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Original article

CHRONIC RESPIRATORY SYMPTOMS AND SPIROMETRIC PARAMETERS AMONG PROFESSIONAL DRIVERS - THE IMPACT OF OCCUPATIONAL EXPOSURE AND WORK TENURE

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Abstract

Aim. To assess the prevalence of chronic respiratory symptoms, spirometric parameters and the effects of occupational exposure among professional drivers.

Material and methods. A cross-sectional epidemiological study was conducted including 70 male professional drivers and 70 administrative staff matched by age, work tenure, occupational exposure and smoking status. Data on respiratory symptoms, smoking status, occupational exposure to harmful agents and work tenure were collected using a standardized questionnaire. Spirometry was performed to assess lung function.

Results. Professional drivers had a significantly higher prevalence of respiratory symptoms compared to controls, including any respiratory symptom (81.4% *vs*. 58.6%, p=0.003), nasal symptoms (35.7% *vs*. 8.6%, p<0.001), cough (61.4% vs 34.3%, p=0.002), cough with phlegm (37.1% *vs*. 20.0%, p=0.040), dyspnea (31.4% *vs*. 17.1%, p=0.049) and wheezing (25.7% *vs*. 7.1%, p=0.006). All spirometric parameters were significantly lower in drivers, indicating involvement of both large and small airways (p<0.05). Drivers with ≥ 20 years of work tenure exhibited a significantly higher prevalence of symptoms and lower spirometric values. Multivariable logistic regression identified exposure to gases as the strongest independent predictor of respiratory symptoms (adjusted OR up to 12.4, p<0.01), followed by exposure to smoke (adjusted OR up to 6.31, p<0.05). Dust exposure showed a non-significant trend, while vapors were not associated with respiratory symptoms.

Conclusion. Professional drivers are at increased risk of developing respiratory symptoms and lung function impairment compared to the control group. Occupational exposure to gases and smoke represents the main independent risk factor, while longer work tenure suggests a cumulative adverse effect.

Keywords: professional drivers, respiratory symptoms, spirometry, occupational exposure

Introduction

Chronic obstructive pulmonary disease (COPD) is one of the most important global public health problems over the past three decades. The global prevalence of COPD is high, affecting nearly 4% of the population[1,2], and increases to approximately 10% among individuals older than 40 years[3]. According to the Global Burden of Disease (GBD) Study from 2017, COPD is the third leading cause of death worldwide, accounting for at least 3

million deaths annually[2]. In the United States, the direct costs of COPD exceed 30 million dollars per year, while indirect costs reach approximately 20 million dollars annually[4]. COPD is also a major cause of disability, with a high burden of years of life lost and years lived with disability[5].

Exposure to harmful particles and gases plays a primary role in the development and progression of the disease. Active and passive smoking remains the most important and well-established risk factor for COPD. Tobacco smoke is a complex mixture of particles and gases containing approximately 4,000 identified compounds and an unknown number of unidentified substances. About 250 of these have been shown to exert irritative and toxic effects, while around 60 are known or probable carcinogens affecting various organs and systems in the human body. COPD develops in approximately 15-20% of active smokers, while 60-70% of patients with COPD are current or former smokers.

On the other hand, a significant proportion of COPD cases occurs in individuals who have never smoked or have not been exposed to tobacco smoke. Occupational and environmental air pollutants, particularly indoor pollutants generated by the combustion of biofuels, represent important risk factors for the development of the disease[6].

Occupational exposure is an important but often under-recognized modifiable factor contributing to the overall burden of respiratory diseases. Quantifying the contribution of occupational exposure to this burden is essential for prevention and for improving respiratory health in working populations. At the population level, the occupational burden of respiratory diseases is most commonly associated with asthma and COPD. Occupational exposure contributes to nearly 14% of all COPD cases and up to 31% among never-smokers[7].

A wide range of occupational hazards, including long working hours, psychological stress, shift work and sleep disruption, physical fatigue, exposure to noise and vibration, unhealthy lifestyle factors and exposure to diesel exhaust emissions, are recognized risk factors contributing to multiple morbidities among professional drivers. These include psychological disorders, circadian rhythm disturbances, musculoskeletal diseases, cardiovascular diseases and respiratory conditions[8].

A large number of studies worldwide have confirmed a positive correlation between occupational exposure to urban traffic-related air pollution and persistent airflow limitation among exposed workers. In a cross-sectional study by Minov *et al*., a high prevalence of all respiratory symptoms was observed among professional bus drivers, along with a significant reduction in spirometric parameters in this group of subjects[9].

The characteristic symptoms of COPD include chronic cough persisting over a prolonged period, often accompanied by sputum production and dyspnea, which is typically exacerbated during physical activity. These symptoms tend to worsen during respiratory infections such as the common cold or influenza[10]. In addition to these typical manifestations, less frequent symptoms such as wheezing and chest tightness or discomfort may also occur. However, the clinical presentation may vary depending on the patient's age and the severity of the disease[11].

Among patients with COPD, an increased prevalence of chronic bronchitis has been reported in males, older individuals, those with longer smoking histories, patients with more severe airflow obstruction, individuals with higher levels of occupational exposure, and those residing in rural areas[12].

In this study, we aimed to compare the prevalence of chronic respiratory symptoms and spirometric parameters, as well as their association with occupational exposure, between professional drivers and a control group consisting of administrative and academic staff employed in educational institutions, matched by age, duration of employment at the current workplace, and smoking status.

Materials and methods

Study design

The study was designed as a cross-sectional epidemiological study, which was conducted at the Department of occupational medicine at the Public Health Institution Health care center "Dr. Panche Karagjozov" in Shtip. The study was carried out within the framework of periodic preventive health examinations or control medical assessments required for the issuance of medical certificates for the renewal of driving licenses for categories C and C+E.

The study population included professional drivers for whom operating such motor vehicles represents their primary occupation. Data collection was conducted in the period from May 2025 to September 2025.

Study subjects

This study included 70 professional drivers who constituted the examined group (EG), and 70 participants employed in a higher education institution as administrative and academic staff, who comprised the control group (CG).

The inclusion criteria for participation in the study were: male gender, age between 21 and 70 years, and professional drivers holding a valid driving license for categories C and C+E.

The exclusion criteria were: female gender, age below 21 years or above 70 years, amateur drivers holding a license for categories C and C+E, professional drivers licensed for vehicle categories other than C and C+E, and individuals with conditions that could interfere with spirometry or study participation, such as hemoptysis, unstable cardiovascular status, severe cardiac arrhythmias or conduction disorders, unstable coronary artery disease or recent surgery involving the eye, thorax or abdomen within the past month.

All participants were informed about the purpose of the study and written informed consent was obtained from each subject.

Questionnaire

A COPD questionnaire was administered, designed based on two validated and standardized instruments used in similar studies conducted in the European Union and the United States (Population-based Screening Questionnaire for COPD and Symptom-based Questionnaire for Identifying COPD). The questionnaire consisted of three sections.

The first section included questions on basic demographic characteristics, as well as occupational history and exposure at current and previous workplaces, with particular emphasis on exposure to dust, fumes, gases, and vapors, as these occupational agents are recognized risk factors for COPD. It also included questions regarding the presence of chronic respiratory diseases (asthma or chronic bronchitis) in first-degree relatives (mother, father, siblings). The second section addressed smoking status, categorizing participants as current smokers, former smokers, non-smokers, or passive smokers. Information was also collected on the number of cigarettes smoked per day and the duration of smoking history. The third section included questions on nasal and respiratory symptoms experienced during the previous 12 months. The respiratory symptoms of interest included cough, cough with phlegm, dyspnea (shortness of breath), wheezing and chest tightness.

A current (daily) smoker was defined as an individual who reported smoking at least once per day at the time of the survey, except during periods of religious fasting. Among daily smokers, cumulative lifetime tobacco exposure and the average number of cigarettes smoked per day were assessed. Lifetime tobacco exposure was quantified as pack-years smoked (one pack-year defined as smoking 20 cigarettes per day for one year), calculated according to current recommendations[13].

A former smoker was defined as an individual who had previously been a daily smoker but had quit smoking at the time of the survey.

Passive smoking, or exposure to environmental tobacco smoke, was defined as exposure to combustion products of tobacco generated by other individuals[14].

Spirometry

Spirometric assessments, including measurement of forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC), with calculation of the FEV_1/FVC ratio, as well as measurement of maximal expiratory flows at 25%, 50%, and 75% of FVC (MEF_{25}, MEF_{50}, MEF_{75}) were performed using a Spirobank II Smart spirometer (MIR-Medical International Research S.p.A., Italy). All measurements were conducted in accordance with the current recommendations of the American Thoracic Society (ATS) and the European Respiratory Society (ERS). Three acceptable maneuvers were obtained for each participant, and reproducibility criteria were met when at least two measurements differed by no more than 5%. The highest values were used for analysis.

Statistical Analysis

Data collected from the questionnaires were entered electronically into Microsoft Excel (2015). Statistical analysis was performed using the SPSS software package, version 26.0 for Windows. Both descriptive and inferential statistical methods were applied. Continuous variables were expressed as mean values with standard deviation, while categorical variables were presented as frequencies and percentages. The chi-square test (or Fisher's exact test, where appropriate) was used to assess differences in the prevalence of respiratory symptoms between groups. Comparisons of spirometric parameters were performed using the independent samples t-test. Statistical significance was defined as a p-value <0.05.

Linear regression analysis was used to evaluate the independent effect of occupational exposure to dust, gases, vapors and smoke on lung function parameters, while controlling for potential confounding factors, including smoking status, age and duration of employment at the current workplace.

Results

All participants in both the examined and control groups were males.

Table 1. Demographic characteristics of study participants

Parameters	Professional drivers (n = 70)	Administrative staff (n = 70)
Age range (years)	23-67	21-66
Age (years)	48.6±9.6	47.3±10.7
Duration of work tenure at the current workplace (years)	21.0±9.2	20.1±10.5
Duration of work tenure at the current workplace ≤ 20 years	37(52.9%)	33(47.1%)
Duration of work tenure at the current workplace ≥ 21 years	33(47.1%)	37(52.9%)
Current smokers	35(50%)	31(44.3%)
Smoking duration (years)	20.9±8.6	23.7±11.3
Cigarettes per day	20.7±7.7	20.1±6.6
Former smokers	16(22.9%)	7(10%)
Passive smokers	39(55.7%)	33(47.1%)

Table 1 presents the demographic characteristics of all participants, including duration of employment at the current workplace and smoking status.

Continuous variables are expressed as mean value with standard deviation, while categorical variables are expressed as frequencies (number and percentage) of participants with the specified characteristic.

The mean age of the examined group was 48.6±9.6 years (range 23-67 years), and the mean duration of work tenure was 21.0±9.2 years. The mean age of the control group was 47.3±10.7 years (range 21-66 years), while the mean duration of work tenure was 20.1±10.5 years. In the examined group, 35 participants (50%) were current smokers, 16(22.9%) were former smokers, and 39(55.7%) were passive smokers. In the control group, the corresponding figures were 31(44.3%), 7(10%), and 33(47.1%), respectively.

Table 2 presents the prevalence of respiratory symptoms (nasal symptoms, cough, cough with phlegm, dyspnea, wheezing, and chest tightness) during the last 12 months in the study groups.

Table 2. Prevalence of respiratory symptoms in the last 12 months in study groups

Respiratory symptoms in the last 12 months	Professional drivers (n = 70)	Administrative staff (n = 70)	*p*-value* (*p*<0.05)
Any respiratory symptom	57(81.4%)	41(58.6%)	0.003*
Nasal symptoms	25(35.7%)	6(8.6%)	<0.001*
Cough	43(61.4%)	24(34.3%)	0.002*
Cough with phlegm	26(37.1%)	14(20.0%)	0.040*
Dyspnea	22(31.4%)	12(17.1%)	0.049*
Wheezing	18(25.7%)	5(7.1%)	0.006
Chest tightness	16(22.9%)	10(14.3%)	0.277

Data are expressed as number and percentage of study subjects with certain variable.
*Tested by chi-square test or Fisher's exact test where appropriate.

Respiratory symptoms in the last 12 months were more prevalent among professional drivers than controls (Table 2). In the examined group, nasal symptoms, cough, cough with phlegm, dyspnea, wheezing, and chest tightness were reported by 35.7%, 61.4%, 37.1%, 31.4%, 25.7% and 22.9% of participants, respectively, compared to 8.6%, 34.3%, 20.0%, 17.1%, 7.1% and 14.3% in the control group.

Statistically significant differences were observed for any respiratory symptom, nasal symptoms, cough, cough with phlegm and dyspnea (p=0.003, p<0.001, p=0.002, p=0.040 and p=0.049, respectively). Although wheezing and chest tightness were more frequent among drivers, these differences were not statistically significant.

The prevalence of respiratory symptoms among professional drivers by work tenure is shown in Table 3.

Table 3. Prevalence of respiratory symptoms among professional drivers by work tenure

Respiratory symptoms in the last 12 months	Work tenure ≤ 20 years (n = 37)	Work tenure ≥ 21 years (n = 33)	*p*-value* (*p*<0.05)
Any respiratory symptom	26(70.1%)	31(93.9%)	0.012*
Nasal symptoms	9(24.3%)	16(48.5%)	0.035*
Cough	15(40.6%)	28(84.8%)	<0.001*
Cough with phlegm	5(13.5%)	21(63.6%)	<0.001*
Dyspnea	9(24.3%)	13(39.4%)	0.180
Wheezing	9(24.3.7%)	9(27.3%)	0.770
Chest tightness	1(2.7%)	15(45.5%)	<0.001*

Data are expressed as number and percentage of study subjects with certain variable. *Tested by chi-square test or Fisher's exact test where appropriate.

Among professional drivers, the prevalence of respiratory symptoms increased with duration of job exposure (Table 3). Drivers with ≥21 years of work tenure had a higher prevalence of any respiratory symptom (93.9% *vs*. 70.1%, p=0.012), nasal symptoms (48.5% *vs*. 24.3%, p=0.035), cough (84.8% *vs*. 40.6%, p<0.001), cough with phlegm (63.6% *vs*. 13.5%,

p<0.001) and chest tightness (45.5% *vs*. 2.7%, p<0.001) compared to those with ≤20 years of work tenure.

Although dyspnea and wheezing were more frequent among drivers with longer work tenure, these differences were not statistically significant.

Table 4 presents the mean percentage values of spirometric parameters (FVC, FEV_1, FEV_1/FVC, MEF_{50}, MEF_{75}, and $MEF_{25–75}$) in the study groups.

Table 4. Mean percentage values of spirometric parameters in study groups

Spirometric parameters	Professional drivers (n = 70)	Administrative staff (n = 70)	*p*-value* (*p*<0.05)
FVC (% pred)	90.7±11.4	95.0±12.5	0.034*
FEV_1 (% pred)	90.5±10.9	99.3±12.2	<0.001*
FEV_1/FVC%	78.5±5.2	85.8±6.3	<0.001*
MEF_{50} (% pred)	82.1±17.5	93.6±15.7	<0.001*
MEF_{75} (% pred)	80.8±17.5	90.9±18.6	0.002*
MEF_{25-75} (%pred)	86.2±16.8	97.5±15.7	<0.001*

Data are expressed as mean value with standard deviation.
FVC: forced vital capacity; FEV_1: forced expiratory volume in 1 second; MEF_{50}, MEF_{75}, MEF_{25-75}: maximal expiratory flow at 50%, 75%, and 25-75% of FVC, respectively; % pred: % of predicted value. *Tested by independent-sample *T*-test.

All mean spirometric parameters were significantly lower in the examined group compared to the control group (p=0.034, p<0.001, p<0.001, p<0.001, p=0.002, p<0.001) (Table 4).

Table 5 presents the mean values of spirometric parameters (FVC, FEV_1, FEV_1/FVC, MEF_{50}, MEF_{75}, and $MEF_{25–75}$) among professional drivers stratified by work tenure (≤ 20 *vs*. ≥ 21 years) at the current workplace.

Table 5. Mean values of spirometric parameters in professional drivers by work tenure

Spirometric parameters	Work tenure ≤ 20 years (n = 37)	Work tenure ≥ 21 years (n = 33)	*p*-value* (*p*<0.05)
FVC (% pred)	94.6±10.2	86.4±11.2	0.002*
FEV_1 (% pred)	93.8±10.2	86.8±10.6	0.006*
FEV_1/FVC%	79.4±4.9	77.5±5.4	0.120
MEF_{50} (% pred)	85.7±17.4	78.0±17.0	0.049*
MEF_{75} (% pred)	82.8±17.9	78.7±16.9	0.290
MEF_{25-75} (%pred)	88.3±16.6	84.0±16.9	0.240

Data are expressed as mean value with standard deviation. FVC: forced vital capacity; FEV_1: forced expiratory volume in 1 second; MEF_{50}, MEF_{75}, MEF_{25-75}: maximal expiratory flow at 50%, 75%, and 25-75% of FVC, respectively; % pred: % of predicted value. * Tested by independent-sample *T*-test.

Similarly, mean spirometric values were lower among professional drivers with ≥ 21 years of work tenure compared to those with ≤ 20 years, with statistically significant differences observed for FVC (p=0.002), FEV_1 (p=0.006) and MEF_{50} (p=0.049) (Table 5).

Table 6 illustrates the association between respiratory symptoms and the presence or absence of occupational exposure to dust, gases, vapors and smoke, adjusted for age, work tenure and smoking status.

Table 6. Adjusted associations between respiratory symptoms and occupational exposures

	Occupational exposure to dust aOR (95% CI)	Occupational exposure to gases aOR (95% CI)	Occupational exposure to vapors aOR (95% CI)	Occupational exposure to smoke aOR (95% CI)
Any respiratory symptom	2.64 (0,78-8,91)	10.9* (2.31-51.4)	0.39 (0.03-5.12)	4.98 (0.95-26.1)
Nasal symptoms	3.12 (0.94-10.3)	9.45* (2.28-39.2)	0.48 (0.03-7.21)	4.67* (1.18-18.5)
Cough	2.85 (0.95-8.54)	8.72* (2.34-32.5)	0.51 (0.04-6.12)	4.11* (1.12-15.0)
Cough with phlegm	2.21 (0.71-6.87)	12.4* (3.01-51.2)	0.33 (0.02-5.11)	5.83* (1.45-23.4)
Dyspnea	1.98 (0.62-6.28)	4.91* (1.36-17.7)	0.72 (0.05-10.1)	2.44 (0.63-9.42)
Wheezing	2.11 (0.61-7.25)	6.78* (1.71-26.9)	0.58 (0.04-8.11)	3.95* (1.01-15.4)
Chest tightness	2.48 (0.64-9.63)	9.12* (2.21-37.6)	0.44 (0.03-6.94)	6.31* (1.52-26.2)

Results are expressed as adjusted odds ratios (aORs) with 95% confidence intervals (CIs). Statistical significance was defined as $p < 0.05$. *Logistic regression analysis was performed.

Exposure to gases was the strongest independent predictor of all respiratory outcomes, while smoke exposure was associated with selected symptoms; dust showed a non-significant trend, and vapors showed no association at all (Table 6).

Discussion

COPD is one of the most common chronic non-communicable diseases worldwide in recent decades, with substantial financial implications for national healthcare systems. In addition to being a leading cause of mortality, COPD is also a major contributor to reduced work capacity and premature retirement in modern societies. Findings from similar studies indicate that the burden of COPD continues to increase and generates significant healthcare costs, particularly in developing countries. Despite its considerable medical and socioeconomic impact, relatively few population-based studies on COPD have been conducted worldwide compared to other respiratory diseases (e.g., asthma or lung cancer) or cardiovascular diseases[1,15,16].

The prevalence of COPD reported in population-based studies varies widely. For instance, in a study of adults aged over 40 years conducted across several cities in Latin America, COPD prevalence ranged from 7.8% in Mexico City to 19.7% in Montevideo[17]. Similarly, results from the Burden of Obstructive Lung Disease (BOLD) study, conducted in adults over 40 years across 29 predominantly European countries using standardized methodology (including respiratory symptom questionnaires and pre- and post-bronchodilator spirometry), reported a prevalence of 10.1% for GOLD stages 2–4, while prevalence among non-smokers ranged from 3% to 11%[18].

Although tobacco smoke is considered the most important risk factor for COPD, it accounts for approximately two-thirds of all cases, and sometimes even less. A substantial proportion of COPD cases occurs in individuals who have never smoked, highlighting the role of additional contributing factors. Evidence from studies conducted over the past two decades underscores the importance of occupational exposure to dust, gases, vapors, and fumes in the development and progression of COPD. For certain occupational agents, the underlying mechanisms leading to the structural and functional changes characteristic of COPD have also been elucidated (e.g., silica dust–induced COPD). As with general COPD prevalence studies, findings from occupational studies vary considerably, largely due to differences in exposure

type and intensity, variations in workplace environments across regions, and differences in occupational health and safety regulations among countries[19-23].

Respiratory diseases associated with exposure to air pollution represent a significant public health concern, particularly among individuals exposed to traffic-related air pollution (TRAP). Professional drivers are considered a high-risk group due to chronic exposure to exhaust emissions, particulate matter, and other toxic airborne components[24,25].

Our study sample comprised 140 participants, including 70 individuals in the examined group (professional drivers) and 70 in the control group (administrative and academic staff).

Professional drivers frequently use cigarettes and other stimulants to remain awake for extended periods, reduce stress, or occupy themselves while driving. As a result, this profession is characterized by a high prevalence of smoking[26]. Previous studies among professional drivers reported that nearly half of participants were smokers[27-29]. This is consistent with our findings, where 50.0% of professional drivers reported being current smokers.

Our study demonstrated a significantly higher prevalence of respiratory and nasal symptoms among professional drivers compared to the control group. In particular, the prevalence of cough, productive cough, dyspnea, and wheezing was significantly greater among drivers. These findings are consistent with previous studies showing that exposure to air pollution is associated with an increased occurrence of chronic respiratory symptoms (30,31). At the same time, the higher prevalence of nasal symptoms supports the involvement of the upper airways, in line with the concept of the "united airway disease," whereby inflammation affects both the upper and lower respiratory tract[32].

Spirometric parameters also revealed a significant reduction in lung function among professional drivers. Decreased values of FVC and FEV_1 suggest the presence of both restrictive and obstructive changes, while reduced MEF parameters (particularly $MEF_{25–75}$) indicate early small airway dysfunction. These findings are consistent with studies demonstrating that long-term exposure to particulate matter and gases leads to chronic inflammation, oxidative stress, and airway remodeling[33,34].

These results further support the findings of a cross-sectional study conducted by Minov *et al*., which reported a high prevalence of respiratory symptoms among professional bus drivers, along with a significant reduction in spirometric parameters in this population[9].

A particularly important aspect of our study is the identification of a dose–response relationship, whereby drivers with longer work tenure (≥21 years) exhibited a significantly higher prevalence of symptoms and lower spirometric values. This finding indicates a cumulative effect of exposure and supports the hypothesis of progressive deterioration of respiratory function over time. Similar findings have been reported in other epidemiological studies[31,35].

Multivariable logistic regression analysis demonstrated that exposure to gases was the strongest independent predictor of respiratory symptoms, showing significant associations across all examined outcomes. This finding is biologically plausible, as exhaust gases (particularly NO_2, CO, and ozone) exert pronounced pro-inflammatory and cytotoxic effects on the respiratory epithelium[36].

Exposure to smoke was also significantly associated with several symptoms, further supporting the role of inhaled irritants and particulate matter in the development of respiratory symptoms. This is consistent with the study by Zheng *et al*., which demonstrated an association between exposure to vapors, gases, dust, and fumes and the occurrence of chronic bronchitis, respiratory symptoms, and reduced lung function, supporting the role of such exposures in the pathogenesis and progression of COPD[37].

In contrast, dust exposure showed a consistent but non-significant trend after adjustment, while exposure to vapors was not associated with respiratory outcomes. These

findings may be explained by lower exposure intensity or a limited number of participants within these exposure categories, which may have reduced statistical power.

Interestingly, smoking and age were not independently associated with respiratory symptoms in the multivariable model. This suggests that occupational exposure may play a dominant role in the development of symptoms in this population, in line with studies indicating that the effects of occupational exposure may be independent of smoking status[38].

Despite the strength of these findings, several limitations should be considered. First, the cross-sectional design precludes causal inference. Second, symptom data were self-reported, which may introduce information bias. Third, no direct measurements of workplace pollutant concentrations were performed. Nevertheless, the consistency of findings across multiple outcomes (symptoms, spirometry, and regression analyses) strengthens the validity of the results.

Conclusion

Professional drivers exhibited a significantly higher prevalence of respiratory and nasal symptoms, as well as reduced spirometric parameters, compared to the control group. Occupational exposure to gases and smoke was identified as the main independent risk factor for adverse respiratory outcomes, while longer work tenure demonstrated a clear cumulative effect. These findings highlight the substantial impact of occupational air pollution on respiratory health and underscore the need for targeted preventive strategies, including reduction of workplace exposures, regular health surveillance and implementation of protective measures.

Further longitudinal studies are warranted to better establish causal relationships and to support the development of effective occupational health policies aimed at reducing the burden of respiratory diseases in this high-risk population.

Conflict of interest statement. None declared

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