

Research Article

Similar Lung Function Impairment in Auto Mechanics Operating in Stand-alone Auto Repair and Auto Repair Shops Shared with Spray Painters

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Summary: Automotive mechanics are reported to have lower lung function indices. Spray painting is associated with impairment of lung function among spray painters. It is a common practice by auto repairers in Calabar to operate in the vicinity of spray-painting shops. Whether such dual exposure to auto repair and spray-painting environments worsens the lung function of auto mechanics is not documented. Lung function was evaluated in 300 males divided into three groups: control (group 1), auto mechanics in stand-alone auto repair shops (group 2) and auto mechanics working in the vicinity of spray-painting shops (group 3). Each group consisted of 100 subjects. Forced vital capacity (FVC), forced expiratory volume in the first second (FEV₁), peak expiratory flow rate (PEFR) and forced expiratory volume in the first second expressed as percentage of FVC (FEV₁%) were assessed using a Vitalograph spirometer. Percentage oxygen saturation was evaluated using a pulse oximeter. Results showed no significant differences in age, weight and height among various groups. FVC was significantly reduced in groups 2 and 3 ($p < 0.05$ and $p < 0.001$ respectively) compared to control but not between groups 2 and 3. FEV₁ was significantly reduced in groups 2 and 3 ($P < 0.001$ each) compared with control but not significantly different between groups 2 and 3. FEV₁% was significantly lower in groups 2 and 3 ($p < 0.001$ each) compared with control but not between groups 2 and 3. The PEFR was significantly reduced in groups 2 and 3 ($p < 0.001$ each) compared with control but not significantly different between groups 2 and 3. Percentage oxygen saturation was significantly reduced in groups 2 and 3 ($p < 0.05$ and $p < 0.001$ respectively) and also significantly lower in group 2 compared with group 1 ($p < 0.01$). In conclusion, auto mechanics in auto repair only and stand-alone auto repair shops shared with spray painters have lower lung function compared with control but no significant difference in lung function between auto mechanics in stand-alone auto repair shops compared with those in auto repair shops shared with spray-painters.

Keywords: Auto mechanics, lung function, spray painting, paints, exhaust fumes, petrol

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INTRODUCTION

Spirometric evaluation of pulmonary function represents a simple non-invasive method of determining the pulmonary health of an individual and by extension other related systems. There is a strong relationship between pulmonary function and other systems like cardiovascular system, nervous system, urogenital system etc. Reduction in lung function parameters especially obstructive patterns of such pulmonary dysfunction have been associated with increased incidence of atrial fibrillation and other cardiovascular diseases (Fell *et al*, 2014). Chronic obstructive airway diseases arising from occupational exposures have also been linked with increased morbidity and mortality especially in the presence of predisposing factors such as smoking, obesity and infection (Toren *et al* 2007).

Auto mechanics are involved in the repair and maintenance of motor vehicles. These mechanics use

garages or open spaces as workshops. By virtue of their occupation, auto mechanics are exposed to organic, inorganic and particulate materials from exhaust fumes, and petrochemical products used in the industry all of which could have negative effects on lung function and quality of life of the individual (Toren *et al* 2007). The quantity of exhaust fumes emitted is dependent on the degree of combustion of the fuel used by the vehicle (Burr and Gregory, 2011). Exhaust fumes are products of fuel combustion in the engines and contain pollutants such as hydrocarbons, nitrogen and nitrogen oxides, carbon monoxide, sulphur oxide, particulate matter and other toxic pollutants (Omidvarbana, 2014). Carbon monoxide (CO) a colorless and odorless gas produced from incomplete combustion of fuels (Ayres and Roberts, 2009), inhalation of which may cause respiratory and non-respiratory symptoms. Carbon monoxide reacts with hemoglobin to form carboxyhemoglobin which impairs normal transport of oxygen and may cause

chronic hypoxia, increased risk of atherosclerosis, neurological diseases, cardiovascular diseases and increased morbidity (Schwela, 2000; Guzman, 2012; Bleecker, 2015).

Sulphur dioxide arises from combustion of sulphur-containing fossil fuel (Bascon, 2008). It is a respiratory tract irritant which may result in the development of cough, wheezing and bronchial asthma (Australian Department of Environment and Energy, 2016). Particulate matter especially Pm10 and Pm2.5 contain reactive oxygen species (ROS) which can penetrate and damage the lungs or the pulmonary tree and may result in lung cancer, asthma and other forms of chronic obstructive airway diseases (Lewtas, 2007, Toren *et al* 2007, Luxham and Nieuwenhuijsen, 2019). Auto mechanics are also exposed to petrol and other petroleum-based byproducts while applying these agents directly on engines or using them to wash engine parts. A recent report revealed that inhalation of petrol is associated with impaired lung function (Meghta *et al*, 2017).

Spray paints are liquid substances made up of solvents, like styrene isocyanates, xylene and alcohol combined with inhibitors and pigments such as acrylates and methylacrylates as well as metal additives (Kopeliovich, 2020). These substances are known to have adverse effect on the respiratory system including, occupational asthma, bronchitis, painters lungs and respiratory depression (Fox, 1984, Pronk *et al* 2007, Kandyala *et al* 2010). Exposure to isocyanates for instance, or paint byproducts remain the commonest cause of occupational asthma (Meredith and McDonald 1994; Bascon, 2008).

Previous reports on lung function evaluation in auto mechanics have demonstrated that the occupation is associated with lower lung function indices with clinical correlates and determinants (Chattopayay, 2007; Krishna and George, 2017; Akintunde *et al*, 2018). Similarly spray painting or exposure to paint products has also been identified as a cause of impaired lung function among spray painters (Randolph *et al* 1997; Pronk, 2007; Aribo and Antai, 2014).

From the fore-going, it could be inferred that auto mechanics and auto body spray painters are prone to developing impairment of lung function from exposure to chemicals in their work environments. There is a possibility that an auto mechanic working in the same vicinity as a spray painter may have more serious effects from exposure to pollutants in the two work environments associated with impairment of lung function. It is a common observation to find auto mechanics operating in the vicinity of or sharing shops with spray painters. The possible synergistic or additive adverse effects of this dual exposure on the lung function of auto mechanics operating in

workshops which double as spray painting shops has not been explored and hence this study.

MATERIALS AND METHODS

This was a cross-sectional study carried out among auto mechanics in Calabar metropolis a coastal city which doubles as the capital of Cross River State, Nigeria. It was conducted in September, 2018.

A total of three hundred male participants aged between 18-45 years. Mean ages of groups 1, 2 and 3 were 29.00 ± 0.24 , 29.66 ± 0.29 and 29.31 ± 0.45 respectively. They were randomly selected and divided into three groups (groups 1, 2 and 3) of 100 subjects per group. Group 1 was the control and made up of students, business men and civil servants not involved in auto repair, spray painting or similar activities. Group 2 was made up of auto mechanics working in stand-alone auto repair shops while auto mechanics sharing shops with or operating in the vicinity of spray-painting shops constituted group 3. All subjects were resident in Calabar.

Anthropometric parameters (weight and height) were measured. Data about their ages, length of time spent at work, social habits and medical history were taken using interview technique. Subjects with cardiopulmonary symptoms, including bronchial asthma, pulmonary tuberculosis and thoracic deformities were excluded. Also excluded were subjects living in areas heavily polluted with dust or smoke of any nature. Informed consent was obtained from every participant involved in the study.

Assessment of lung function: Lung function indices were evaluated using a Vitalograph spirometer (Alpha Touch Vitalograph, Ireland) with build-in computer program in standard laboratory methods. The spirometer recorded several parameters of lung function. The procedure or spirometric manoeuvres were explained and demonstrated to the subjects. To carry out the procedure, each subject in standing position, was asked to breath in deeply to his full capacity, With his nose clipped, the participant was asked to put the mouth piece into his mouth in such a way as to allow the lips sealed over it and then expel the air from his lungs very fast, forcefully, sustained and completely. Three measurements were recorded for each subject. A participant's best of 3 values was selected as the participant's lung function parameter. The mouth pieces were disinfected with antiseptic solution before another participant was taken through the process. A print-out from the machine was produced which stated among other parameters, forced expiratory volume in the first second (FEV₁), forced vital capacity (FVC), forced expiratory volume in the first second expressed as a percentage of forced vital

capacity (FEV₁%) and peak expiratory flow rate (PEFR) for each subject.

Determination of Percentage Oxygen Saturation:

This was done with the aid of a pulse oximeter (Medilab, India) which was clipped on the ring finger of the right hand of each subject. Pulse oximetry measures oxygen saturation in arterial blood using the differential light absorption at different wave lengths by oxyhaemoglobin (infrared/940nm) and deoxyhaemoglobin (red light/660nm) and the fact that absorbance of light fluctuates with cardiac cycle/arterial pulsation. The relative amount of light that is absorbed at both wave lengths is used to ultimately determine the proportion of haemoglobin bound to oxygen by the oximeter (Chan *et al*, 2013).

Evaluation of Ambient Air Quality at Experimental Sites:

This was carried out with the aid of CROWCOM Gasman portable gas monitor. Using this mobile air quality monitoring device, three sites each were randomly selected for control, stand-alone auto repair and auto repair shops located in the vicinity of spray-painting shop sites and analyzed. The control sites were University of Calabar, Marian market and Etim Edem motor park all in Calabar. The air quality assessment was carried out with regards to five criteria of air pollution namely Pm10, Pm2.5, SO₂, NO₂ and radiation. Particulate matter sizes (Pm10, Pm2.5) were determined with a HAZ-DUST particulate monitor (California Analytical Instruments, USA).

Ethical Approval: Ethical approval was obtained from the Cross-River State Health Research Ethics Committee, (CRSMOH/RP/REC/2018/612).

Statistical Analysis: Results were presented as mean \pm standard error of the mean (SEM) and analyzed by one-way Analysis of Variance (ANOVA) followed with a post hoc test of least significant difference to assess among groups differences. A P-value of <0.05 was considered to be statistically significant.

RESULTS

Previous studies show that TPO diet has deleterious effects on several body functions with one of such studies associating the diet with male reproductive dysfunction and systemic expression of oxidative stress markers (Aribio *et al*, 2018). The results obtained from our present study are presented in figures and tables as shown below.

Anthropometric parameters: The results did not show any significant differences in the mean ages (yrs.), weights (kg) and heights (m) of the subjects in the different experimental groups as shown in Table 1.

Forced vital capacity (L) in different experimental groups:

Forced vital capacity (FVC) of auto mechanics in stand-alone auto repair shops (3.33 ± 0.07) and those in auto repair + spray painting shops (3.33 ± 0.07) were significantly lower ($p < 0.05$ and $P < 0.001$ respectively) compared to control (3.75 ± 0.09). There was no significant difference in the FVC of the two groups of auto mechanics. This is shown in fig 1.

Table 1

Age and anthropometric parameters in various groups of subjects

Parameter	Control	Stand-alone shops	Auto repair+Spray painting
Age (years)	29.00 ± 0.24	29.66 \pm 0.29	29.31 ± 0.45
Weight (kg)	66.01 ± 0.85	67.93 \pm 0.44	67.52 ± 0.95
Height (m)	1.69 ± 0.01	1.69 \pm 0.01	1.68 ± 0.01
Chest circumference (cm)	88.21 ± 0.62	89.77 \pm 0.75	88.25 ± 0.63

No significant difference among groups

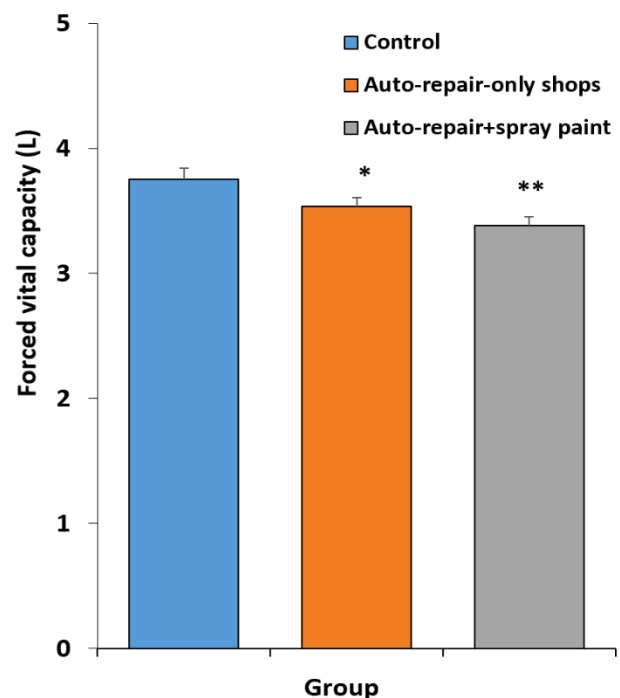


Figure 1:

Forced vital capacity in the different experimental groups.

Values are mean \pm SEM, $n = 100$.

* $p < 0.05$, *** $p < 0.001$ vs control

Forced expiratory volume in the first second (L) in the different experimental groups:

Forced expiratory volume in the first second (FEV₁) was significantly lower in both mechanics in stand-alone

auto repair (1.33 ± 0.03) and mechanics in auto repair + spray painting (1.39 ± 0.06) shops; $P < 0.001$ and $P < 0.001$ respectively compared with control group (1.90 ± 0.05). There were however no significant differences in this index between the two groups of auto mechanics. This is shown in Fig. 2.

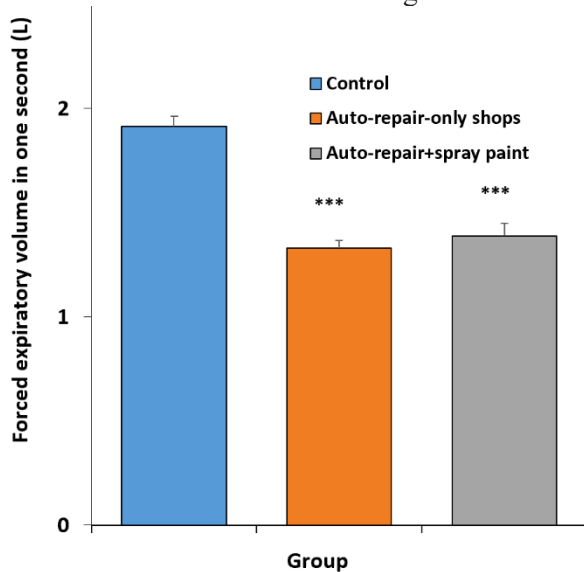


Figure 2
Forced expiratory volume in one second in the different experimental groups. Values are mean ± SEM, n = 100; ***p<0.001 vs control

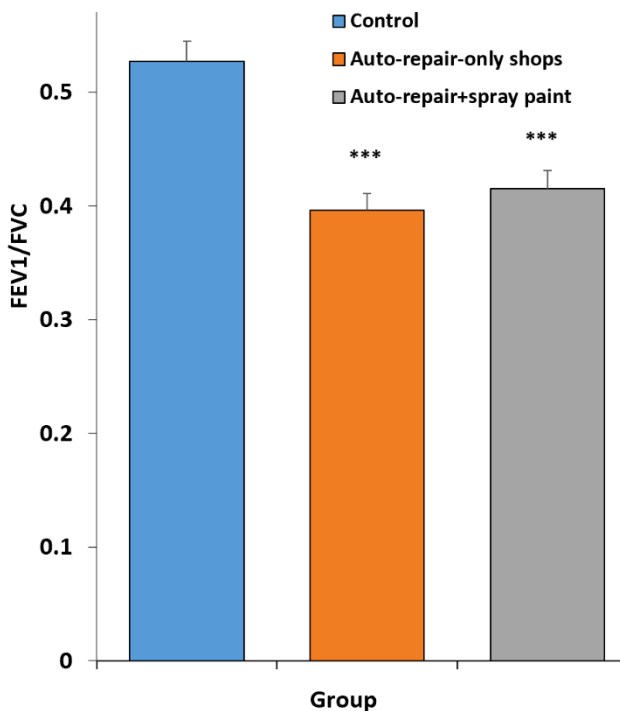


Figure 3
FEV₁/FVC in the different experimental groups. Values are mean ± SEM, n = 100.; ***p<0.001 vs control

FEV₁/FVC (%) in different experimental groups: The FEV₁% of control, mechanics in stand-alone auto repair and mechanics in auto repair + spray painting shops were 0.53 ± 0.02 , 0.30 ± 0.01 and 0.42 ± 0.02

respectively. FEV₁% were significantly lower among mechanics in stand-alone auto repair shops ($P < 0.001$) and those in auto repair shared with spray painting shops ($P < 0.001$) compared with control. No significant difference in FEV₁% between the two groups of auto-mechanics was observed as shown in Fig.3.

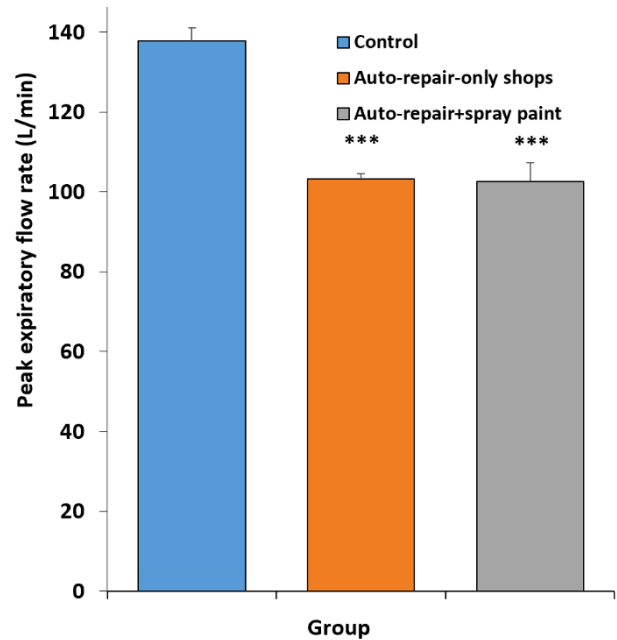


Figure 4
Peak expiratory flow rate in the different experimental groups. Values are mean ± SEM, n = 100. ***p<0.001 vs control

Peak expiratory flow rate (L/Min) in different experimental groups: Peak expiratory flow rate (PEFR) of both mechanics in stand-alone auto repair (103.3 ± 1.28) and auto repair + spray painting (102.56 ± 4.71) shops were significantly decreased ($P < 0.001$ and $P < 0.001$ respectively) compared with control (137.74 ± 3.39). PEFR were similar in groups 2 and 3 as seen in fig. 4.

Percentage oxygen saturation: Percentage oxygen saturation of both mechanics in stand-alone auto repair (93.1 ± 0.41) and auto repair + spray painting (94.4 ± 0.25) shops were significantly decreased ($P < 0.001$ and $P < 0.05$ respectively) when compared with control (95.39 ± 0.29). It was also significantly reduced among auto mechanics in stand-alone auto repair compared with those in auto repair + spray painting shops ($P < 0.01$). This is demonstrated in Fig. 5.

Relationship between length of time in occupation and lung function parameters in both groups of auto mechanics: There was no significant difference between lung function indices and length of time in occupation as shown in Tables 2 and 3.

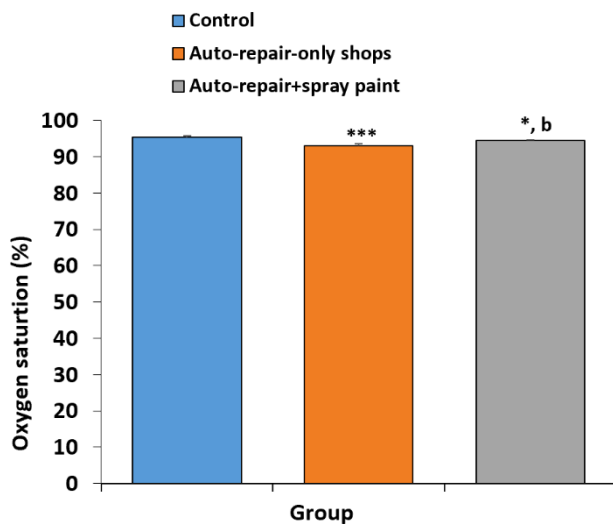


Figure 5:

Oxygen saturation in the different experimental groups. Values are mean \pm SEM, n = 100.

* $p < 0.05$, *** $p < 0.001$ vs control; b = $p < 0.01$ vs Auto repair-only

Table 2:

Relationship between length of time in occupation and lung function in mechanics in stand-alone shops

Parameter	r	r ²	P < value
FVC (L)	-0.084	0.0071	0.406 $p > 0.05$
FEV ₁ (L)	-0.180	0.0324	0.074 $p > 0.05$
FEV ₁ /FVC (%)	0.184	0.0339	0.067 $p > 0.05$
PEFR (L/min)	-0.096	0.0093	0.341 $p > 0.05$
O ₂ saturation	-0.062	0.0038	0.341 $p > 0.05$
Pulse rate (Beat/Minute)	-0.115	0.0132	0.256 $p > 0.05$

r = correlation coefficient

$p > 0.05$ = Non-significant negative correlation

$p > 0.05$ = Non-significant positive correlation

Table 3:

Relationship between length of time in occupation and lung function in mechanics in auto repair + spray painting shops

Parameter	R	r ²	P < value
FVC (L)	-0.120	0.0144	0.234 $p > 0.05$
FEV ₁ (L)	-0.148	0.0220	0.141 $p > 0.05$
FEV ₁ /FVC (%)	-0.130	0.0161	0.196 $p > 0.05$
PEFR (L/min)	-0.116	0.0134	0.251 $p > 0.05$
Pulse rate (Beats/Minute)	-0.041	0.0017	0.686 $p > 0.05$

r = correlation coefficient

$p > 0.05$ = Non-significant negative correlation

Air quality assessment in experimental sites: Mean particulate matter, Pm₁₀ ($\mu\text{g}/\text{M}^3$) in control, (70.68 \pm 30.47) stand-alone auto repair (107.33 \pm 15.34) and auto repair + spray painting (107.67 \pm 13.72) sites did not show any significant difference between the sites (Table 3). Particulate matter, Pm_{2.5} ($\mu\text{g}/\text{M}^3$) in control (69 \pm 29.54), auto repair- only (84.67 \pm 4.18) and auto

repair + spray painting (92.67 \pm 1.45) sites were not significantly different (Table 4).

Radiation (Count per minute) in experimental sites

There was no significant differences in radiation in the control (15.1 \pm 1.73), stand-alone auto repair (18.33 \pm 2.03) and auto repair + spray painting (18 \pm 2.08) (Table 4).

Sulphur dioxide (SO₂) in experimental sites

Concentration of SO₂ (m³) in stand-alone auto repair (0.047 \pm 0.003) and auto repair + spray painting (0.037 \pm 0.009) sites were significantly higher ($P < 0.001$ and $P < 0.001$ respectively) compared with control (negligible). It was however insignificantly different between the stand-alone auto repair compared with auto repair + spray painting sites as in table 4.

Nitrogen dioxide (NO₂) in different experimental sites

The concentrations of NO₂ (m³) in stand-alone auto repair (0.02 \pm 0.006) and auto repair + spray painting (0.02 \pm 0.006) sites were significantly higher ($P < 0.05$ and $P < 0.05$ respectively) compared with control site (0.00) but not significantly different between the two groups of auto repair shop sites as shown in Table 4.

Table 4:

Air quality assessment, radiation and concentrations of NO₂ and SO₂ in the different experimental sites

Parameter	Control	Stand-alone shops	Auto-repair+Spray painting
Particulate matter ($\mu\text{g}/\text{m}^3$)	Pm _{2.5} 69.00 \pm 28.54	84.67 \pm 4.18	92.67 \pm 1.45
	Pm ₁₀ 70.68 \pm 30.47	107.33 \pm 15.34	107.67 \pm 13.72
NO ₂ (m ³)	0.00 \pm 0.00	0.02 \pm 0.006*	0.02 \pm 0.006*
SO ₂ (m ³)	0.00 \pm 0.00	0.047 \pm 0.003***	0.037 \pm 0.009**
Radiation (cpm)	15.00 \pm 1.73	18.33 \pm 2.028	18.00 \pm 2.08

* $p < 0.0$, ** $p < 0.01$, *** $p < 0.001$ vs control

Cpm = count per minute)

DISCUSSION

The environment in auto repair workshops is known to be polluted with a cocktail of gases and particulate matter that can be detrimental to pulmonary health. Auto mechanics are therefore at risk of inhalational injuries (Mirabelli *et al* 2012) and tend to have lower lung function indices (Akintunde *et al* 2018). Spray painting releases toxic substances in aerosols which may also affect pulmonary function and not surprisingly, is associated with a reduction in lung function indices among spray painters. (Aribo *et al*

2018). The combined effects of pollutants in auto shops alone and spray auto shops on mechanics operating in the two shops were examined in this study.

The significantly reduced FVC, FEV₁, FEV₁% and PEFR in both groups of auto mechanics compared with control is in agreement with previous studies that indicate that auto mechanics generally have a lower FVC (Krishna and George, 2017; Akintunde *et al*, 2018) confirming previous findings. Gases and particulate matter present in auto shop environments are toxic ((Toren *et al* 2007; Omidvarbana, 2014) and could have pulmonary and non-pulmonary affectation (Ayres and Roberts, 2009). The impaired lung function indices in this group of workers could be attributed to the effects of inhaled exhaust fumes, particulate matter, gasoline and other petro-chemical products on the respiratory system, which are known to be injurious to the respiratory system (Mirabelli, *et al* 2012, Jewtas, 2007, Mehta *et al* 2017). SO₂ induces inflammatory response (Wigenstam *et al*, 2016) and decreased surfactant production (Wilkins and Fettesoff, 1981) in the lungs. NO₂ causes oxidative stress and associated reduction in surfactant production (Muller *et al*, 2001). Exposure to petroleum hydrocarbon is known to induce lipid peroxidation and impair antioxidant defense system in rats which could lead to alveolitis, interstitial inflammation and bronchial necrosis (Azeez *et al*, 2012).

In spirometry, three forms of lung function defects are recognized which are restrictive, obstructive and mixed patterns of pulmonary dysfunctions (Haynes and Kaminsky, 2015). In obstructive pulmonary dysfunctions FEV₁ and FEV₁% are reduced due to increased pulmonary resistance (Kumar and Clark, 2005; Ranu *et al*, 2011), but FVC and PEFR may be normal or reduced (Ranu *et al*, 2011; Guyton and Hall, 2011). In restrictive dysfunctions there is a low FVC but FEV₁% may be normal (Ranu *et al*, 2011; Ponce and Sharma, 2020). Mixed pattern of respiratory dysfunction is characterized by a normal or decreased FVC and a decrease in FEV₁ % (Boros *et al*, 2003; Guyton and Hall, 2011). The decreases in FVC, FEV₁, FEV₁% and PEFR in both groups of auto mechanics therefore means that the auto mechanics have a mixed pattern of ventilatory dysfunction. The observed insignificant differences in FVC, FEV₁, FEV₁% and PEFR between mechanics in stand-alone auto repair and auto repair + spray painting shops could be as a result of the design of the auto repair workshops in Calabar which are mainly open space/shops. This allows the gases and particulate matter to be dispersed easily from the work environment reducing their concentration and consequently the inhaled doses of spray paint aerosols and exhaust fumes. Dispersion reduces concentration of gases and particulate matter and as a consequently the dose of pollutants inhaled

(Cichowicz *et al*, 2017). Inhalation of exhaust fumes (which contain carbon monoxide) causes elevation of carboxyhaemoglobin (Topacoglu *et al*, 2014). Carbon monoxide reduces oxygen saturation since it binds preferentially with haemoglobin to form carboxyhaemoglobin (Blumenthal, 2001)

Our results did not show any significant differences in the concentrations of particulate matters Pm10 and Pm2.5 in the different groups of sites. Particulate matters are usually contents of exhaust fumes and aerosols from spray paints. The insignificant differences in the particulate matters so observed might be attributed to the open shops/spaces types of shops used by these artisans which allows for fast ventilation and dispersal of the particulates. Dispersal reduces the concentration of pollutants in the air (Samson, 1988; Cichowicz *et al*, 2017).

Petrol, other petroleum-based products as well as combustion of sulphur-containing compounds are major sources of SO₂ (Australian Government Department of the Environment and Energy, 2005). Inhalation of SO₂ is known to impair lung function. SO₂ is readily absorbed in the respiratory system because of its high solubility in aqueous media and is converted to sulphuric and sulphurous acids. The decomposition of these acids yield their bi-sulphite and sulphide radicals which are implicated in inflammatory, epithelial damage and hyperplasia in the lungs (Wigenstam *et al*, 2016; World Health Organization Regional Office for Europe, 2006). Nitrogen dioxide is a major air pollutant (United States Environmental Protection Agency, 2016) and is used as inhibitor for acrylates used in the manufacture of spray paints. The difference in concentration of gases observed in both groups of auto repair shops was therefore the result of their emission from fuel combustion and aerosols from spray paints. Inhalation of these gases is known to impact negatively on lung function (United States Environmental Protection Agency, 2016). NO₂ is a toxic free radical gas which on inhalation initiates oxidative damage to the alveolar epithelium and causing denudation followed by proliferation and airway remodeling including fibrosis (Persinger *et al*, 2002). The oxidative damage also results in a decrease in surfactant production (Muller *et al*, 2001) which affects pulmonary function.

Percentage oxygen saturation denotes the percentage of bound oxygen to hemoglobin (Ganong, 2011). At a percentage less than 90%, hypoxia results. Adequate oxygen is supposed to be bound to hemoglobin so that the oxygen can be delivered adequately to tissues for tissue metabolism. Lower percentage oxygen saturation in the two groups of auto mechanics compared with control but which was not significantly different between the two groups of auto mechanics. A decrease in the percentage oxygen saturation can be the result of anemia and chronic

obstructive airway diseases like asthma. It can also be caused by restrictive airway diseases like pulmonary fibrosis from particulate matter or carbon monoxide toxicity (Weaver, 2009) as well as scarring (Guyton and Hall, 2011) and carbon monoxide poisoning. Exposure to exhaust fumes, petrochemical products and spray paint constituents is known to cause varying degrees of obstructive or restrictive lung diseases which may affect the percentage oxygen saturation (Australian Government Department of Environment and Energy, 2005, Bascon 2008, Lewtas, 2007). Another possible explanation for the lower percentage oxygen saturation in the two groups of auto mechanics could be the effects of inhaled carbon monoxide from exhaust fumes. Carbon monoxide has 200 times more affinity with hemoglobin than oxygen (Sembulingam and Sembulingam, 2013). It therefore displaces oxygen from hemoglobin and binds with it to form carboxyhemoglobin, a more stable complex. The percentage oxygen saturation therefore falls (Topakoglu *et al*, 2014).

Contrary to previous reports (Krishna and George, 2017, Mehta *et al*, 2017, Akintunde *et al.*, 2018), our findings did not show any significant differences between lung function indices and length of time in occupation among auto mechanics. The probable explanation could be the types of shops (open spaces/shops) where the repairs take place. Open spaces or shops are well ventilated and as a result, pollutants from the vehicles or spraying guns are quickly dispersed. Dispersion of pollutants in air reduces their concentration (Sampson, 1998; Cichowicz *et al*, 2017)) and so reducing pollutant doses (Manisalidis *et al*, 2020). This might have reduced the pulmonary effect of long term exposure to these pollutants.

In conclusion, auto mechanics in stand-alone auto repair shops and those whose shops are located within the vicinity of spray-painting shops have similar impairment in lung function as demonstrated by reductions in FEV₁, FEV₁%, FVC and PEFr compared with control. These parameters were not significantly different in the two groups of auto mechanics. Auto mechanics in stand-alone auto repair shops have a much-reduced percentage oxygen saturation than those in shops shared with spray painters.

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