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Comparative Evaluation of Pulmonary Function in Male Street Vendors *Versus* Smokers: Insights into Occupational and Lifestyle Impact

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ABSTRACT

Background: *Occupational and lifestyle factors, such as smoking and street vending, may pose risks to pulmonary health. Previous studies explored the effect of both smoking and exposure to street pollutants on health. However, a study comparing the pulmonary functions of street vendors (who do not smoke) and smokers has not been conducted before.*

Objective: *The objective of this study was to compare the pulmonary function parameters among three groups consisting of smokers, street vendors and controls in order to discern potential differences in respiratory health between the three groups.*

Methods: *This cross-sectional study was conducted in the Deoghar district of the Jharkhand state, in India, over a period of five months (between January 2023 and May 2023). A total of 90 male participants, including 30 smokers, 30 street vendors and 30 age-matched control research participants, underwent pulmonary function testing (forced spirometry) using standardized methods. The comparison among the three groups was conducted by one-way analysis of variance with the post-hoc test.*

Results: *A total of 30 controls with a mean age of 33.77±6.01 years, street vendors with a mean age of 32.93±6.29 years and smokers with a mean age of 32.27±7.86 years participated in the present study. There was an average exposure to road pollutants for 13.47±9.48 years and smoking for 13.23±8.29 years (P=0.92). Lung function parameters, except for the forced expiratory volume in one second divided by the forced vital capacity (FEV_1/FVC), were lower in street vendors and smokers than controls.*

Conclusion: *Street vendors in Deoghar, Jharkhand, have lung function parameters comparable to smokers. Hence, although they are not smoking tobacco, their lung health is at risk. Hence, early interventions are required to protect them from pollutants.*

Keywords: smoking, forced expiratory volume, lung, life style, environmental pollutants, India.

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INTRODUCTION

Smoking is a well-established risk factor for respiratory diseases, which is profoundly affecting the pulmonary function (1, 2). Inhaling tobacco smoke exposes the respiratory system to a complex cocktail of substances, including carcinogens, irritants and poisons (3). Chronic exposure to these substances can lead to inflammation, airway remodeling and reduced lung function (4). Specifically, smoking is associated with a decline in lung function parameters such as forced expiratory volume in the first second (FEV_1) and forced vital capacity (FVC) (5). These changes are indicative of airflow limitation and are characteristic of chronic obstructive pulmonary disease (COPD) and other smoking-related respiratory conditions (6).

In urban environments, street vendors represent a unique occupational group exposed to various environmental pollutants, including dust, exhaust fumes and particulate matter. These pollutants, often generated by vehicle traffic and industrial activities, can have detrimental effects on the respiratory health (7). Chronic exposure to airborne particulates can lead to airway inflammation, oxidative stress and respiratory symptoms such as coughing, wheezing and breathlessness (8). Hence, street vendors, who spend prolonged periods of time outdoors in urban areas, are particularly susceptible to the adverse effects of air pollution.

Comparing the pulmonary function of smokers and street vendors offers valuable insights into the distinct mechanisms through which occupational and lifestyle factors impact the respiratory health. While smoking primarily affects the lung function through direct exposure to tobacco smoke constituents, street vendors face a different set of challenges related to environmental pollution and occupational hazards. By examining the lung function of these two groups, the current study aims to compare the impact of smoking *versus* air pollution on the respiratory dysfunction.

METHODS

Type and setting of study

This was a cross-sectional study conducted in an urban setting in the district of Deoghar, Jharkhand, India. The air quality index (AQI) in the area remains at an annual average value of 82, with particulate matter (PM) having <2.5 microns in diameter ($PM_{2.5}$) = 104 and PM <10 microns in diameter (PM_{10}) = 77, nitrogen dioxide (NO_2) = 28 and ground-level ozone (O_3) = 24. The present study was conducted from January 2023 to May 2023.

Sample recruitment methods

Participants were recruited from nearby urban areas, through convenience sampling methods, using defined inclusion and exclusion criteria. Male street vendors were approached at their respective vending sites within the designated urban area. Only non-smoker street vendors were included. Participants in the group of smokers were recruited from people living in the same locality who used to smoke at least five cigarettes per day for the last five years. Unlike street vendors, smokers were not exposed to air pollution. Control subjects were age-matched individuals selected from the non-smoker general population residing in the vicinity. This study was conducted in an area where women commonly do not take part in street vending and do not smoke. Hence, female subjects were not aimed to be included. Any adult (age >18 years) street vendor, smoker or control was recruited based on preliminary clinical history. All individuals with diagnosed asthma, chronic obstructive or restrictive pulmonary diseases and tuberculosis were excluded from our research. This study obtained the approval of the institutional ethics committee (2022-42-IND-02, dated 30-01-2022) and was conducted with strict adherence to the WMA Declaration of Helsinki updated in 2013.

Smokers were defined as smoking tobacco (≥ five cigarettes or bidis *per* day) for more than five years. Similarly, non-smoker street vendors were defined as any vendors sitting or standing in his stall facing the street within five meters of the road side and opening shops at least five days a week for ≥ five years.

Data collection method

Patients' age and exposure to either smoking or street pollutants were measured in years. The height was measured by a portable stadiometer to the nearest 1 mm and weight was measured by a digital weighing scale with 100 gm sensitivity. The body mass index (BMI) was calculated. A physiologist with expertise in anthropometry and pulmonary function testing collected data from all participants. Spirometry was performed accor-

ding to established guidelines using a Medicaid SpiroExcel device with bi-directional digital turbine (14 L/s or more with 3% accuracy) and American Thoracic Society (ATS) criteria of prediction, providing provisional diagnosis of airway disease with the report. Participants were instructed to perform forced expiratory maneuvers into a spirometer, which measured parameters such as FVC, FEV_1, FEV_1/FVC ratio, forced expiratory flow at 25–75% of forced vital capacity (FEF25–75) and peak expiratory flow rate (PEFR). All parameters were taken as percentage of predicted values for the particular age, sex, height, and weight of the subject for a better comparison between the groups. The automated report from the spirometer shows the categories of pulmonary impairment – degrees of restrictive lung disease (mild, moderate, severe) and obstructive lung disease (small airway obstruction, mild, moderate, severe obstruction). Additionally, it reports mixed patterns such as combinations of restriction and obstruction. Restrictive diseases are identified by reduced total lung capacity (TLC) with proportionally reduced FEV_1 and FVC, while obstructive diseases are marked by a reduced FEV_1/FVC ratio. Small airway obstruction is detected through FEF25–75% and can be an early indicator of obstructive lung disease, even if the FEV_1/FVC ratio is normal.

Statistical analysis

The mean and standard deviation (SD) of data were used to express the central tendency. The parameters were compared using a one-way analysis of variance (ANOVA) and Tukey's post-hoc test among the three groups. The mean difference and 95% confidence interval (CI) of the mean difference are used to express the difference between pairs (e.g., smoker *versus* control). The statistical tests were performed using GraphPad Prism 9.5.0 (GraphPad Software Inc., USA) and the significance level was set at $p < 0.05$. ❑

RESULTS

A total of 30 controls with a mean age of 33.8±6 years, street vendors with a mean age of 32.9±6.3 years, and smokers with a mean age of 32.3±7.9 years participated in the study. There was an average exposure to road pollutants for 13.5±9.5 years and smoking for 13.2±8.3 years

TABLE 1. Age, anthropometric data, and exposure to pollutants of smoking in control, street vendors and smokers

Parameter	Controls (n = 30)	Street vendors (n = 30)	Smokers (n = 30)	p
Age (years)	33.8±6	32.9±6.3	32.3±7.9	0.7
Height (cm)	167±5.2	164.9±7.2	161.5±8.1	0.01 (C-Sm)
Weight (kg)	62.5±10.1	57.4±13.3	57±10.4	0.1
BMI (kg/m^2)	22.4±3.5	20.8±3.6	21.5±2.3	0.1
Exposure (years)	-	13.5±9.5	13.2±8.3	0.9*
C-Sm: statistically significant difference in control and smoker groups *p value of unpaired t test between street vendors and smokers Te remaining p values are of one-way ANOVA.				

TABLE 2. Dynamic pulmonary function test parameters in control, street vendors and smokers

Parameter	Controls (n = 30)	Street vendors (n = 30)	Smokers (n = 30)	p (post-hoc)
FVC	95.6±7	68.7±11.3	73.2±11.4	<0.0001 (C-St, C-Sm)
FEV_1	99±8.5	68±10.4	70.3±7.4	<0.0001 (C-St, C-Sm
FEV_1/FVC	102.7±3.8	100.9±11.9	97.1±9.3	0.05 (C-Sm)
FEF 25-75	92.5±10.2	69.5±26.9	63±20.1	<0.0001 (C-St, C-Sm)
PEFR	84.6±7.6	62.6±22.3	65.5±14.3	<0.0001 (C-St, C-Sm)
p value is of one-way analysis of variance. C-St: control *versus* street vendors, C-Sm: control *versus* smoker All parameters were taken as percentage of predicted values				

TABLE 3. Post-hoc analysis details about mean difference and its confidence interval

Test parameter	Pair	Mean difference	95% CI of mean difference	Adjusted p
FVC	C-St	26.9	20.7 to 33.2	<0.0001
	C-Sm	22.5	16.2 to 28.7	<0.0001
	St-Sm	-4.5	-10.7 to 1.8	0.2
FEV_1	C-St	31	25.5 to 36.4	<0.0001
	C-Sm	28.7	23.3 to 34.1	<0.0001
	St-Sm	-2.3	-7.7 to 3.2	0.6
FEV_1/FVC	C-St	1.9	-3.7 to 7.4	0.7
	C-Sm	5.6	0.1 to 11.1	0.047
	St-Sm	3.7	-1.8 to 9.3	0.3
FEF25-75	C-St	23	10.6 to 35.5	<0.0001
	C-Sm	29.5	17 to 42	<0.0001
	St-Sm	6.5	-6 to 18.9	0.4
PEFR	C-St	21.9	12.1 to 31.7	<0.0001
	C-Sm	19.1	9.3 to 29	<0.0001
	St-Sm	-2.8	-12.6 to 7	0.8
C-St: controls *versus* street vendors; C-Sm: controls *versus* smokers; St-Sm: street vendors *versus* smokers; CI: confidence interval				

(p = 0.9, unpaired t-test). The age, height, weight, BMI and exposure details are shown in Table 1.

The pulmonary function parameters are shown in Table 2. All parameters showed significant differences in analysis of variance (ANOVA). However, when we tested pair-wise data, we found that, except for FEV_1/FVC, all remaining parameters were lower among street vendors and smokers in comparison to controls, and there was a similar level of lung function among the groups of street vendors and smokers. Regarding FEV_1/FVC,

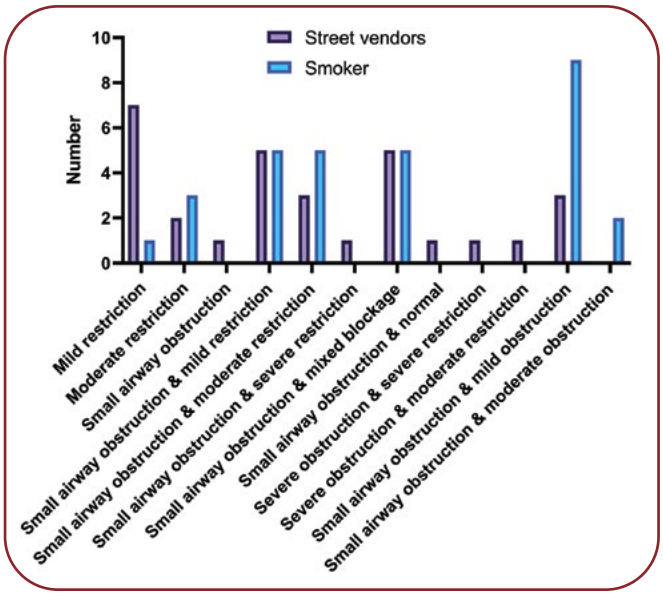

FIGURE 1. Distribution of street vendors and smokers according to ventilatory dysfunction

although there was no significant variance among the three groups, there was a statistically significant difference in FEV_1/FVC ratio values between controls and smokers. For a better understanding of the post-hoc test result, the mean difference and 95% CI of mean difference are shown in Table 3.

All participants in the control group had their lung function test parameters within normal limit. The number of participants in the groups of street vendors and smokers are shown in Figure 1. There was a similar distribution in the two groups (Chi-square (11) = 15.2, p = 0.2). ❑

DISCUSSION

The major finding of the present study is that both street vendors and smokers exhibit significantly impaired pulmonary function compared to control individuals. The possible reason for these findings lies in the chronic exposure of street vendors to air pollutants in their work environment and smokers to the harmful chemicals present in cigarette smoke (10-12). These exposures can lead to airway inflammation, bronchoconstriction and impaired lung function over time, ultimately resulting in decreased lung volumes, airflow limitation and compromised respiratory health (13, 14). The current study highlights the importance of addressing not only smoking cessation but to limit exposure to pollutants in people who are exposed to those pollutants due to their occupations.

Air pollutants and cigarette has been correlated with different attributes (15). Increased levels of ozone, PM and ambient tobacco smoke have been linked to impaired lung function (13). Hence, air pollution has also been referred to have as ill effect as smoking tobacco (16, 17). However, the study of disease burdens disapproved this and suggested that ambient air pollution should not be considered equal to smoking tobacco as the disease burden had a lower impact than smoking (18). In a previous study, Jones *et al* found that when the vendors worked in closed shop on the road sides, their pulmonary functions also deteriorated similarly to that of roadside vendors (19). Soeroso *et al* compared lung functions between grill and non-grill street vendors and found that vendors who worked in grills-fast food outlet had higher exhaled carbon monoxide level when compared with non-grill street vendors (20). A study from India reported that there was a decrease in lung functions among street vendors; however, the difference was not statistically significant (21). From the perspective of lung functions, in our study we found that street vendors and smokers had similar lung function, which was lower than that of non-street vendors and non-smokers. Hence, our study indicates that prolonged exposure to pollutant may be considered to affect the lung functions as smoking tobacco does.

The implications of this study are significant for public health policy and clinical practice. Its findings highlight that street vendors are exposed to pollutants that are as harmful as smoking. Implementing environmental regulations to reduce air pollution in urban areas could help mitigate the adverse effects on pulmonary function and improve respiratory health outcomes (22, 23). Additionally, healthcare providers should be vigilant in screening individuals with occupational exposures or smoking habits for early signs of respiratory impairment and provide appropriate education and resources for prevention and management.

While the study participants have similar age, height and weight, additional unknown confounding factors may exist. Furthermore, the study's cross-sectional design restricts its capacity to determine causation between exposure to air pollutants or cigarette smoking and observed changes in pulmonary function. We studied a small sample size, which may not be represen-

tative of the overall population because it was drawn from specific places or towns with distinct air quality. Future research should strive to overcome these limitations by using more rigorous study designs, controlling for additional confounding variables and recruiting larger, more varied and representative study groups. In addition, there is a need for a study with participants having combined exposure (street vending and smoking) as a separate group for further insight. ❑

CONCLUSIONS

This study highlights significant differences in pulmonary function between control subjects, street vendors and smokers. Street vendors and smokers show impaired lung function compared to controls, indicating the detrimental effects of chronic exposure to air pollutants and cigarette smoke on respiratory health. Street pollutants may be as harmful as smoking. Future research should focus on longitudinal studies to better understand these relationships and develop comprehensive strategies to mitigate the burden of respiratory diseases in affected communities. ❑

Conflicts of interest: none declared.

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