive smokers (n=97) and nonsmokers (n=87). Self-reported exposure to passive smoking was defined as being in the same room as a smoker for a minimum of one hour per day for 12 consecutive months or more.[18]

Height was recorded to the nearest centimeter (Cm) with the subject standing, and head in the Frankfurt imaginary plane. Weight was recorded in kilograms (Kg) in usual light clothing. Body mass index (BMI) was calculated using the formula weight in Kg/(height in meters)^2. Waist circumference and hip circumference were measured to the nearest centimeter and waist to hip ratio was calculated. Boys who were obese based upon BMI were excluded from the study.

PEFR was measured using the Wright's peak flow meter by adhering to standard guidelines.[19] Each subject was first explained the technique of performing the lung function test and then was demonstrated as how to perform PEFR before the actual measurement was recorded. Each subject was asked to perform the test thrice in the standing position and the highest value was taken as final.

Data was recorded on a predesigned proforma, and analysed using SPSS-20. Data was explored for normality by using the Shapiro Wilk Test, and accordingly non parametric tests were chosen for inferential statistics. Mann-Whitney U Test and Spearman's Rank Correlation Coefficient were applied to the quantitative parameters of the data, and $p<0.05$ was considered to be statistically significant.

RESULTS

A total of 184 male students participated in the study. The mean age of the study participants was 18.65±0.88 years. Among the study participants, 52.7% were passive smokers and 47.3% were non-smokers. The median peak expiratory flow rate was 450 (IQR 370–550) L/min. The median height of the participants was 173 (IQR 169–177) Cm and weight was 71 (IQR 62–81) Kg. Median BMI was 23.99 (IQR 20.79–36.83). Participants had a median waist and hip circumference of 86 (IQR 81–91) Cm and 96 (IQR 92–104) Cm respectively, and the median waist to hip ratio of the sample was found to be 0.89 (IQR 0.85–0.91). The results of the anthropometric values and PEFR of all study participants are summarized in Table-1.

When compared by the Mann-Whitney U Test, it was noted that the difference in PEFR between non-smokers and passive smokers is significant ($p<0.01$). Participants who were nonsmokers had a higher peak expiratory flow rate than passive smokers as suggested by their mean ranks. Non-significant differences were observed on other anthropometric parameters between the two groups (Table-2).

Spearman's Rank Correlation Coefficient was applied to the quantitative parameters of the data. Table-3 shows the result of Spearman's Rank Correlation Coefficient where a positive significant relationship was observed between peak expiratory flow rate and height of the subjects.

Table-1: Anthropometric variables and peak expiratory flow rate (PEFR) reported with their median value, lower quartile (LQ), and upper quartile (UQ) for all study participants (n=184)

Variables	Median	LQ	UQ
PEFR (L/min)	450	370	550
Age (Years)	19	18	19
Height (Cm)	173	169	177
Weight (Kg)	71	62	81
BMI (Kg/Cm^2)	23.99	20.79	36.83
Waist Circumference (Cm)	86	81	91
Hip Circumference (Cm)	96	92	104
Waist to Hip Ratio	0.89	0.85	0.91

Table-2: Mann-Whitney U Test for PEFR with anthropometric parameters between non-smokers and passive smokers (n=184) (Mean Ranks)

Variables	Non Smokers (n=87)	Passive Smokers (n=97)	*p*
PEFR (L/min)	109.86	76.93	0.01*
Age (Years)	95.65	89.68	0.42
Height (Cm)	84.18	99.96	0.05
Weight (Kg)	88.46	96.12	0.33
BMI (Kg/Cm^2)	90.37	94.41	0.61
Waist Circumference (Cm)	89.16	95.49	0.42
Hip Circumference (Cm)	88.45	96.13	0.33
Waist to Hip Ratio	96.00	89.36	0.40

*Significant

Table-3: Spearman's rank correlation coefficient between PEFR with anthropometric parameters for non smokers and passive smokers

Variables	Age		Height		Weight		WC		HC		WHR		BMI	
	rho	*p*	rho	*p*	rho	*p*	rho	*p*	rho	*p*	rho	*p*	rho	*p*
Non Smokers	0.09	0.42	0.20	0.06	0.12	0.27	0.00	0.99	0.04	0.72	-0.12	0.27	0.03	0.81
Passive Smokers	0.17	0.10	0.21	0.04*	0.10	0.35	0.19	0.06	0.10	0.31	0.19	0.06	0.05	0.65

*Significant

DISCUSSION

Passive smoking is attributed to cause a decrease in pulmonary functions, as shown by previous researches. In our study, there was a significant difference between the PEFR of passive smokers and non-smokers inducted in the first-year MBBS. The results of our study are in line with the findings reported by an Iraqi researcher whose study demonstrated a statistically significant difference in PEFR between young adult passive smokers and nonsmokers.[20] Similar findings have been reported from a study previously done in Lahore which evaluated differences in PEFR between adult passive smokers and nonsmokers to be statistically significant, with nonsmokers having a lower PEFR than their passive smoking counterparts.[21]

The key variables that affect PEFR are the strength of respiratory muscles producing a contraction that results in expiration, lung compliance, airway competency, and resistance offered to airflow.[22] Gender, age, height, weight, and body surface area have shown a significant correlation for PEFR in previous studies.[23] The results of our study are also in line with the findings reported by Indonesian researchers, however, their study population comprised of a younger age group between the ages of 10–13 years.[22] This shows that the effect of passive smoking is the same on lung function regardless of the age group affected.

Considering gender has been reported to affect PEFR, we conducted the study in only males to rule out gender differences and evaluate the correlates within the same gender for various variables. Our study highlighted a significant positive correlation between height and PEFR, where taller male subjects had a higher PEFR value, a finding which is supported by previously conducted studies.[24] With a height increment, there is an increment in the chest girth, and the thoracic area hence total surface area of the lungs increases. Because taller people have a larger surface area for air exchange than shorter people, a greater amount of air can circulate in and out, resulting in an increase in vital capacity and consequently PEFR in taller people. This is probably because taller subjects have a greater chest volume and with an increment in height the effort by the expiratory muscles and the growth of the airway passages also increases thus increasing PEFR with height as evidenced in previous literature.[25] Previous studies have reported that in males, not only does an increase in height causes an increase in PEFR but a weight increment also causes PEFR to increase, this however, does not support our research findings.[26] A study done in Nigeria reported a significant correlation between height and PEFR of men subjected to passive smoking, this finding resonates with the findings of our study which showed similar correlation between the two indices, however the study also showed a correlation between PEFR and other anthroprometric indices such as weight, which does not support our study findings of nonsignificance between weight and PEFR.[27]

The current study has a few limitations. The role of other attributes like socioeconomic status, malnutrition, years of exposure to second-hand smoke, and childhood smoke exposure history in non-smokers was not explored. A larger sample size taken at random and evaluating other lung function tests such as FVC and FEV_1 could help improve future researches. The active metabolite of nicotine, cotinine may be measured in passive smokers. Furthermore, evaluating PEFR corrected for forced expiratory pressure could shed more light on the disparities in PEFR results between the two groups.

CONCLUSIONS

First-year MBBS male students who are exposed to passive smoking have lesser PEFR values as compared to their non-smoking non-exposed class fellows. This study highlights the need to create awareness about the detrimental effects of passive smoking on an individual's health and the need for regulation of its control to curb the passive smoking issue.

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Received: 5 Jan 2021 **Reviewed: 17 Sep 2021** **Accepted: 18 Sep 2021**

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NSS: Data curation, methodology design, original draft writing, reviewing and editing draft, reference cross-checking
MMA: Methodology design, formal statistical analysis of data on SPSS, result write-up for manuscrip
MT: Data curation, methodology design, reference cross-checking
SZ: Data curation, methodology design, reference cross-checking
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Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the IRB