Original Research Article

Evaluation of Respiratory Symptoms and Lung Function in Car Spray Painters in Ibadan, Nigeria

Abstract

Aim: This study investigated the correlation between respiratory symptoms a ventilatory function among car spray painters.

Methodology: The study was a cross-sectional analytical study. The study population comprised car spray painters from various automobile workshops in Ibadan and control subjects. The control group was comprised of individuals not exposed to spray paint or other respiratory hazards in their workplaces. The sample size was calculated using the formula for comparison of two proportions, giving a total sample size of 500 participants, 250 car spray painters, and 250 control subjects. The car spray painters were selected using a multistage sampling technique. Data were collected using a structured, interviewer-administered questionnaire designed in English and translated to Yoruba (the local language) when necessary. Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1), Peak Expiratory Flow Rate (PEFR) and Diffusing Capacity of the Lungs for Carbon Monoxide (DLCO) were determined using standard methods. Data were analyzed using SPSS.

Results: The study highlighted a significant difference in educational levels between both groups. Additionally, most car spray painters (91.2%) reported the use of personal protective equipment, with safety goggles being the most common type used. A high percentage of the painters worked in open spaces (61.2%) and had access to ventilation facilities (94.8%). The health and lifestyle assessment revealed a significant disparity in smoking and alcohol consumption habits, with higher prevalence among car spray painters. Results showed that FVC, FEV1, FEV1:FVC ratio, PEFR, and DLCO, with the car spray painters presenting lower values except for the FEV1:FVC ratio and DLCO, which were higher. The car spray painters also showed a higher prevalence of obstructive (35.2%) and restrictive (23.2%) ventilatory patterns compared to the control group.

Conclusion: The findings indicate a strong association between car spray painting and respiratory symptoms, a decrease in certain ventilatory functions, and a higher prevalence of obstructive and restrictive patterns. This underscores the importance of occupational health and safety interventions, including education and improved use of personal protective equipment, to mitigate the adverse effects of this profession on respiratory health.

Keywords: Car spray painters; lung function; occupational hazard; respiratory symptoms

1. INTRODUCTION

Occupational health is a critical field of study worldwide, with a plethora of research dedicated to understanding and improving the health conditions and safety of workers in various industries. Among these, the automotive refinishing industry has come under scrutiny due to its potential to expose workers to a range of harmful chemicals, specifically isocyanates, the primary ingredient in polyurethane paints, which have been shown to induce respiratory problems [1]. This study focuses on the city of Ibadan, Nigeria, where such health concerns are emerging as the automobile industry continues to grow and evolve.

Spray painters in the automotive industry are consistently exposed to a cocktail of chemicals such as isocyanates, solvents, lead, and chromates. Of these, isocyanates are considered particularly dangerous because they are potent sensitizers, which means that they can induce asthma in those who are genetically predisposed [2]. Apart from asthma, exposure to isocyanates can also lead to hypersensitivity pneumonitis, tuberculosis-like conditions, and even, in some cases, a decline in lung function [3].

In Nigeria, there has been a surge in the automobile industry with increased demand for car painting and bodywork services [4]. Ibadan, being one of the largest cities, houses a substantial number of automobile workshops. However, there is a dearth of comprehensive studies addressing the potential occupational health risks that car spray painters in this region face.

While some studies have focused on the general risk assessment and identification of harmful substances in spray paints [5], few have targeted the specific implications of these substances on respiratory symptoms and ventilatory function, particularly within the African context. Moreover, the unique work conditions, practices, and lack of effective personal protective equipment use in many Nigerian workshops could potentially exacerbate the health effects in these workers [6].

Existing research from other regions of the world suggests that chronic exposure to paint fumes, especially in poorly ventilated environments, can result in decreased lung function, respiratory symptoms such as coughing, wheezing, and dyspnea, and can also contribute to the development of chronic obstructive pulmonary disease (COPD) [7].

However, the unique local conditions in Ibadan and the lack of robust, context-specific data necessitated this research. This study aims to provide a comprehensive evaluation of respiratory symptoms and ventilatory function in car spray painters in Ibadan, Nigeria, in order to understand the occupational health risks more thoroughly and to inform future interventions.

2. RESEARCH METHODOLOGY

2.1 Study Area

The study was carried out in Ibadan, Nigeria. Ibadan, the capital city of Oyo State, is a major industrial and commercial hub in Nigeria, and it hosts a considerable number of automobile workshops and car spray painting outfits.

2.2 Study Design

The study was a cross-sectional analytical study designed to evaluate respiratory symptoms and ventilatory function in car spray painters in Ibadan, Nigeria.

2.3 Study Population

The study population comprised car spray painters from various automobile workshops in Ibadan and control subjects. The control group was comprised of individuals not exposed to spray paint or other respiratory hazards in their workplaces. They included lecturers, primary and secondary school teachers, as well as bankers who are 20 years and above, working and residing in Ibadan, the study area.

2.4 Sample Size and Sampling Technique

The sample size was determined using Fisher's formula [8] giving a total sample size of 500 participants, 250 car spray painters, and 250 control subjects. The car spray painters were selected using a multistage sampling technique across the eleven (11) local government areas in Ibadan.

2.5 Data Collection

Data were collected using a structured, interviewer-administered questionnaire designed in English and translated to Yoruba (the local language) when necessary. The questionnaire was divided into four sections: demographic information, work environment and conditions, health and lifestyle, and ventilatory function assessment.

2.6 Lung Function Test

2.6.1 Determination of Forced Vital Capacity (FVC) and Forced Expiratory Volume in 1 second (FEV1)

Forced Vital Capacity (FVC) and Forced Expiratory Volume in 1 second (FEV1) were determined according to the methods of Graham et al. [9]. Spirometry equipment was calibrated using a 3-liter syringe and the procedure was explained to the participants. They were asked to sit in a comfortable position with a nose clip to prevent air leakage. They were instructed to take as deep a breath as possible and then exhale into the mouthpiece of the spirometer as quickly and completely as possible. They continued exhaling until the volume-time curve plateaus for at least one second or forced exhalation has been sustained for at least six seconds. Several attempts were needed to achieve a satisfactory result. The best value out of three satisfactory tests was used as the FVC value while the FEV1 value is the volume of air that has been forcefully exhaled in the first second. The test was repeated at least three times to get reproducible results, and the highest value was chosen as the representative FEV1.

2.6.2 Determination of Peak Expiratory Flow Rate (PEFR)

Peak Expiratory Flow Rate (PEFR) was determined according to the methods of Graham et al. [10] using a Peak Flow Meter. The procedure was explained to the participants. The peak flow meter was set to zero. The participants were asked to stand up straight, to ensure maximum lung capacity. Where standing was not possible, sitting upright was acceptable. They were asked to take as deep a breath as they can. The mouthpiece of the meter was put in their mouth, sealing their lips tightly around it. It's important to make sure the tongue does not obstruct the mouthpiece. They were told to blow out as hard and fast as possible in a single exhalation. The reading on the scale was recorded as the PEFR. The test was repeated three times, with the participants allowed to take a few normal breaths between each test. The highest of the three readings was used as the PEFR.

2.6.3 Determination of Diffusing Capacity of the Lungs for Carbon Monoxide (DLCO)

Diffusing Capacity of the Lungs for Carbon Monoxide (DLCO) was determined according to the methods of Graham et al. [11]. Spirometry equipment was calibrated using a 3-liter syringe and the procedure was explained to the participants. They were asked to sit in a comfortable position. They were asked to exhale completely to get rid of as much air in the lungs as possible. They then inhaled a single deep breath of the test gas mixture, which contains a known small amount of carbon monoxide and helium as a tracer. They held their breath for about 10 seconds. This allowed for the gas exchange between the alveoli (air sacs in the lungs) and the pulmonary capillaries. They then exhaled, and the first part of the exhaled gas was discarded as it reflects the air in the anatomical dead space (parts of the airway that do not participate in gas exchange). The next portion of the exhaled gas was collected and analyzed to measure the concentrations of CO and the tracer gas (helium).

2.7 Data Analysis

Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics were computed for all relevant data. The chi-square test was used to assess the relationship between categorical variables, while the student's t-test was used to compare means between the two groups. The level of statistical significance was set at $p < 0.05$.

3. RESULTS

The demographic information of respondents, including age, marital status, and education level are presented in table 1. Table 2 provides data on the working environment and conditions of the car spray painters, such as their use of personal protective equipment (PPE), the type of workspace they use (open or enclosed), whether they are exposed to other chemicals at their workplace, their working duration, and the number of hours they spend in a paint spraying environment daily.

Table 3 contains data on health and lifestyle of the car spray painters and the control subjects. It reports on behaviours such as smoking and alcohol consumption, as well as various health symptoms related to respiratory issues. Many of the health variables show statistically significant differences ($p < 0.05$). Table 4 reports on lung function assessments, comparing the car spray painters with the control subjects. The test results (Forced vital capacity - FVC, Forced expiratory volume in 1 second - FEV1, Peak Expiratory Flow Rate - PEFR, and Diffusing Capacity for Carbon Monoxide - DLCO) are provided as means ± standard deviations.

Table 1: Demographic Information of Respondents

Demographic Information	Car Spray Painters n = 250 (%)	Control Subjects n = 250 (%)	p-value
Age (in years)			1.006
Less than 30	26 (10.40)	52 (20.80)	
31 – 40	83 (33.20)	91 (36.40)	
41 – 50	94 (37.60)	81 (32.40)	

Above 50	47 (18.80)	26 (10.40)	
Marital Status			0.938
Single	11 (4.40)	20 (8.00)	
Married	171 (68.40)	189 (75.60)	
Separated/Divorce	42 (16.80)	23 (8.80)	
Widowed	26 (10.40)	18 (7.20)	
Educational Level			0.042*
No Formal Education	29 (11.60)	18 (7.20)	
Primary Education	94 (37.60)	32 (12.80)	
Secondary Education	116 (46.40)	62 (24.80)	
Tertiary Education	11 (4.40)	138 (55.20)	

* = significant difference

Table 2: Working Environment and Conditions of Car Spray Painters

Variable	Frequency (n = 250)	Percentage (%)
Do you use any form of personal protective equipment (PPE) while working?		
Yes	228	91.20
No	22	8.80
***If yes, what type do you usually use (Select all that applies to you) (n = 429*)**		
Respirator/Mask	81	18.89
Gloves	73	17.02
Safety goggles	149	34.73
Overall	110	25.64
Others	16	3.73
How often do you use your PPE?		
Always	139	55.60
Often	56	22.40
Sometimes	19	7.60
Rarely	14	5.60
Never	22	8.80
Do you work in an open or enclosed space?		
Open	153	61.20
Enclosed	97	38.80
Are there ventilation facilities at your workspace?		
Yes	237	94.80
No	13	5.20
What type of ventilation does your workspace have?		
Natural Ventilation only	138	55.20
Mechanical Ventilation only	84	33.60
Both	15	6.00
None	13	5.20
Are you exposed to other chemicals or dusts at your workplace apart from paint?		
Yes	74	29.60
No	63	25.20
Unsure	113	45.20
How long have you been a car spray painter		
Less than one year	19	7.60
1 – 5 years	59	23.60
6 – 10 years	95	38.00
More than 10 years	77	30.80
How many hours per day, on average, do you work in a paint spraying environment?		
Less than 4 hours	8	3.20
4 – 5 hours	17	6.80
6 – 7 hours	68	27.20
8 – 9 hours	126	50.40
More than 9 hours	31	12.40

* = multiple response

Table 3: Health and Lifestyle of Car Spray Painters and Control Subjects

Variable	Car Spray Painters n = 250 (%)	Control Subjects n = 250 (%)	p-value
Do you smoke?			0.008*
Yes	138 (55.20)	63 (25.20)	
No	112 (44.80)	187 (74.80)	
Do you consume alcohol?			0.026*
Yes	169 (67.60)	78 (31.20)	
No	81 (32.40)	172 (68.80)	
Have you ever been exposed to other environments or substances that can potentially harm your lungs (like mining, cement factory, etc)?			2.751
Yes	34 (13.60)	31 (12.40)	
No	216 (86.40)	219 (87.60)	
Have you ever experienced shortness of breath after working?			0.000*
Yes	104 (41.60)	3 (1.20)	
No	149 (59.60)	247 (98.80)	
Have you ever experienced chest tightness after working?			0.000*
Yes	132 (52.80)	2 (0.80)	
No	118 (47.20)	248 (99.20)	
Have you ever experienced chronic cough after working?			0.000*
Yes	193 (77.20)	42 (16.80)	
No	57 (22.80)	208 (83.20)	
Have you ever experienced wheezing or whistling in your chest after working?			0.000*
Yes	166 (66.40)	5 (2.00)	
No	84 (33.60)	245 (98.00)	
Have you ever experienced frequent respiratory infections after working?			0.000*
Yes	147 (58.80)	7 (2.80)	
No	103 (41.20)	243 (97.20)	
Have you ever experienced production of sputum or phleg after working?			0.000*
Yes	182 (72.80)	29 (11.60)	
No	68 (27.20)	221 (88.40)	
If yes to any of the above, do these symptoms improve when you are away from work?			0.000*
Yes	179 (71.60)	6 (2.40)	
No	22 (8.80)	3 (1.20)	
Not Applicable	49 (19.60)	241 (96.40)	
Have you ever had to take time off work due to these symptoms?			0.000*
Yes	160 (64.80)	3 (1.20)	
No	43 (17.20)	9 (3.60)	
Not Applicable	47 (18.80)	238 (95.20)	
Have you ever visited a doctor because of these symptoms?			0.000*
Yes	172 (68.80)	2 (0.08)	
No	30 (12.00)	10 (4.00)	
Not Applicable	48 (19.20)	238 (95.20)	
Have you noticed a decrease in your physical activity due to respiratory problems?			0.000*
Yes	183 (73.20)	8 (3.20)	
No	67 (26.80)	242 (96.80)	

Do you regularly exercise?			0.009
Yes	148 (59.20)	183 (73.20)	
No	102 (40.80)	67 (26.80)	
How would you rate your overall health?			0.011
Poor	00 (0.00)	00 (0.00)	
Fair	48 (19.20)	00 (0.00)	
Good	93 (37.20)	105 (42.00)	
Very Good	88 (35.20)	89 (35.60)	
Excellent	21 (8.40)	56 (22.40)	

* = significant difference

Table 4: Lung Function Assessment

Variable	Car Spray Painters n = 250 (%)	Control Subjects n = 250 (%)	p-value
Have you ever had a spirometry test done?			0.000*
Yes	151 (60.40)	12 (4.80)	
No	99 (39.60)	238 (95.20)	
FVC (L)	3.51±0.29	3.84±0.36	0.014*
FEV1 (L)	2.88±0.18	3.49±0.24	0.003*
FEV1:FVC ratio	0.82±0.02	0.91±0.04	0.034*
PEFR (L/min)	341.62±14.62	482.14±12.93	0.001*
DLCO (mL/min/mmHg)	41.89±3.78	27.32±2.83	0.000*

* = significant difference

Legend: FVC = Forced vital capacity, FEV1 = Forced expiratory volume in 1 second PEFR = Peak Expiratory Flow Rate, DLCO = Diffusing Capacity for Carbon Monoxide

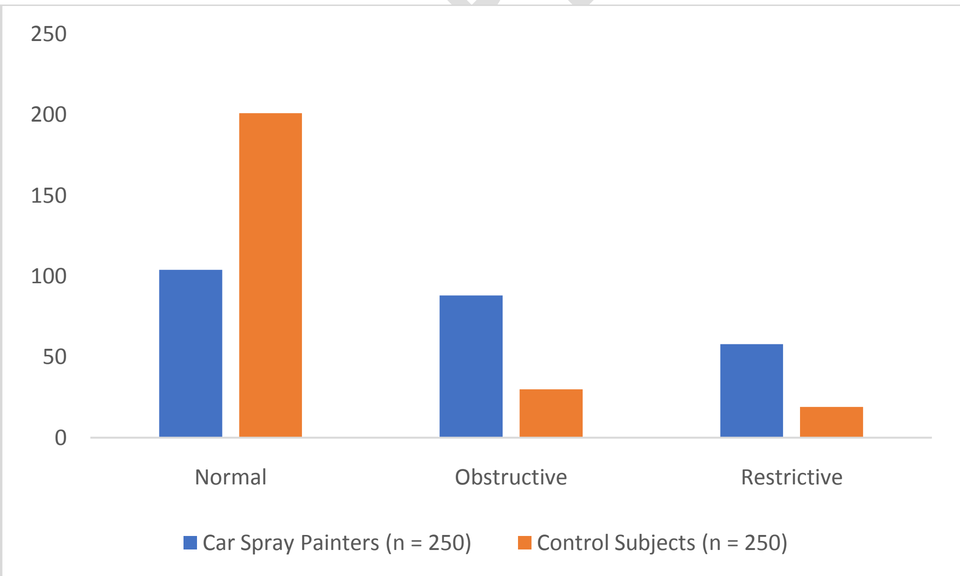

Figure 1: Pattern of Lung Function in the Car Spray Painters and Controls

4. DISCUSSION

In this study, no significant difference was observed in the age and marital status distribution between car spray painters and control subjects, suggesting that the sample is representative of the general population. The age distribution of car spray painters showed that most of the respondents (37.6%) were in the age group of 41-50 years, closely followed by the 31-40 years group (33.2%). For the control group, most of the subjects were in the 31-40 years (36.4%) and 41-50 years (32.4%) age groups as well. This is supported by previous studies which indicate that factors such as age, socio-economic status, and education levels can impact health outcomes [12,13].

Exposure to various chemicals used in car spray painting can be harmful to the respiratory system. This is a well-known fact, as various studies conducted worldwide have demonstrated a significant relationship between the occupational exposure of car spray painters to harmful chemicals and the occurrence of respiratory symptoms [14]. The city of Ibadan in Nigeria, being an industrial hub, is no exception, and it is therefore crucial to evaluate the respiratory symptoms and lung function of car spray painters in this region.

When it comes to marital status, a majority of car spray painters (68.4%) and control subjects (75.6%) were married. A small proportion of both groups were single (4.4% of car spray painters and 8% of control subjects), while others were either separated, divorced, or widowed. As the p-value for age and marital status is greater than 0.05, there is no statistically significant difference between the car spray painters and the control group in these two categories. This implies that any differences in respiratory symptoms or ventilatory function between the two groups cannot be attributed to differences in age or marital status.

The most significant difference between the two groups was found in the educational level. A large proportion of the car spray painters had either no formal education (11.6%) or only had primary (37.6%) or secondary education (46.4%). This contrasted starkly with the control group, where a significant percentage (55.2%) had received tertiary education. This result is statistically significant ($p = 0.042$) and could have implications for health literacy and adherence to occupational safety measures among car spray painters. This differential in education level could potentially affect the interpretation of the results, as numerous studies have shown that individuals with lower levels of education often have worse health outcomes [15,16]. It could also impact the understanding and application of safety measures, increasing the risk of exposure to harmful chemicals used in car spray painting.

Considering the complexity and potential risks of the car spray painting profession, it is surprising that such a high proportion of workers have limited education. This finding aligns with previous research, which has shown that low levels of education can be associated with increased occupational risks due to lower awareness about occupational hazards and less adherence to safety guidelines [17].

The result suggests the need for focused educational interventions and trainings on safety precautions among car spray painters. This could include teaching them about the potential hazards of the chemicals they work with, and the importance of personal protective equipment (PPE) to mitigate the risks [18].

Moreover, these findings may indicate that car spray painters could potentially be more prone to respiratory symptoms due to their exposure to harmful chemicals, their lower educational levels, and potential lack of awareness about safety precautions [19].

This research also investigates the working environment, conditions, and potential respiratory health risks among car spray painters in Ibadan, Nigeria. The study is important due to the potentially harmful occupational exposures car spray painters face, including various chemicals, solvents, and particulate matter that can lead to adverse respiratory health effects [20]. It has been well established that exposure to the chemical contaminants commonly found in paints, such as toluene, xylene, and formaldehyde, can lead to significant respiratory complications [21]. This risk is even more pronounced for car spray painters who may have prolonged exposure due to the nature of their work [22].

The surveyed population included 250 car spray painters. A majority of the participants (91.2%) reported using personal protective equipment (PPE) while working. This is a significant figure given the potential exposure to hazardous substances. Among those using PPE, the most common types were safety goggles (34.73%), overalls (25.64%), respirators or masks (18.89%), and gloves (17.02%). A small proportion of respondents (3.73%) reported using other forms of PPE. The limited use of respirators/masks, despite their critical role in protecting workers from airborne chemicals, may be due to factors such as cost, discomfort, or lack of knowledge about their importance [23]. These results align with the World Health Organization's (WHO) recommendations that car spray painters should wear protective clothing, safety glasses, gloves, and particulate respirators to reduce the risk of health problems [24].

However, the study reveals that there is still room for improvement in terms of PPE usage consistency. Only 55.6% of the participants reported always using PPE, with 22.4% using it often, and 7.6% sometimes. A total of 5.6% rarely use PPE and 8.8% never use PPE at all. These figures highlight a significant risk of exposure to respiratory hazards for those who do not consistently use PPE. This infrequent use of PPE undermines its protective benefits, as inconsistent use may still expose workers to significant amounts of hazardous chemicals [25]. Various studies have demonstrated that inconsistent use of PPE contributes to higher incidences of occupational respiratory diseases [26].

The study also examined the work environment of the car spray painters. Most of them (61.2%) worked in an open space, while 38.8% worked in enclosed spaces. Enclosed spaces may increase the risk of concentrated exposure to harmful substances, underscoring the importance of adequate ventilation [27,28].

Fortunately, a large majority (94.8%) of the respondents indicated that their workspace had some form of ventilation. More specifically, 55.2% of the workspaces had natural ventilation only, 33.6% had mechanical ventilation only, and 6% had both. A small proportion (5.2%) of the respondents reported having no ventilation in their workspace. Ventilation is an essential feature in the mitigation of airborne contaminants and can significantly reduce the risk of respiratory diseases [29]. Relying only on natural ventilation can be less effective than mechanical ventilation at removing airborne contaminants [30].

The study also inquired about exposure to other chemicals or dusts apart from paint. This question is important since exposure to multiple hazards can have a cumulative or synergistic impact on health [31]. The results showed that 29.6% of the workers were exposed to other chemicals or dusts apart from paint, while 25.2% were not. However, a significant portion (45.2%) was unsure, which indicates a potential knowledge gap regarding occupational hazards among car spray painters.

The duration of exposure is also a critical factor in the likelihood of developing occupational diseases. The largest group (38%) of the respondents had been working as car spray painters for 6-10 years, followed by those with more than ten years (30.8%), 1-5 years (23.6%), and less than one year (7.6%).

The average daily and total work duration can affect cumulative exposure to harmful chemicals. The majority (50.40%) reported working between 8-9 hours daily in a paint spraying environment. This duration can be a significant factor in respiratory health risks, given that longer exposure times increase the probability of inhaling more chemicals [32].

In this study, it was found that a significant proportion of car spray painters reported smoking (55.20%) and consuming alcohol (67.60%), compared to control subjects (25.20% and 31.20% respectively), with p-values of 0.008 and 0.026. The statistical significance suggests these differences cannot be attributed to chance alone, but the results do not provide insight into whether these lifestyle factors are a cause or effect of their profession. However, previous studies suggest that workplace stress can increase the propensity for substance use [33].

The study also investigated the participants' exposure to other environments or substances that could potentially harm their lungs, but the findings were not statistically significant (p-value 2.751). This indicates that both groups had similar levels of exposure to other harmful environments or substances outside their primary occupations.

Significantly, the survey reveals a stark contrast in respiratory health between the two groups. Car spray painters reported significantly higher rates of shortness of breath, chest tightness, chronic cough, wheezing, frequent respiratory infections, and production of sputum or phlegm after working. These differences were all statistically significant ($p<0.001$), underlining the high prevalence of respiratory symptoms in this group.

Further underlining the severity of these symptoms, 71.6% of car spray painters reported that their symptoms improved when away from work, compared to only 2.4% of control subjects. Additionally, 64.8% reported taking time off work due to these symptoms, compared to just 1.2% of controls. This suggests that the work environment itself is a major factor in inducing or exacerbating these symptoms.

It was also found that 68.8% of car spray painters had sought medical attention due to their symptoms, compared to just 0.08% in the control group. This discrepancy not only highlights the health impact of the spray painters' occupation but also underscores their need for medical care.

One important finding was the decline in physical activity due to respiratory problems. A significant 73.2% of car spray painters reported this decrease compared to a mere 3.2% in the control group. This could potentially contribute to a lower overall quality of life, given the critical role of physical activity in maintaining health [34].

Regarding regular exercise, more control subjects reported regular exercise than car spray painters (73.2% vs. 59.2%). This finding may be influenced by the spray painters reduced physical activity due to respiratory problems.

Lastly, regarding self-rated overall health, no participants from either group reported poor health. Still, car spray painters reported higher rates of fair health and lower rates of excellent health compared to the control group. This demonstrates the perceived health impact on car spray painters, potentially due to their occupational exposure.

The present study presents a deep dive into the correlation between respiratory symptoms and ventilatory function of car spray painters. The field of car spray painting is associated with exposure to various harmful substances, often leading to serious health implications, particularly related to respiratory health [35].

The results demonstrate some stark differences between car spray painters and the control group. A significantly higher number of spray painters (60.40%) reported having undergone a spirometry test as compared to only 4.8% of the control subjects. This can possibly be linked to the greater occupational health risks car spray painters are exposed to, necessitating periodic health checks [36].

We evaluated several parameters, namely, Forced vital capacity (FVC), Forced expiratory volume in 1 second (FEV1), FEV1:FVC ratio, Peak Expiratory Flow Rate (PEFR), and Diffusing Capacity for Carbon Monoxide (DLCO). Spirometry is a common pulmonary function test that measures the amount (volume) and the speed (flow) of air that can be inhaled and exhaled [37]. The results highlight significant differences between the two groups in all parameters evaluated.

FVC is the total amount of air exhaled during a forced breath. A significantly lower FVC (3.51±0.29 L) was observed in car spray painters compared to the control group (3.84±0.36 L). This suggests a restrictive lung disease pattern, which is often associated with prolonged exposure to harmful substances, such as the particulates present in the spray paint. This result corroborates previous studies that highlighted such a decline in individuals exposed to similar occupational hazards [38].

FEV1, the volume exhaled in the first second of a forced breath, was also lower in car spray painters (2.88±0.18 L) than in control subjects (3.49±0.24 L). Reduced FEV1 is a common characteristic of obstructive lung disease, indicating potential lung damage in these workers [39]. These measures are crucial in assessing pulmonary disorders such as chronic obstructive pulmonary disease (COPD) and asthma [39].

Similarly, the FEV1:FVC ratio was lower in the car spray painters, suggesting an obstructive pattern of lung disease, which is common in occupations with high exposure to airborne pollutants [40]. This indicates a probable restriction or obstruction in their airways, common in conditions like Chronic Obstructive Pulmonary Disease (COPD) and asthma [40].

PEFR, a measure of how fast an individual can exhale, was considerably lower in car spray painters (341.62±14.62 L/min) than in the control group (482.14±12.93 L/min), indicating a diminished ability to expel air from the lungs swiftly, further confirming the likelihood of an obstructive respiratory disease. This can be linked to respiratory muscle weakness, airway obstruction, or other lung diseases [41].

Finally, DLCO, which measures the lung's efficiency in transferring gas from inhaled air to the red blood cells, was significantly higher in car spray painters (41.89±3.78 mL/min/mmHg) than in control subjects (27.32±2.83 mL/min/mmHg). While DLCO is typically reduced in lung disease, an elevated DLCO might be suggestive of an increased blood volume or polycythemia, often a compensatory response to chronic hypoxia [43]. DLCO is a measure of how well gases are exchanged between the lungs and the bloodstream. A higher DLCO can suggest a compensatory mechanism to chronic exposure to pollutants or may suggest early alveolar damage with increased membrane permeability [44].

Based on the data presented in figure 1, it is apparent that there are significant differences between the ventilatory functions of the car spray painters and the control subjects. Notably, 41.60% of the car spray painters exhibited normal ventilatory function compared to 80.40% in the control group, highlighting a statistically significant reduction in normal ventilatory function among car spray painters ($p<0.01$). These findings are consistent with other studies that suggest occupational exposure to chemical pollutants, including spray paints, can lead to impaired lung function [45,46].

The observed rate of obstructive ventilatory dysfunction in car spray painters was 35.20%, a strikingly higher proportion compared to the 12.00% prevalence in the control group. This suggests a relationship between car spray painting and obstructive lung disease, which includes conditions like chronic obstructive pulmonary disease (COPD) and asthma. Studies have shown that individuals exposed to organic solvents and aerosols from spray paints are at a higher risk of developing COPD and asthma, with lung function progressively declining with prolonged exposure [47,48].

The research also revealed a higher prevalence of restrictive ventilatory dysfunction in the car spray painters (23.20%) compared to the control group (7.60%). Restrictive lung disease is characterized by a reduction in lung volume, often due to an external force that's compressing the lungs or because of lung stiffness, thus making it difficult for the lungs to expand fully (Pellegrino et al., 2015). Prolonged exposure to aerosols and particles in car spray paints may lead to a build-up in the lungs and cause inflammation and fibrosis, leading to restrictive lung disease (Rom, 2018).

These findings raise concerns about the occupational safety and health conditions for car spray painters in Ibadan, Nigeria. While further studies are required to determine the exact causal relationship, the implications from this research are that protective measures, such as effective ventilation and use of appropriate respiratory protective equipment, should be considered essential for this population to prevent long-term damage to their respiratory health (Vieira et al., 2018).

CONCLUSION

This study highlights a potential occupational hazard among car spray painters, who show a higher prevalence of lung-related symptoms and decreased lung function parameters compared to control subjects. The frequent use of PPE and awareness of workplace risks were also found lacking among some of the car spray painters. The results stress the need for stricter adherence to safety measures, including consistent use of PPE and regular health check-ups, especially spirometry tests, to monitor lung health. It is also important to conduct further education and awareness sessions regarding potential occupational hazards and their impact on health, given the higher prevalence of tertiary education among the control subjects, which might correlate with better health behaviours and outcomes.

Recommendations

Based on the findings of this study, the following recommendations are offered:

1. **Longitudinal Study Design:** The study was a cross-sectional study, making it difficult to ascertain the cause-and-effect relationship. It would be beneficial to perform a longitudinal study to examine the progression of respiratory symptoms and lung function over time in car spray painters.
2. **Controls Adjustment**: To improve the comparison between car spray painters and control subjects, the control group should ideally have similar demographics and lifestyle habits (smoking, alcohol consumption, exercise, etc.). This would help to isolate the effects of paint fumes on respiratory health.
3. **Detailed Exposure Assessment**: While this study has a good start, additional information about the types of paints and chemicals used, frequency of specific tasks, and duration of exposure could be valuable in understanding risk. In addition, it would be helpful to know more about the 8.8% of respondents who do not use any PPE and the reasons behind this.
4. **Intervention Study**: Future research could investigate the effectiveness of interventions, such as improved ventilation systems or enhanced personal protective equipment. Given the high percentage of workers experiencing symptoms, interventions are urgently needed.
5. **Other Health Outcomes**: While the study focused on respiratory symptoms and lung function, it would be interesting to examine other potential health outcomes related to exposure to car paint, such as neurological symptoms, skin problems, or cancers.
6. **Education and Training**: Given the significant percentage of car spray painters who experienced symptoms and the lower educational level in this group compared to

controls, more emphasis should be placed on educational interventions about the risks associated with their job and the importance of using PPE consistently and properly.

7. **Routine Health Check-ups**: Consideration should be given to developing routine health surveillance for this occupational group, given the significant respiratory health issues identified in the study.
8. **Policy Recommendations**: The findings of this study and future studies could be used to influence public health policies, such as stricter regulations for safety measures in the car spray painting industry, including requirements for appropriate

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