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ORIGINAL RESEARCH

Lung functions abnormalities among auto mechanics in Ogbomoso, Nigeria: Clinical correlates and determinants

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Abstract

Background: Auto mechanics are exposed to various organic, inorganic and particulate matters as a result of their occupation. Determining the association between environmental pollutant and risk of lung function abnormalities among auto mechanics is important to prevent long-term morbidity and mortality. ***Objective:*** To describe lung function abnormalities and their determinants among auto mechanics in Ogbomoso, Nigeria.
Methods: One hundred and three auto mechanics were randomly selected from Ogbomoso, Nigeria. Their clinical and demographic data were obtained using a data form. Spirometry was performed using the CONTEC handheld Spirometer. The personal best values of three measurements FEV_1, FVC and PEFR were determined. Lung function abnormalities were described according to standardized criteria.
Results: The mean (SD) age of the participants was 38.5 (11.9) years. The mean systolic blood pressure, mean diastolic pressure and mean duration of the job as auto mechanics were 128.7 (17.9) mmHg, 81.2 (11.4) mmHg and 20.2 (12.5) years respectively. Restrictive, obstructive and mixed lung function abnormalities were demonstrated among 53%, 10% and 2% respectively. The mean values of FEV_1 and FVC reduced significantly with increasing job duration.
Conclusion: Lung function abnormalities occurred frequently among auto mechanics in Ogbomoso, Nigeria. There seemed to be a progressive decline in lung functions with age and duration of exposure to organic and inorganic pollutants by auto mechanics. Strict environmental and occupational safety measures may limit the hazards associated with poor air quality and other chemical/physical hazards among auto mechanics in Nigeria.

Keywords: Airflow limitations, Auto mechanics, Lung functions abnormalities, Occupational hazards, Nigeria

Introduction

Many occupations are associated with significant hazards affecting the quality of life and optimal health. Auto mechanics have significant risks of inhalational injury from fine and particulate matters, gasoline and petroleum products and other hydrocarbons. [1] Some authors have shown that engagement in auto mechanic works and other jobs such as building, with a significant risk of inhalational injury, is associated with a year on year progressive decline in lung functions even in the absence of lung functions abnormalities prior to such

contact. [1,2] Others have shown this to be attenuated among young adults. [3] Previous history of atopy, smoking and increasing age, among other factors have been shown to exacerbate the injury incurred from chronic exposure to organic dust or inhalational agents. [4,5]

Reduction in Forced Expiratory Volume in 1 second (FEV1) and other spirometric parameters, especially obstructive pattern of lung functions abnormalities, have been associated with increased incidence of atrial fibrillation and other cardiovascular diseases. [6,7] Work-related chronic obstructive pulmonary disease (COPD) has been described as related to several occupations with long-term exposure to particulate matters, gases, fumes and dust. Exposure to organic and inorganic dust can also be related to the development of work-related COPD even among non-smokers. [8,9] Other co-morbid factors which are associated with progressive decline in lung functions among workers with chronic exposure to inhalational materials include increased risk of ischaemic heart diseases and higher morbidity and mortality for infectious pneumonia. [10,11]

Roadside auto mechanics abound on major streets of Nigeria and are involved in the repair, servicing and maintenance of automobiles, most of which are at different stages of mechanical dysfunction. With poor environmental impact control of the organic and inorganic inhalational and physical hazards associated with the job, few authors have shown significant risks among Nigerian auto mechanics. [12,13] Among Nigerians living in Ibadan, a negative correlation was shown between FEV_1 and air pollution index by particulate matters (PM10). [14]

The formation of carboxyhaemoglobin, consequent upon many inhalational injuries, impairs the transport of oxygen. The consequent effects include chronic hypoxia and increased risk of inflammatory changes, atherosclerotic cardiovascular disease, neurological deficits and increased risk of mortality from cardiovascular diseases. Short-term acute effects of some of the pollutants include obstructive airway pattern changes, the decline in pulmonary functions, airway inflammation and mortality. [15]

Data on the pulmonary functions abnormalities among auto mechanics are scarce in Nigeria. This study was aimed at describing the lung functions and their abnormalities among auto mechanics in Ogbomoso, Nigeria. It also aimed at describing the various pattern of spirometric abnormalities found among them and their clinical or demographic correlates.

Methods

This was a cross-sectional study carried out between August and December 2016. One hundred and three auto mechanics were selected by stratified random sampling technique among all the auto mechanics in Ogbomoso, South-west Nigeria. They were invited to participate in the study after due explanation and informed consent was taken. Their clinical and demographic data were obtained using a data form. The information obtained included the age, duration on the job, marital status, highest level of education, history of intake of alcohol and cigarette smoking, history of hypertension or diabetes mellitus and family history of hypertension, diabetes mellitus or sudden death in the participant's family. Those who had used alcohol or cigarette in the past or are still using it were classified as using alcohol or cigarette.

Clinical parameters

The body weight of each participant was recorded using a standard digital weighing scale to the nearest 0.1kg. The height was also obtained using a standard non-expandable linear foldable metal scale with each subject

standing on a flat surface. Waist circumference was obtained as the maximal diameter the midpoint between the lowermost rib and the anterior superior iliac spine during mid-expiration. Body Mass Index (BMI) was obtained using standard formula [weight (kg)/height (m)^2] and obesity was classified into overweight (BMI 25-29.9 kg/m^2), mild obesity (BMI 30-34.9 kg/m^2) moderate obesity (BMI 35-39.9 kg/m^2) and severe obesity (BMI >40kg/m^2). [16]

Blood pressure was obtained according to standardized international guidelines. [17] An average of three measurements was obtained with intervals of at least three minutes between the measurements. Hypertension was defined as systolic blood pressure > 140 mmHg and/or diastolic blood pressure > 90 mmHg and/or the current use of antihypertensive medications. [17] Full general physical examination and systemic examination were performed for all participants.

Laboratory investigations

All the participants had some relevant investigations done for them. These included random blood sugar done using the glucose oxidase method, fasting lipid profile done using the colourimetric analysis and Randox® (United Kingdom) Kits. The total cholesterol, triglycerides, high-density lipoprotein (HDL-cholesterol), low-density lipoprotein (LDL-cholesterol) were measured. Lipid abnormalities were defined according to the National Cholesterol Education Program Adult Treatment Panel III. [18] Other investigations carried out as indicated included packed cell volume and urinalysis.

Spirometry and Lung Functions

The portable CONTEC® Spirometer was used for all the participants. Each participant was made to sit comfortably while the procedure was performed by a pulmonologist with satisfactory spirometry skills. Spirometric manoeuvres were adequately described and demonstrated for the participants. Three satisfactory measurements of Forced Expiratory Volume in 1 second (FEV_1), Forced Vital Capacity (FVC) and Peak Expiratory Flow Rate (PEFR) were recorded. The personal best values were used to obtain the FEV_1/FVC ratio. The spirometer estimated the fraction of the measurements relative to expected values based on age, gender, height, weight and previous history of smoking, which were initially imputed into the spirometer before the performance of the lung functions tests. This was used to derive the fractions of the readings to expected values.

Normal spirometry values were defined as FEV_1, FVC and FEV_1/FVC >79.9%. Obstructive lung function was defined by FEV_1<80%, FVC >79.9% and FEV_1/FVC <70%. Restrictive lung function was defined by FEV_1<80%, FVC <80% and FEV_1/FVC >70%. A mixed pattern of lung functions was defined by FVC <80% and FEV_1/FVC <70%. These definitions were as provided in the American Thoracic Society Guidelines. [19]

Statistical analysis

Statistical analysis was done using the Statistical Package for Social Sciences (SPSS) Version 18.0, Chicago, Ill, USA). Data were summarized as frequencies and percentages for qualitative variables and means (standard deviations) for quantitative variables. Student's t-test was used to compare differences in mean values of groups while Chi-Square was used to compare proportions of variables. P-values less than 0.05 were taken as statistically significant.

Ethical considerations

Institutional ethical approval was obtained from the Research Ethics Committee of the Ladoke Akintola University of Technology Teaching Hospital, Ogbomoso, Nigeria. All the participants gave written informed consent before participating in the study. The subjects identified with clinical cardiovascular or

systemic diseases were appropriately facilitated for prompt referral and treatment at the relevant specialist clinic.

Results

One hundred and three randomly selected auto mechanics formed the study population. All of them were males. Their mean age was 35.8 (11.9) years. The study participants have been engaged in the automobile repair and maintenance job for a mean duration of 20.2 (12.5) years with a range of 0.2-56 years. The mean BMI, waist circumference, pulse rate and serum glucose were 23.1 (4.0) kg/m^2, 83.1 (11.5) cm, 79.9 (11.7) beats/min and 5.0 (1.4) mmol/l respectively. Average systolic and diastolic blood pressures were 128.7 (17.8) mmHg and 81.1 (11.3) mmHg respectively. Most of them had secondary school education as their highest level of education and were married. Hypertension had earlier been diagnosed among 11.7% of the participants and they were receiving care from clinics and hospitals. Smoking and alcohol intake were documented in 9.7% and 51.5% respectively. This is shown in Table I.

Table I: Mean values of some demographic and some laboratory parameters of study participants

Variables	Mean (S.D)	Range
Age (years)	38.54 (11.94)	18-79
Duration of job (years)	20.2 (12.51)	0.2-56
BMI (kg/m^2)	23.1 (4.09)	15.5-38.58
Waist circumference (cm)	83.1 (11.51)	63-120
Pulse (/min)	79.93 (11.75)	50-114
Glucose (mmol/l)	5.07 (1.40)	2.7-9.3
Total cholesterol (mmol/l)	4.22 (1.11)	2.1-6.6
TG (mmol/l)	1.11 (0.57)	0.1-3.2
HDL(mmol/l)	1.17 (0.47)	0.5-2.4
LDL(mmol/l)	2.54 (1.04)	0.6-4.9
Average SBP (mmHg)	128.7 (17.87)	96-196
Average DBP (mmHg)	81.19 (11.37)	61-111
Married [n (%)]	80 (77.7%)	
Highest level of education not more than secondary school [n (%)]	98 (95.1%)	
Previous hypertension [n (%)]	12 (11.7%)	
Alcohol intake [n (%)]	53 (51.5%)	
Cigarette [n (%)]	10 (9.7%)	

BMI-body mass index, TG- Triglyceride, HDL-high density lipoprotein, LDL-low density lipoprotein, SBP-systolic blood pressure, DBP-diastolic blood pressure, S.D-standard deviation.

Spirometry data are shown in Table II. Three readings were taken for the FEV_1, FVC and PEFR and the mean FEV_1, FVC and PEFR are as recorded in Table II. There was a consistent but slight improvement in these values from the first to the third measurement without statistical significance. The mean values of FEV_1, FVC and PEFR were all less than 80% of expected values and demonstrated significant impairment despite the relatively young age of the study participants. The mean FEV_1 and FVC (personal best values) were 2.80 ± 0.62L/minute and 3.19 ± 0.70 L/minute respectively while the mean FEV_1/FVC ratio was 88± 7%.

The frequency of occurrence of various lung functions abnormalities as defined by the American Thoracic Society/European Thoracic Society guideline showed That restrictive impairment was the commonest demonstrated abnormality and was observed among 55 (53.4%) of study participants. Obstructive spirometric abnormalities were demonstrated among 10 (9.7%) while the mixed pattern was recorded among 2(1.7%) of study participants. Thirty-six (35.0%) participants had normal lung functions.

Table II: Mean values of spirometry and lung functions parameters among study participants

Parameters	Mean (SD)	Range
FEV1B (l) [%]	2.62 (0.68) [70.05 (16.29)]	0.66-4.77(24-109)
FVC A (l) [%]	2.84 (0.83) [63.51 (17.26)]	0.43-4.53(12-110)
FVC C (l) [%]	3.04 (0.72) [68.0 (14.92)]	0.83-4.54(24-109)
PEFR B (l) [%]	6.08 (2.19) [69.61 (25.04)]	1.15-11.38(15-160)
FEV1 PB(l)	2.80 (0.62) [68.8 (20.2)]	0.84-4.77
FEV1/FVC	0.88 (0.07) [70.6 (15.4]]	0.66-100

FEV1- Forced expiratory volume in the 1st second. FVC-First vital capacity., PEFR- Peak expiratory flow rate, S.D- standard deviation, PB-personal best of values, A,B,C- 1st, 2nd and 3rd readings.

Table III showed the frequency of occurrence of some cardiovascular risk factors among the study participants based on the duration of exposure to their job hazards. Visceral obesity was more predominant as the duration increased up to about 34 years on the job. However, it reduced among participants who had been involved with the job for >35 years. There was no demonstrable relationship between the frequency of occurrence of hypertension, elevated LDL, generalized obesity, low HDL cholesterol, hypercholesterolaemia and job duration as shown in Table III. The table also shows that the mixed pattern of lung functions abnormalities tended to occur among the very elderly while obstructive and restrictive impairment occurred among younger participants.

Demographic and laboratory parameters were contrasted between study participants with various lung functions abnormalities as shown in Table IV. Age was the only factor associated with the occurrence of lung functions abnormalities; the restrictive or obstructive pattern was associated with the younger age group while the mixed pattern was associated with old age. The mean BMI, waist circumference, pulse rate, serum total cholesterol, serum glucose, systolic and diastolic blood pressures were not significantly different between the four groups.

Table V shows the progressive decline in some spirometric readings among study participants with increasing job duration. The mean FEV_1 (personal best values) was significantly reduced from 3.01(0.38) L/minute among participants who have worked for <5 years compared to 2.15 L/minute among those who have worked for >35 years. Similarly, FVC was also significantly reduced from participants with <5years of job exposure to those with > 35years of exposure

[3.36 (0.46) L/minute vs. 2.50 (0.66) L/minute; p = 0.011 respectively).

Table III: Metabolic profile and pattern of lung functions abnormalities among study participants

Variables	<5 years	5-14 years	15-25	26-34	>35 years	P values
N	19	19	34	21	10	
Visceral obesity (n)	0 (0.0)	0 (0.0)	7 (20.6)	6 (28.6)	1 (10.0)	0.021*
Hypertension (n)	2 (10.5)	1 (5.3)	12 (35.3)	7 (33.3)	3 (30.0)	0.178
High LDL (n)	3 (15.8)	6 (31.6)	9 (26.5)	9 (42.9)	3 (30.0)	0.444
Generalized Obesity (n)	0 (0.0)	0 (0.0)	3 (8.8)	3 (14.3)	0 (0.0)	0.050
Low HDL (n)	7 (36.8)	9 (47.4)	14 (41.2)	13 (61.9)	4 (40.0)	0.516
High TC (n)	5 (26.3)	6 (31.6)	8 (23.5)	6 (28.6)	2 (20.0)	0.995
	Pattern of lung functions abnormalities on spirometry					
Mixed	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (20.0)	0.009*
Normal	4 (21.1)	5 (26.3)	15 (44.1)	8 (38.1)	4 (40.0)	
Restrictive	11 (57.9)	13 (68.4)	17 (50.0)	11 (52.4)	3 (30.0)	
obstructive	4 (21.1)	1 (5.3)	2 (5.9)	2 (9.5)	1 (10.0)	

***Statistically significant**
p-value obtained by Chi-Square test.
LDL-low density lipoprotein, HDL-high density lipoprotein, TC-Total cholesterol.

Table IV: Demographic and clinical parameters across various lung functions abnormalities

Variables	Normal (36)	Restrictive(55)	Obstructive (10)	Mixed (2)	P values
Age(years)	40.83 (11.00)	36.80 (11.49)	35.90 (4.39)	58.50 (9.2)	0.033*
BMI (kg/m^2)	24.20 (4.05)	22.66 (4.2)	21.44 (3.29)	23.75 (0.21)	0.175
Waist circumference(cm)	84.86 (11.19)	82.49 (12.06)	78.80 (9.94)	88.00 (2.83)	0.436
Pulse rate (/min)	78.49 (10.69)	81.62 (12.74)	76.20 (10.08)	77.5 (2.12)	0.436
Total cholesterol (mmol/l)	4.33 (1.01)	4.15 (1.21)	4.18 (0.98)	4.15 (1.48)	0.910
SBP (mmHg)	129.7 (18.95)	128.8 (17.2)	126.4 (20.10)	120.5 (17.0)	0.876
DBP (mmHg)	80.5 (11.09)	82.62 (11.26)	77.8 (13.1)	70.8 (4.60)	0.315
Glucose (mmol/l)	5.30 (1.21)	4.99 (1.57)	4.60 (1.0)	5.35 (1.06)	0.510

***-Statistically significant**
SBP-systolic blood pressure, DBP-diastolic blood pressure, BMI-body mass index.

However, changes in the PEFR did not achieve statistical significance even though there was also a tendency towards a reduction as the number of years of work as auto mechanics increased.

Discussion

Auto mechanics in Nigeria are obviously exposed to a varying grade of air pollutants, hydrocarbons and particulate matters as occupational hazards. The long-term health effect of engaging in such a job has not been clearly studied in developing countries like Nigeria where regulation about occupational safety and air pollution control are very ineffective and even absent in most situations.

Table V: Mean (SD) spirometric parameters based on the duration of exposure

Parameters	< 5 years	65-14 years	15-24 years	25-34 years	>35 years	P value
FEV1A (l)	2.73 (0.42)	2.52 (0.84)	2.48 (0.79)	2.42 (0.59)	1.98 (0.72)	0.047*
FEV1B (l)	2.85 (0.34)	2.75 (0.72)	2.70 (0.72)	2.53 (0.64)	1.99 (0.69)	0.014*
FEV PB (l)	3.01 (0.38)	2.96 (0.58)	2.84 (0.67)	2.71 (0.56)	2.15 (0.64)	0.003*
FVC A (l)	3.05 (0.47)	2.92 (0.99)	2.92 (0.92)	2.72 (0.71)	2.27 (0.76)	0.438
FVC B (l)	3.10 (0.39)	3.09 (0.79)	3.06 (0.82)	2.87 (0.74)	2.26 (0.82)	0.029*
FVC PB (l)	3.36 (0.46)	3.36 (0.66)	3.26 (0.76)	3.12 (0.67)	2.50 (0.66)	0.011*
PEFR A (l)	6.21 (1.60)	4.38 (6.2)	6.2 (1.97)	5.45 (2.31)	5.11 (2.18)	0.516
PEFR B(l)	6.53 (1.45)	5.57 (2.23)	6.63 (2.28)	5.92 (2.36)	4.67 (2.10)	0.084

***- statistically significant**

FEV1- Forced expiratory volume in the 1st second. FVC-First vital capacity., PEFR- Peak expiratory flow rate, PB-personal best of values, A, B, C- 1st, 2nd and 3rd readings.

This study showed that auto mechanics who have been exposed over a long time developed remarkable lung functions abnormalities. Restrictive lung function abnormalities were observed to be the commonest among the participants in this study, followed by obstructive airflow limitation pattern and then lastly, a mixed pattern of lung functions abnormalities. Only about 35% of the study participants had normal lung functions on spirometry. The type of abnormality detected was also age-related as mixed patterns were detected among the elderly compared to restrictive and obstructive patterns among middle-aged individuals. The mechanism for the progressive lung functions abnormalities may be related to the chronic inhalational injury which precipitated hypoxic injury to the alveoli, atherosclerosis, increased fibrosis, inflammation and ischaemic changes. [11-14] While short-term changes can induce airflow limitation with the obstructive pattern on spirometry, progressive lung damage and oxygen transport impairment may induce a restrictive and mixed pattern of abnormalities as it was found in this study. [14,15]

Lung functions abnormalities have been demonstrated in many occupations in Africa. [20-22] The frequency of airway limitation or obstructive pattern shown in this study is far higher than that previously shown among saw millers in Ibadan, Nigeria. Only 4.1% of the participants had an obstructive pattern on spirometry as against 9.7% reported in the present study. [20] The present study also suggested that there may be a progressive decline in lung functions with age and duration of exposure to possibly organic and inorganic materials which abound in the automobile mechanic workshop. The longer duration of exposure and the fact that gasoline, hydrocarbons and particulate matters associated with auto mechanic job may be more deleterious than the occupational hazards of sawmilling. This is, however, less than the frequency reported among bakery workers in Ibadan, where 23.2% were shown to have some degree of airway obstruction. [21] Workers exposed to wood dust were shown to have restrictive pattern ventilatory functions impairment in a study from Calabar. [22]

The work environment portends a bad picture of environmental control where organic and inorganic materials are constantly being flared without any control. The massive exposure to the toxic materials may predispose auto mechanics to increased oxidation and inflammatory reactions which are the underlying factors in many cardiovascular and

chronic respiratory diseases. [17,19] Similarly, other researchers from across the world have shown that long-term employment in the automobile industry especially in auto repairs may be associated with lung functions impairment. [23,24]

In a study on pulmonary functions abnormalities associated with exposure to automobile exhaust in India, restrictive, obstructive and mixed patterns of ventilatory functions impairment were demonstrated among 28.4%, 1.7% and 2.9% of the participants. Similar to the present study, the restrictive pattern was the commonest abnormality reported in the Indian study. [25] In agreement with the present study, the Indian subjects also showed a gradual impairment of lung functions with increasing age and duration of exposure.

Forced Expiratory Volume in the first second (FEV_1) progressively reduced with increasing duration of job which is an indirect measure of exposure to occupational hazards among auto mechanics. This is also similar, although at a lesser extent, to the pattern of Forced Vital Capacity (FVC) and both were statistically significant. However, the Peak Flow Rate (PEFR) decline did not achieve statistical significance. The disparity in progressive decline may be related to varying impact of several occupational hazards on auto mechanics in Nigeria. Handheld spirometers are now available and have made the performance of spirometry easier but there have doubts about the reproducibility of their measurements. Automated spirometry has been shown to be better correlated with patient's functional status than manual vitalographs which has limitations of reproducibility and difficulty of the procedure. Hand-held spirometers are easy to use, inexpensive and ultraportable in the diagnosis of lung functions abnormalities in health and disease states. The present study also showed that there was no relationship between spirometric abnormalities and cardiovascular risk factors. This may be indirectly interpreted as lack of evidence for the additional impact of smoking since smoking could have led to cardiovascular risk factors 'burden among the participants.

Chronic respiratory diseases are the fourth commonest cause of death due to non-communicable diseases. Despite this high burden, there are few reports from sub-Saharan Africa on its morbidity and mortality pattern. [26] Abnormal spirometry was standardized for age, gender, smoking status, race, weight and height in order to arrive at the expected spirometer measurements. Spirometric abnormalities have been associated with increased morbidity and mortality even in the absence of respiratory symptoms and a diagnosis of respiratory disease. [27,28]

The American Thoracic Society/European Thoracic Society suggest that regular spirometry should be part of the comprehensive workplace respiratory health program for early detection of lung functions impairment and prevention of associated morbidity and mortality associated with chronic respiratory diseases. [29] This is particularly more important in occupations such as automobile engineering with significant exposure to exhaust fumes, fuels such as diesel, petrol, as well as fine and coarse particulate matters which can precipitate impairment of respiratory functions in affected individuals. It is, therefore, a wake- up call to formulate policies to limit exposure to occupational hazards among auto mechanics in Nigeria so as to reduce the burden of chronic respiratory diseases among them in the future.

A limitation of this study is the fact that smoking among the study participants could be a major confounder for the findings. It was difficult to isolate the effect of smoking among those with previous or current exposure to cigarette. Although the frequency of smoking

was rather low, it would still have yielded stronger evidence if the impact of smoking was rather removed. Another limitation lies in the interpretation of lung functions measurements where upper/lower limits of normal were used instead of a fixed ratio.

Conclusion

Auto mechanics in Nigeria are at significant risk of impairment of lung functions, most probably as a result of the interface between occupational exposure to inhalational and chemical hazards of the job. They are also at increased risk of developing chronic respiratory diseases over time. Appropriate workplace protective strategies with environmental control may reduce the impact on lung functions among these skilled labourers.

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