

Occupational exposure to air pollution and respiratory health among urban street vendors in South India

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Abstract

Background

Street vending is a non-formal, vital domestic workforce in most developing nations. The street vendors operate in an unregulated environment and are frequently exposed to hazardous environmental pollutants, which is linked to chronic respiratory health problems. However, there is underreporting of this public health problem in literature, creating a blind spot in global health.

Objective

To assess the association between air quality, occupational exposure characteristics, and pulmonary function among street vendors in an urban community.

Methods

A cross-sectional study was conducted among 298 street vendors in Chennai city, India. Pulmonary function was assessed using peak expiratory flow rate (PEFR) and breath-holding time (BHT). Respiratory symptoms were evaluated using the Modified Borg Dyspnea Scale. Air quality was measured using the Air Quality Index (AQI). Linear regression analysis identified independent predictors of PEFR.

Results

The mean age of participants was 38.5 ± 11.08 years, with 65.4% female. Mean PEFR was 376.1 ± 71.39 L/min, and BHT was 33.32 ± 9.07 seconds. High prevalence of respiratory symptoms was observed: coughing at work (58.7%) and morning phlegm (44%). Significant negative predictors of PEFR included years working as a vendor ($\beta = -3.34$, $p < 0.001$), daily outdoor exposure hours ($\beta = -6.48$, $p < 0.001$), annual AQI ($\beta = -1.80$, $p = 0.002$), weight ($\beta = -1.19$, $p < 0.001$), and dyspnea at rest. BHT showed a strong positive association with PEFR ($\beta = 3.03$, $p < 0.001$). Only 2.3% of vendors reported using masks during work.

Conclusion

Street vendors demonstrate measurable respiratory compromise associated with cumulative occupational exposure to air pollution. Long-term exposure metrics (annual AQI, years of work) were stronger predictors than short-term measures, emphasizing the chronic nature of occupational health risk. Findings underscore the need for targeted respiratory screening, awareness programs, and feasible protective interventions for this vulnerable informal workforce.

Background

Urban air pollution has emerged as a critical public health crisis in developing nations, causing 4.2 million premature deaths annually worldwide. [1] India ranks among the world's most polluted countries, with the Environmental Performance Index placing it 177th out of 180 nations in air quality parameters. [2] The Air Quality Index (AQI) categorizes air quality from 0–50 (good) to above 400 (severe/hazardous). [3] While developed countries maintain AQI values below 50, Indian metropolitan areas experience chronic pollution—Delhi averages AQI 220–250 with winter peaks exceeding 450, and Chennai records AQI 100–150, consistently in the moderate to poor range. [1, 3, 4] These cities exceed WHO-recommended PM_{2.5} levels ($5 \mu\text{g}/\text{m}^3$) by 8–24 fold, with Delhi at 110–120 $\mu\text{g}/\text{m}^3$ and Chennai at 40–50 $\mu\text{g}/\text{m}^3$ [5]. Among urban populations, street

vendors represent a uniquely vulnerable occupational group—10 million workers across India spend 8–12 hours daily at roadside locations with direct, unprotected exposure to vehicular emissions and particulate matter. [5, 6]

The adverse health consequences of occupational exposure to outdoor air pollution are well documented globally[1]. Studies from Nepal, Botswana, Malaysia, South Africa, Egypt, Thailand, and India have reported poor air quality in urban environments where occupational groups like traffic police, street cleaners, and street vendors workers are at high risk[7–12]. In most of these studies, the reported AQI frequently ranges between 120 and 250 levels, which is considered unhealthy for prolonged exposure [8, 9, 11, 13]. Particularly, the informal workforces, like street vendors, have reported a high prevalence of respiratory symptoms like shortness of breath, cough, throat irritations, and wheezing[14]. Previous studies have also used objective pulmonary function measures, particularly peak expiratory flow rate (PEFR), to identify respiratory impairment among occupational groups exposed to outdoor pollution, such as street vendors, traffic police, and street sweepers. Chronic exposure to traffic-related air pollutants and particulate matter has been associated not only with respiratory disorders but also with systemic conditions such as cardiovascular diseases and diabetes mellitus [4, 15]. In India, metropolitan cities including Delhi and Pune have reported particularly poor air quality, with AQI (Air Quality Index) levels reaching approximately 250 and 150, respectively, during peak pollution periods [16, 17]. Despite these observations, evidence examining the respiratory health of street vendors in South Indian urban settings remains scarce.

Globally, exposure to air pollution contributes to about 1.2 million premature deaths annually, and GBD studies indicate that about 460–540 million people live with chronic respiratory diseases, with a substantial contribution from outdoor air pollution[1, 4]. Asia has a large share of people affected by the air pollution-related respiratory diseases. Most of the South Asian and East Asian countries are identified as high-risk zones with high mortality due to chronic respiratory diseases[15]. In India, governmental data indicates on several instances the people experienced severe air pollution episodes and subsequent hospital visits for respiratory symptoms in major metropolitan cities between 2022 and 2025[4, 16]. Beyond respiratory effects, chronic exposure to outdoor air pollution increases risks of cardiovascular disease, diabetes mellitus, tuberculosis, and malignancies.

Several studies have reported the pulmonary health of occupational groups like police, street cleaners, and solid waste management workers who are exposed to outdoor air pollution in India. India's air pollution problem is getting worse. For example, 304 cities (88.4%) do not meet the National Ambient Air Quality Standards, and particulate matter levels in Chennai often exceed World Health Organization limits by 8–10 times [17, 18]. However, the pulmonary function of the informal occupational group, like street vendors in Tamil Nadu, has not been systematically evaluated using objective instruments, and the association of the air quality indices and measurable respiratory parameters in urban areas of South India has not been thoroughly investigated.

This study aimed to evaluate the respiratory function among street vendors using Peak Expiratory Flow Rate (PEFR) as recommended by the American Thoracic Society guidelines alongside Breath Holding Time (BHT) and the Modified Borg Dyspnea Scale and to examine the association of respiratory variables with the air quality indicators, socio-demographic factors, and occupation-related characteristics. The findings of this study will be relevant for informing strategies to protect similar informal work populations in urban environments across low- and middle-income countries experiencing comparable outdoor air pollution challenges.

Methods

Study Design

A community-based cross-sectional study was conducted among adult, street vendors located at Porur, Chennai City, Tamil Nadu, India, between June 2025 and August 2025. The study was reported in accordance with the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines[17].

Study Area

This study was conducted in Porur (13.0356° N, 80.1588° E), one of the major urban hubs in the metropolitan city of Chennai, India. The study area is about 6.7 meters above sea level and characterized by dense population and a daily commute of approximately 2.5 million individuals. The study area was stratified into four primary busy corridors (North, South, East, and West) radiating from the main Porur Junction (Arcot Road, Fig. 1). These corridors represent the busiest urban hubs in Chennai city and are characterized by commercial activity, infrastructural expansion, and heavy motor traffic congestion. Like other metropolitan cities in India, the study area has a high volume of diesel and petrol vehicles, including buses, trucks, three-wheelers, and motorcycles, which most often substantially contributes to ambient air pollution and suspension of street dust particles, resulting in continuous exposure to vehicular emissions, dust, and particulate matter among those working outdoors in these zones, like traffic police, sanitation workers, and solid and waste management employees, including the non-formal street hawkers or street vendors. Multiple bus stops with high commuter density contribute to frequent vehicle idling and traffic accumulation. The locality reflects a mix of residential, commercial, and informal economic activities, including roadside eateries and street vending clusters.

Sampling frame, sampling procedure, and sample size estimation

A preliminary field survey was conducted along the full length of the four primary corridors, and the sampling procedure was designed accordingly. The length of the primary vending corridors was measured and mapped, and when combined with selected link roads, the total defined coverage length was approximately 19 km (Fig. 2). The detailed road segments and their respective lengths included within the defined geographic boundary are presented in Table 1.

Table 1 Sampling frame of vendors			
Road corridors (Road Name)	Marked length	Targeted sample	Participants
North (Poonamalee road)	4 km	105	70
South (Guindy Road)	5 km	106	75
East (Arcot Road)	6 km	106	84
West (Kundrathur Road)	4 km	105	69

Table 1: Sampling frame of vendors

Given the informal nature of the study population (street vendors) and their dispersed spatial workplace, a systematic spatial sampling technique was used to recruit participants from each identified corridor’s main roads, which comprise the sampling frame. To allow a geographical sample representation and capture of diverse spatial exposure profiles of vendors for commuter density, motor vehicle idling, and ambient particulate matter, the total length of the identified vending road corridors (19 km) was mapped. Based on the allocated sample size for each corridor, a sampling interval (kth) was calculated by dividing the total corridor length by the required sample from each corridor. The data collectors approached the nearest street vendor and screened for eligibility, upon consent to participate, street vendors were recruited until the required sample size was reached or the marked corridor ended.

The power-calculated minimum sample for this study was estimated using the single population proportion formula[18], $N = (Z\alpha/2)^2 \times P(1 - P) / d^2$. In the absence of prior regional prevalence data and maximize the sample size, a conservative prevalence (P) was assumed to be 0.5 (50%) to ensure a larger sample and maximum variability. A z-value of 1.96 corresponding to a 95% confidence interval was used, and the margin of error (d) was set at 5% ($d^2 = 0.0025$), assuming an infinite population. The estimated sample size was $n = 384$, considering 10% for contingency, the final sample was inflated to $n = 422$.

Participants and eligibility criteria

The study included both male and female street vendors aged 18 years and above, able to speak the regional language (Tamil), and working as street vendors in the study area for a minimum of one year. Individuals with medically diagnosed respiratory disorders, current or past smoking habits, recent respiratory infections, neurological or painful musculoskeletal conditions that might influence respiratory outcomes, pregnant mothers, recent surgeries (3 months), oral procedures including tooth extraction, or communication impairments, and those who are unable to stand independently with or without mobility aids were excluded from the study.

Data collection tool and procedure

After screening for eligibility, eligible participants were enrolled in the study. A literature-informed structured questionnaire (Supplementary File 1) was developed and pilot tested among 18 street vendors outside the study area to ensure clarity, characteristic coverage, and feasibility. The questionnaire consists of socio-demographic details, including age, sex, height, weight, body mass index, educational attainment, living status, and monthly income. Work related characteristics, occupational exposure characteristics (years of vending, average daily hours spent outdoors, and mask use at work), respiratory symptoms in the past year (shortness of breath during work, cough, wheezing, morning phlegm, frequency of breathlessness, and chest tightness), physical activity level, and wearing a mask at work. Further, objective measurements like height and weight were measured using a stadiometer and calibrated weighing scale, respectively. Pulmonary assessments like Breath Holding Time (BHT, sec) and Peak Expiratory Flow Rate (PEFR) were recorded with participants standing upright. For the BHT, the participants were instructed to inhale maximally through the nose and hold their breath as long as possible, and the time span was recorded in seconds.

The peak expiratory flow rate (PEFR) was measured using a portable PEFR device (Cipla; model MFG/MD/2023/000053) following standardized procedures recommended by the American Thoracic Society. Participants performed 3 maximal expiratory blows in a standing position after full inspiration. The highest value of the 3 performances was recorded in liters per minute. Disposable mouthpieces were used for each participant, and the device was disinfected between each participant.

Perceived breathlessness was assessed using the Modified Borg Dyspnea Scale (0–10) at rest and during activity, explained in simple language, and categorized into no, mild, moderate, or severe breathlessness for analysis. The air quality data, including particulate matter concentration ($PM_{2.5}$ and PM_{10}) and AQI, were obtained from publicly available real-time monitoring data provided by the Central Pollution Control Board through the National Air Quality Index Portal[19]. The portal provides continuously updated air quality information from Continuous Ambient Air Quality Monitoring Stations (CAAQMS) in Chennai city. The monitoring stations closest to the study area were approached to compute one-month and one-year averages of $PM_{2.5}$, PM_{10} , and AQI values. The daily outdoor exposure duration is recorded as the average number of hours per day spent working outdoors as a street vendor, and the duration of street vending is recorded as the self-reported total number of years the participants worked as street vendors. All the data were collected between 1 pm and 5 pm of the day to avoid peak business hours and encourage more participation.

Operational definitions

The self-reported respiratory symptoms (cough, wheezing, morning phlegm, and breathlessness) were assessed using a recall period of the past 12 months. A symptom was operationally defined as frequent if it occurred at once every month during the past year, indicating a recurrent symptom and not an isolated one.[20]

Participants were classified as having respiratory symptoms if they had reported experiencing at least one of the following symptoms: cough, wheezing, morning phlegm, shortness of breath, or chest tightness.

Duration of occupational exposure to outdoor air pollution is measured in the unit of total number of years the participant had worked as a street vendor in the Chennai City, India.

The daily outdoor exposure duration is the average number of hours per day spent outdoors while performing vending activities. Participants were considered as face-mask user, if they self-reported routine use of mask while vending.

Study variable's

Independent (predictor) variables included ambient air quality indicators (PM_{2.5}, PM₁₀, AQI), duration of vending work, daily outdoor exposure hours, proximity to traffic zones, age, gender, height, and weight. Dependent (outcome) variables included PEFR, BHT, and perceived breathlessness (MBDS at rest and during activity) scores.

Operational Definitions

Street Vendor

A street vendor was defined as an adult (≥ 18 years) individual engaged in selling goods or services in a fixed outdoor roadside location within the mapped study area corridors at least one year prior to data collection.

Air Quality Index (AQI)

AQI is a composite numerical indicator used to describe the overall level of ambient air pollution levels based on the concentration of major pollutants. In this study, we computed the monthly and annual AQI values by securing data from CPCB monitoring offices to estimate the temporal air pollution exposure.

Particulate Matter (PM)

The PM is defined as the airborne particles suspended in the atmosphere. PM_{2.5} represents fine particles with an aerodynamic diameter $\leq 2.5 \mu\text{m}$, and PM₁₀ represents particles $\leq 10 \mu\text{m}$. The monthly averages of PM_{2.5} and PM₁₀ concentrations were obtained from the CPCB nearest to the study area.

Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee of SRM Institute of Science and Technology, Kattankulathur, India (Reference No: SRMIEC-ST0125-2054), and prospectively registered with the Clinical Trial Registry of India (REF/2025/04/102907). The study adhered to the Declaration of Helsinki. All the participants were informed about study procedures, purpose, potential risks and benefits, confidentiality of information, and the volunteer nature of participation prior to enrollment, and written informed consent was obtained.

Data analysis

Statistical analyses were conducted using R software (version 4.3.1) and Statistical Package for Social Sciences (SPSS) version 25.0 for Windows. Descriptive statistics were used to summarize the participant characteristics; the continuous variables were expressed as mean $\pm$ standard deviation (SD), while the categorical variables were presented as frequency and percentages. The normality of the continuous variables was tested using the Shapiro-Wilk test, and the Q-Q plots were used for visual inspection of distribution. The relationships between all the continuous variables were explored using Pearson correlation matrix and visualized using a heat map. The independent predictors of the peak expiratory flow rate (PEFR) were identified using the multiple linear regression models. The categorical variables were entered into the models after dummy coding. We used a stepwise modeling approach to ensure the robustness of our estimates. Model 1 included all the hypothesized predictors (age, sex, height, weight, BMI, educational attainment, living with family, years of work as vendor, hours of work in a typical day, income, AQI, PM_{2.5} levels, PM₁₀ levels, shortness of breath, cough, phlegm, dyspnea

scale, wheezing, chest tightness, and breath hold time). The diagnostic checks of model 1 revealed significant collinearity, specifically among height, weight, BMI, age, years of work as vendor, and PM2.5 with a Variance Inflation Factor (VIF) > 5 and tolerance < 0.10. The adjusted model (Model 2) was run systematically by retaining years of work as vendor instead of age, height and weight instead of BMI, and PM10 instead of PM2.5 level to stabilize the model and reduce inflation of standard errors. The goodness of fit of the model was assessed using adjusted R², and the significance level was determined at a two-tailed $\alpha < 0.05$.

Results

A total of 298 street vendors participated in this study out of 403 street vendors who were approached. The response rate was 73.9%, and the most common reasons for non-response were no time and not being willing to participate. There were no missing data, and with 298 recruited participants, the study was able to achieve 77.6% of the power-calculated sample size (n = 384). The mean age of the participants was 38.5 ± 11.08 years, and the majority of them were female (65.4%). The educational attainment was generally low among the participants, with 12.8% having had no formal schooling and 48.3% having primary-level school. On average, the participants have worked as street vendors for 16.45 ± 7.26 years, and the overall mean of monthly income was $12,496 \pm 3414.4$ Indian rupees. Nearly 3/5th (58.7%) self-reported coughing at work in the past year, and morning phlegm was the other frequently reported symptom (44%). The street vendors reported that on average they spent 8.40 ± 1.24 hours outdoors in a typical day in the street selling their products. The mean score of the modified Borg dyspnoea scale during activity was 1.79 ± 1.5 , and during rest it was 0.57 ± 0.17 (Table 1). The mean peak expiratory flow rate (PEFR) of the street vendors was 376.1 ± 71.39 L/min, and the average breath-holding time was $33.32 \pm 9.07 \pm 9.07$ seconds. The one-year average Air Quality Index (AQI) exposure of the participants was 94.31 ± 4.21 . More importantly, a very negligible number of participants (2.3%) reported wearing masks during work.

Table 2 **Demographic, Socio-Occupational Characteristics, Air Quality Index, and Respiratory Characteristics of Street Vendors (n = 298)**

Table 2
Demographic, Socio-Occupational Characteristics, Air Quality Index, and
Respiratory Characteristics of Street Vendors (n = 298)

Variables	Frequency (%)
Age, mean SD	38.5 ± 11.08
Sex n,%	
Male	103 (34.6)
Female	195 (65.4)
Height (cm), mean SD	160.3 ± 10.44
Weight (kg), mean SD	61.68 ± 6.62
BMI (kg/m ²)	23.86 ± 4.19
Education attainment n,%	
No formal school	38 (12.8)
Primary	144 (48.3)
Secondary	91 (30.5)
College	25 (8.4)
Living with n,%	
Family	221 (74.2)
Alone	77 (25.8)
Past year, shortness of breath during work n,%	
No	188 (63.1)
Yes	110 (36.9)
Past year, Cough at work n,%	
No	123 (41.3)
Yes	175 (58.7)
Past year, wheezing at work n,%	
No	221 (74.2)
Yes	77 (25.8)
Past year, Morning phlegm n,%	
No	167 (56)
Yes	131 (44)
Past year, frequency of breathlessness n,%	
Never	38 (12.8)
AQI – Air Quality Index, BHT – Breath Holding time, Inr – Indian rupee, MBDS – Modified Borg Dyspnea Scale	

Variables	Frequency (%)
Rarely	96 (32.2)
Sometimes	109 (36.6)
Often	55 (18.5)
Past year, feeling chest tightness n, %	
No	227 (76.2)
Yes	71 (23.8)
At least one symptom reported, yes n(%)	197 (66.1)
Years of work as a street vendor, mean SD	16.45 (7.26)
Hours spent outdoors daily (hours), mean SD	8.4 (1.24)
Monthly income (Inr), mean SD	12496 (3414.4)
Wearing mask at work, n %	
No	291 (97.7)
Yes	07 (2.3)
MBDS during rest, mean SD	0.57 ± 0.17
MBDS during activity, mean SD	1.79 ± 1.5
BHT (sec), mean SD	33.32 ± 9.07
PEFR (L/min), mean SD	376.1 ± 71.39
AQI one month average	72.25 ± 10.48
AQI one year average	94.31 ± 4.21
PM2.5 one month average	23.36 ± 3.08
PM10 one month average	56.54 ± 4.59
AQI – Air Quality Index, BHT – Breath Holding time, Inr – Indian rupee, MBDS –	
Modified Borg Dyspnea Scale	

Footnote

AQI – Air Quality Index, BHT – Breath Holding time, Inr – Indian rupee, MBDS –

Modified Borg Dyspnea Scale

Participants who reported respiratory symptoms demonstrated significantly lower peak expiratory flow rate (PEFR) values compared to those without symptoms. Those reporting shortness of breath had markedly reduced mean PEFR (320.41 L/min) compared to those without symptoms (381.28 L/min), participants reporting cough at work showed substantially lower PEFR (335.11 L/min vs. 392.52 L/min; $t = 7.37$, $p < 0.001$). Comparable reductions in PEFR were observed among those reporting wheezing (313.02 L/min vs. 374.57 L/min; $t = 6.73$, $p < 0.001$), morning phlegm (335.88 L/min vs. 376.83 L/min; $t = 4.97$, $p < 0.001$), and chest tightness (311.41 L/min vs. 373.63 L/min; $t = 6.67$, $p < 0.001$), Table 3.

Table 3
Difference in Peak Expiratory Flow Rate (PEFR) Between
Participants with and without Respiratory Symptoms

Respiratory symptom	Mean, PEFR, L/min		t	p
	No	Yes		
Shortness of breath	381.28	320.41	7.53	< 0.001
Cough at work	392.52	335.11	7.37	< 0.001
Wheezing at work	374.57	313.02	6.73	< 0.001
Morning phlegm	376.83	335.88	4.97	< 0.001
Chest tightness	373.63	311.41	6.67	< 0.001

Table 3 **Difference in Peak Expiratory Flow Rate (PEFR) Between Participants with and without Respiratory Symptoms**

The correlation heat map (Fig. 3) demonstrates the relationships between the PEFR and other predictors. The participant's age and years spent as a street vendor were observed to have strong negative correlations with the performance-based PEFR scores, $r = -0.67$ and $r = -0.73$, respectively. There was a strong positive correlation ($r = 0.76$) between PEFR and breath-holding time, and higher perceived breathlessness during activity ($r = -0.48$) and rest ($r = -0.42$), indicated by the MBDS scores, was observed to have a moderately negative The PEFR score shows a non-significant weak correlation with the AQI of one month in the correlation matrix, though the yearly AQI was observed to have a significant negative relationship ($r = -0.24$) with the PEFR scores.

The linear regression model (Table 4) identifies the key independent predictors of the PEFR score among the street vendors. The predictors that were significantly associated with the PEFR scores were years of work as vendors ($\beta = -3.34$, $p < 0.001$); with every additional year spent outdoors working as a vendor, the PEFR decreases by 3.34 L/min. The exposure time, or hours spent outdoors in a typical day, has a detrimental effect ($\beta = -6.48$, $p < 0.001$) on the PEFR scores, with every additional hour reducing PEFR by 6.48 L/min. The other predictors that had a negative effect on the PEFR are the annual AQI ($\beta -1.80$, $p = 0.002$), weight ($\beta -1.19$, $p < 0.001$), cough with phlegm, and higher MBDS at rest. The breath-holding time was observed to have a strong positive effect ($\beta = 0.427$, $p < 0.001$) on the PEFR, with a one-second increase in BHT associated with a 3.03 L/min increment in the PEFR correlation with the PEFR score.

Table 4
Linear Regression Analysis Identifying Predictors of Peak Expiratory Flow Rate (PEFR)

Model	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (B)	T	Sig.	95%CI		Collinearity Statistics	
								Tolerance	VIF
(Constant)	509.63	80.39		6.34	0.000	351.35	667.9		
Height(cm)	0.52	0.23	0.076	2.27	0.024	0.07	0.97	0.87	1.15
Weight(kg)	-1.19	0.36	-0.11	-3.35	0.001	-1.89	-0.49	0.89	1.19
Years of work as vendor	-3.34	0.42	-0.352	-7.99	0.000	-4.16	-2.52	0.5	1.99
Hours Spent Outdoors Daily	-6.48	1.94	-0.113	-3.35	0.001	-10.3	-2.67	0.85	1.18
What is your Monthly Income (INR)	0.02	0.01	0.008	0.24	0.808	-0.001	0.002	0.9	1.11
Modified Borg Dyspnea Scale at Activity	-1.55	2.88	-0.032	-0.54	0.590	-7.23	4.12	0.28	3.61
Modified Borg Dyspnea Scale at Rest	-14.37	7.02	-0.116	-2.05	0.042	-28.2	-0.55	0.3	3.29
Breath-hold time (sec)	3.03	0.31	0.427	9.87	0.000	2.42	3.63	0.52	1.93
Air Quality Index/month	-1.06	0.23	0.007	0.21	0.837	-1.41	0.49	0.85	1.17
Air Quality Index/year	-3.8	0.38	-0.306	-8.08	0.002	-5.95	-1.65	0.71	1.73
PM2.5/month	0.99	0.78	0.05	1.28	0.20	-0.54	2.53	0.58	1.7
PM10/Month	-1.352	0.544	-0.091	-2.485	0.014	-2.423	-0.281	0.613	1.631

Table 4 Linear Regression Analysis Identifying Predictors of Peak Expiratory Flow Rate (PEFR)

Discussion

This study investigated the association between occupational exposure to outdoor air pollution and respiratory health among the informal urban street vendors in Chennai City, India. The findings indicate a substantial proportion of respiratory symptoms and measurable reductions in pulmonary function among this informal workforce. Approximately 2/3rd of the participants reported at least one respiratory symptom, and the mean peak expiratory flow rate (376.1 L/min) was lower than the predicted values for healthy Indian adults of comparable age groups. Importantly, our study found that the key variables that mark cumulative exposure to outdoor air pollution, like years of vending and daily outdoor working hours, were observed to be independently associated with reduction in the PEFR values. Further, the long-term air quality indicators, like the one-year average AQI, demonstrated a significant negative association with lung function defined by PEFR values.

The prevalence of self-reported respiratory symptoms in this study is consistent with the previous investigations conducted among occupational groups exposed to urban air pollution[11, 15, 21, 22]. Studies among traffic police populations and roadside workers have similarly reported higher prevalence of respiratory symptoms, including frequent cough, phlegm, and

breathlessness. For instance, research among traffic police officers in South Asian countries has reported respiratory symptom prevalence ranging from 30% to over 80%[7, 9, 12, 13, 23], suggesting substantial respiratory morbidity associated with long-term exposure to vehicular emissions and particulate matter. These findings are consistent with the present study, where cough and morning phlegm were the most frequently reported symptoms. The reported symptoms are commonly associated with airway irritation due to chronic inhalation of particulate matter, road dust, and traffic-related pollutants. A cross-sectional study that included only female street food vendors in Egypt reported that 86.2% of vendors experienced at least one respiratory symptom in the past year[11]. Studies in Thailand, Botswana, and Malaysia among street vendors reported a prevalence of 50%, 81%, and 49.1%, respectively. A study in Bangalore, India, reported prevalence rates of cough (32.2%), breathlessness (31.4%), and asthma (12.4%) among individuals exposed to traffic-related air pollution.[8, 9, 21] It should be noted that in our study some of the respiratory symptoms reported were at work, unlike in most of the studies.

Objective measurement of pulmonary function in this study using the portable, cost-effective, and reliable PEFR meter further supports the presence of respiratory impairment among street vendors[24]. The mean PEFR was lower than expected normative values reported for healthy adults in India for comparable age groups involving about 6000 healthy participants, which ranged from 450 to 600 L/min.[25] Most often, the reduction in PEFR (70–200 L/min versus 376 L/min in our study) indicates airway obstruction or compromise in thoracic or lung compliance, which could plausibly be associated with chronic exposure to traffic-related air pollutants, particulate matter, and vehicular emissions in the street vending environment.[1, 25, 26] Occupational groups exposed to outdoor air pollution, such as street vendors, roadside workers, and traffic police personnel, have shown similar declines in lung function in several studies[5, 10, 14, 23, 27]. Previous studies also reported that exposure to PM_{2.5} and traffic-related pollutants is associated with reduction in key pulmonary parameters like forced expiratory volume and PEFR,[3, 28, 29] which strengthens the hypothesis that occupational exposure to urban air pollution can contribute to progressive airway dysfunction.

A key finding of this study is the strong association between cumulative exposure and PEFR-based pulmonary function. Both the years of working as a vendor and the hours spent outdoors daily were significant predictors of reduced PEFR. This association suggests a possible dose-response relationship between chronic environmental exposure and respiratory impairment[3]. Similar exposure-response relationships have been reported in studies of urban outdoor air pollution-exposed occupational groups, where longer duration of exposure has been associated with increased respiratory morbidity.[30–32] Therefore, the findings of this study support the hypothesis that prolonged exposure to urban outdoor air pollution may lead to a decline in respiratory health. The yearly average AQI demonstrated a significant relationship with the PEFR values, whereas monthly AQI values were not significant predictors in the regression model. These findings again suggest chronic exposure to moderately elevated air pollution levels may have more implications for respiratory health than the short-term fluctuations in air quality.[1]

Despite the high reporting of respiratory symptoms and the high levels of exposure observed among the study participants, the use of face masks was extremely low, with fewer than 3% of vendors reporting mask use during work. Studies conducted among urban outdoor workers have reported similarly low levels of personal protective equipment use, often due to practical barriers such as discomfort, communication difficulties with customers, limited awareness regarding health risks, and economic constraints.[11, 14, 15, 21] In addition, informal workers often lack occupational health training or access to preventive health services. These structural factors contribute to increased vulnerability among informal occupational groups. Similar observations of low or improper mask use among street vendors have been reported in other settings, such as studies in Bangkok[21, 33] where over half of vendors never used respiratory protective equipment, and those who did often used ineffective types of masks. Evidence from Kathmandu, Nepal, indicates poor awareness and inadequate use of appropriate personal protective equipment among street vendors working in traffic-dense environments.[7] These findings align with broader occupational health evidence that outdoor informal workers frequently underuse protective gear, often due to low risk perception, discomfort, communication barriers, and limited access to suitable masks.

It is noteworthy that the difference between low dyspnoea scores at rest and objective measurements of lung function. And, the proportion of self-reported breathlessness were generally low at rest, in spite of many vendors demonstrating below par

PEFR values. This phenomenon probably indicates that the participants are not aware of their early respiratory impairment or even they are slowly adapted to the chronic respiratory impairments. Likewise, previous studies indicate that individuals exposed to prolonged outdoor urban air pollution may get adapted to mild respiratory symptoms, particularly if financial constraints compel them to work despite health concerns.[1, 31, 34]

Clinical and research implications, limitations

The findings of this study have important implications for public health and occupational health policy. Street vendors represent a large informal workforce particularly in many low- and middle-income countries, and they often operate in environments characterized by intense traffic congestion, road dust, and higher air pollution levels. Targeted interventions, such as periodic respiratory health screening using objective measures, awareness programs on air pollution risks, and the promotion of feasible protective strategies, could help reduce health risks in this population. Use of portable screening tools like the peak flow meters and self-reported symptoms may facilitate early detection of respiratory impairment in high-exposure occupational groups. In addition, urban planning to create designated vending zones away from high-traffic corridors may contribute to reducing long-term occupational exposure.

Several limitations should be considered when interpreting the study findings. The cross-sectional design limits the ability to establish causal relationships between air pollution exposure and respiratory outcomes. Air pollution exposure was estimated using ambient monitoring station data rather than personal exposure measurements, which may underestimate the true exposure levels experienced by street vendors. Additionally, pulmonary function was assessed using PEFR rather than spirometry, which limits the ability to differentiate between obstructive and restrictive lung impairments. Finally, we could not exclude healthy worker effect, as individuals with severe respiratory illness may have already left street vending occupations.

However this study also has some strength. We combined objective pulmonary function measurements with subjective symptom assessments, providing a comprehensive evaluation of respiratory health. This study examined both occupational exposure characteristics and environmental air quality indicators, and reported relationships. The focus on street vendors addresses an important evidence gap related to informal occupational groups that are often overlooked in environmental health research.

Recommendation

Future research should consider longitudinal designs to better understand the progression of respiratory impairment among outdoor informal workers. Studies incorporating personal exposure monitoring and comprehensive spirometry assessments would provide more precise estimates of exposure–response relationships. Intervention-based studies evaluating the effectiveness of protective measures such as respiratory masks or modified vending locations may also offer helpful suggestions for occupational health policy.

Conclusion

In conclusion, this study demonstrates that street vendors working in traffic zones of urban environments experience a considerable burden of respiratory symptoms and reduced pulmonary function. The findings highlight the importance of cumulative occupational exposure to air pollution as a determinant of respiratory health. Addressing the occupational health needs of informal workers is essential for reducing the long-term health impacts of urban air pollution in rapidly growing cities.

Abbreviations

AQI – Air Quality Index, BHT- Breath Holding Time, CAAQMS- Continuous Ambient Air Quality Monitoring Stations, CPCB - **Central Pollution Control Board**, Inr – Indian rupee, MBDS –Modified Borg Dyspnea Scale, PM - Particulate Matter, PEFR –

Peak Expiratory Flow Rate.

Declarations

Competing interests

The authors declare that they have no conflict of interest.

Ethical approval and consent to participate

This research was conducted in line with the Helsinki Declaration. SRM Institute of Science and Technology, Institutional Ethical Committee, Kattankulathur, India, approved this study (ref. no. SRM IEC-ST0125-2054). The signed agreement was obtained after delivering a verbal account describing the study from the participants and attesting to informed consent with impartial witness for study participation if the respondent had no formal schooling or was illiterate. Furthermore, the privacy and confidentiality of information was ensured.

Authors' contributions

PM and BJ carried out the data acquisition and data-set tabulation and participated in the study design and analysis. PM, BJ, VGT, VA, NJ, SS and ABU revised the proposal and participated in the analysis and manuscript writing. BJ, HR, NJ and PM were involved in data analysis, conceived the study, participated in its design, reran data analyses, coordinated draft work, and supervised the project. All authors read and approved the final manuscript.

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Consent for publish

Not applicable

Availability of data and material

The study contains all of the study data related to these findings. And, requests for more information on the dataset and questions about data sharing shall be directed to the correspondence author ABU aabithau@srmist.edu.in

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Figures



Figure 1

Study area map of Porur, Chennai, Tamil Nadu, India (Source: Google Maps).

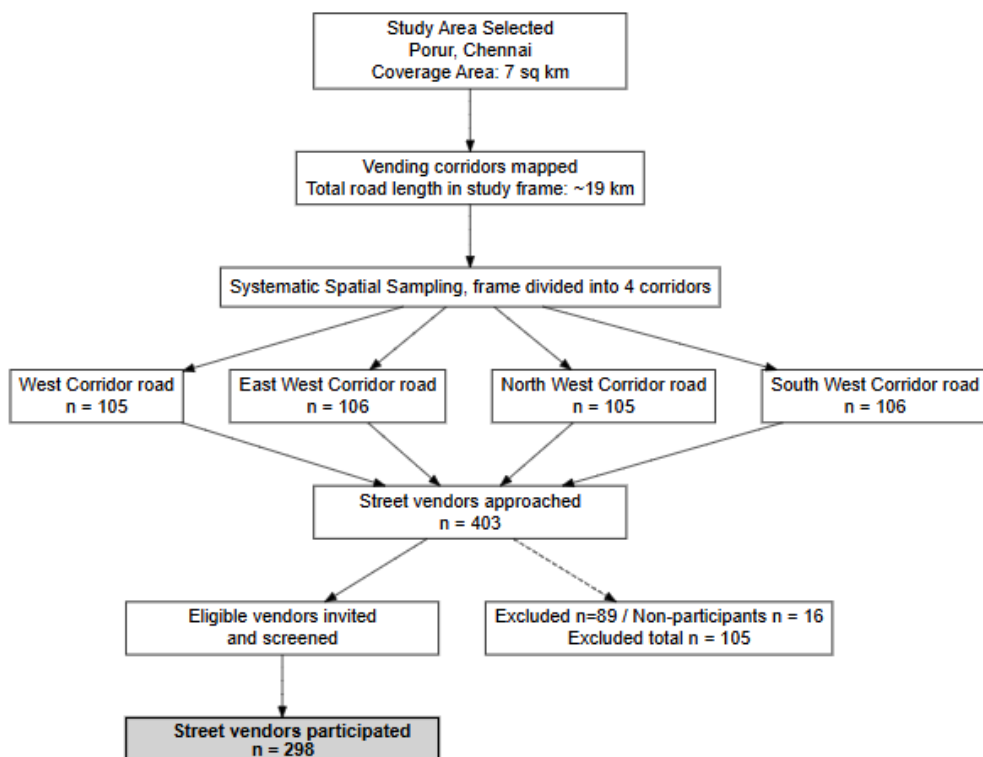


Figure 2

Study area

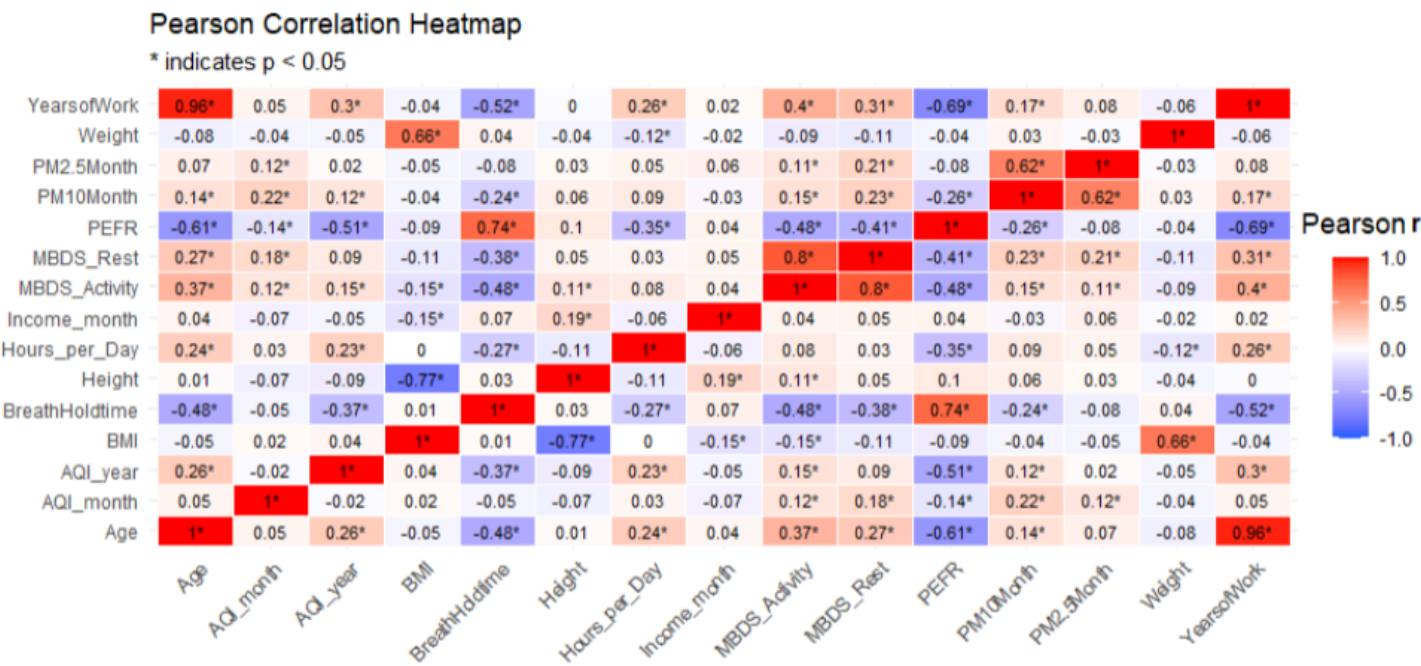


Figure 3

Correlation heat map matrix

Supplementary Files

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